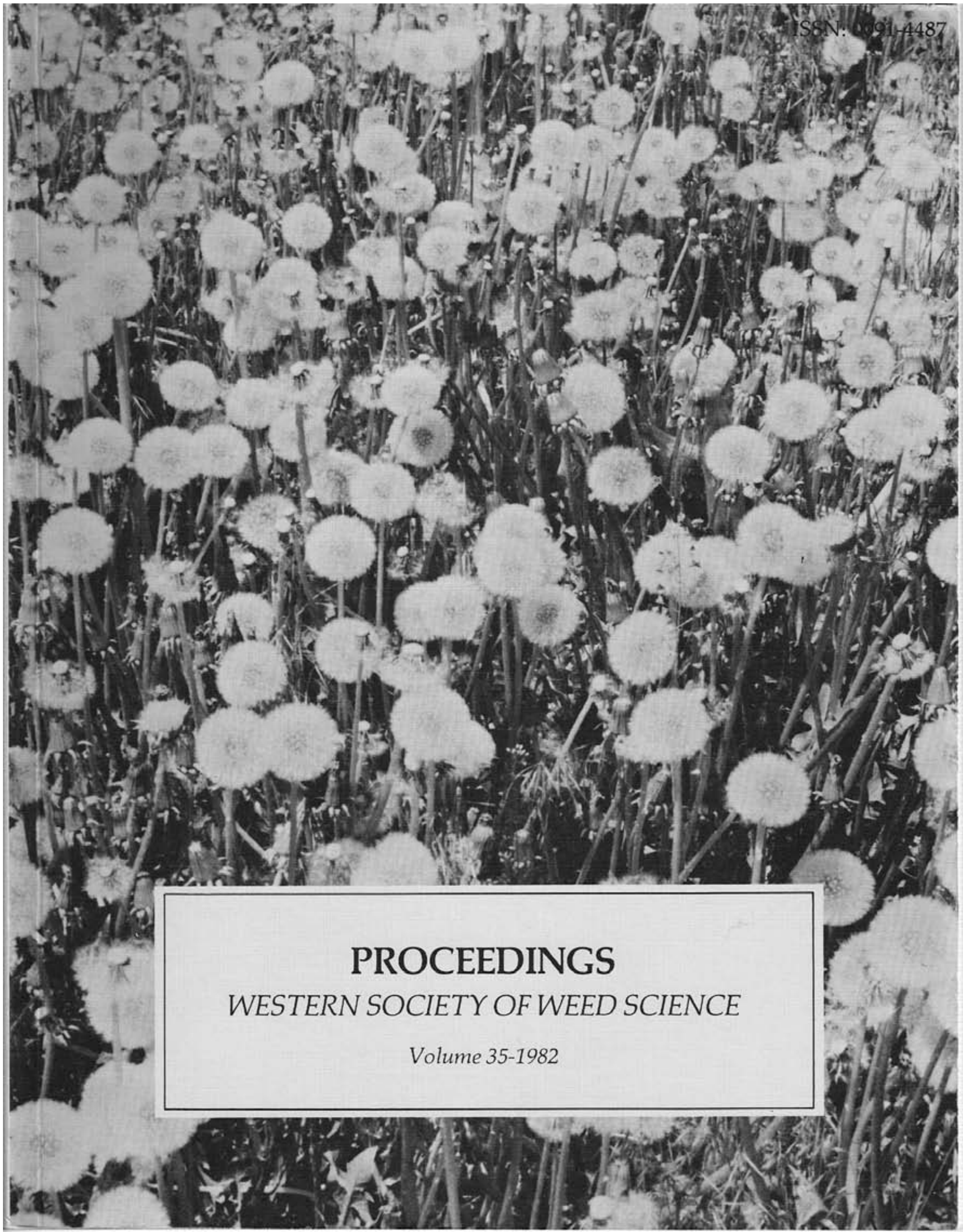
ISSN: 0091-4487



PROCEEDINGS

WESTERN SOCIETY OF WEED SCIENCE

Volume 35-1982

1982

PROCEEDINGS

OF

THE WESTERN SOCIETY OF WEED SCIENCE

VOLUME 35

PAPERS PRESENTED AT THE ANNUAL MEETING

MARCH 9. 10. 11, 1982

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DENVER, COLORADO

PROGRAM AND TABLE OF CONTENTS

Research Section II (Agronomic Crops)

PRESIDENTIAL ADDRESS

Alex G. Ogg, Jr.[1]

Welcome to the 35th meeting of the Western Society of Weed Science! The Western Society of Weed Science, the oldest of the regional Weed Science societies in the United States, held its first conference in 1938 here in Denver. Since that early beginning we have grown and flourished until we now have over 400 members.

This year our Program Committee of Wayne Whitworth, Stan Heathman, and Pete Fay have developed what promises to be an excellent program. One of the unique features of our Conference is the informal discussion periods in the Project meetings. I would like to encourage each of you to attend the Project meetings and participate in the discussion. It is the mutual sharing of ideas that leads to a greater understanding of our science.

One of the most demanding jobs of any conference is that of local arrangements. Harvey Tripple, our Local Arrangements Chairman, has worked hard to see that this year's Conference runs smoothly. Harvey, to you and all of the individuals working with you, thank you!

Members of WSWS, during the course of the meeting, I hope you will express your appreciation to the various individuals responsible for this year's Conference. Also, if you have suggestions for improvement or ideas for next year's meeting, please pass them along to members of the Executive Committee. I am sure Garry Massey, Program Chairman for 1983, would appreciate your ideas.

As your President, I would like to take this opportunity to discuss several items concerning the affairs of our Society. In this year's election we had a tie for the position of President-Elect. The Nominations Committee did an excellent job of selecting two qualified candidates. The tie was settled by a flip of a coin as outlined in our Constitution. The disturbing fact of this tie vote is that only 140 ballots were returned from over 400 mailed out. This year's election clearly shows how important each vote can be. Next year I hope all of you will take those few minutes required to cast your vote for the election of our officers.

I was very pleased with the response I received on the request for volunteers for committee work. I will turn the responses over to Wayne Whitworth, next year's President. Wayne will be making committee assignments this spring, and I'm sure you will be hearing from him.

I received several letters and telephone calls from persons who had attended WSWS meetings prior to 1981 and did not receive mailings for this year's meeting. When you attend the annual meeting, your dues to WSWS are included in the registration fee. However, if you do not attend the annual meeting, you dues of $5.00 must be paid before you will receive the mailings. The dues cover such items as postage, stationery, printing of newsletters and programs, and the $1.00 per member dues that WSWS pays to CAST. If you cannot attend the annual meeting, you will receive one reminder to pay your dues so you can receive the coming year's announcements. Also, LaMar Anderson, our Treasurer-Business Manager, requests that you advise him if you change your address. This will assure you of receiving information on Society affairs.

Inside the back cover of your program is a list of the WSWS Fellows and Honorary Members. The Fellows and Honorary Members Committee

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[1]USDA-SEA/AR. Prosser, WA.

consisting of Larry Burrill, Dick Comes, and Jack Warren would appreciate receiving nominations for individuals to receive these honors. To be elected a Fellow of WSWS, the person must be an active member of WSWS who has given meritorious service to weed science. Honorary Members are persons from outside the Society who have significantly contributed to the field of weed science. Both Fellows and Honorary Members are elected by a two-thirds majority vote of the Executive Committee. Please nominate individuals you feel are worthy of this honor.

The North Central Weed Control Conference and the Southern Weed Science Society sponsor a Graduate Student Paper Contest at their annual meeting and Weed Science Contest in the summer. We have established a committee to investigate the possibility of WSWS sponsoring similar events. John Gallagher, President of the Southern Weed Science Society, is attending our meeting. I hope you will take a few minutes to talk to John about their Weed Science Contest in SWSS and then express your opinion on both the Weed Science and the Graduate Student Paper Contests to our committee of Bob Zimdahl, Larry Morrow, Pete Fay, and Lowell Jordan or any member of the Executive Committee.

Our Business Meeting is scheduled for Thursday morning from 8:00 to 9:30 a.m. in this room. I would like to encourage you to attend and participate in the business of our Society. We need your input.

I would like to digress from Society affairs to pose some questions to you. How many opportunities will you have to make a really significant contribution to agriculture? If your career spans 35 years, then each of those 35 years you will have the opportunity to adjust your objectives to get the maximum productivity. Think of it; 35 chances to really accomplish something significant. Doesn't seem like very many opportunities for a lifetime of work. Therefore, it is very important that each of us critically review our progress each year, weigh that progress against our objectives, and carefully plan for the coming year. Will your work bnenfit only you and those nearest you, or are you making contributions that will continue to help society after you are gone?

I believe that all who work in agriculture have been given the responsibility to see that an adequate food supply will be available in the future. The people of the future, grandsons and granddaughters, some not yet born, are depending on us for a plantiful, wholesome supply of food. We are few compared to those who will be dependent upon us; therefore, when you plan your program for the coming year, consider also those people of the future. Make the most of your 35 opportunities.

In closing I would like to take this opportunity to express my appreciation to the members of the Executive Committee, Standing and Adhoc Committees, and to all of the other individuals who have served the Society when I requested help. It makes the job of President an easy and pleasant task. One of the rewards of participating in the operation of our Society is the development of long-lasting friendships, and I fell I have made many friends. Thank you!

WEED CONTROL APPLIED RESEARCH, WHO WILL DO IT IN THE FUTURE?

Eduation & Regulatory Section Symposium
Stan E. Heathman[1], Moderator

WEED CONTROL APPLIED RESEARCH, WHO WILL DO IT IN THE FUTURE?

R. P. Upchurch[2]

It is a pleasure as one of four panel members to address the Western Society of Weed Science on the subject of applied weed control research. Although my current responsibilities do not permit daily involvement with weed research, it is a subject of great personal interest. The question as to who will do the applied weed research in the future is an important one and I have strong convictions on the subject which will be conveyed in a rather direct manner.

To keep matters in perspective it will be well to have in mind some definition of the term "applied weed research." A suitable definition for our purpose might be that applied weed research is the development of practices to allow and enhance effective utilization of land and water resources and to protect these resources from the ravages of weeds in future generations.

In the short time available I would like to comment on the actual or potential applied weed research role of four agencies. They are: Industry, the U.S. Department of Agriculture (USDA), the Universities, and State Departments of Agriculture.

Industry, and particularly the Agricultural Chemical Industry, will continue to perform a significant amount of applied weed research at the national, regional, and state level. It is extremely important that we realize the very great value of what Industry will do in the area of applied research, but it is also very important to understand what Industry will not do. Industry will work on the application of expertise and products to major weed problems where there is a good profit potential for stockholders. Such contributions have been of great utility in the past and they may be expected to continue in the future. There are many problems in applied research in a given state which Industry will not address because their resources can be put to work more profitably elsewhere. There will even be many cases in which Industry will not adapt its own products to local needs because it is not profitable for them to do so. Someone else must do this work if it is to get done. It may be concluded that the best job will be done in applied weed research if there is a good balance between Industry and non-industry efforts. The public agencies have a high level of public creditability and they can insure that the unblemished facts about any given product or practice are brought to light. This is in the best interest of the public and Industry.

In the USDA the Agricultural Research Service (ARS) has the official "in-house" responsibility for conducting research. ARS has a wonderful opportunity to do basic and long range weed research and to bring a national focus to applied research. It is my strong personal opinion that ARS has been severely handicapped in providing this badly needed national

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[1]University of Arizona, Tucson, AZ

[2]Associate Director, Arizona Agricultural Experiment Station and Director of Development, College of Agriculture, University of Arizona, Tucson, AZ

focus for the past decade because of the decentralization of the agency in 1972. I believe that ARS involvement in applied weed research continues to decrease although it remains of significant consequence. There is much opportunity for increased coordination/cooperation among State, Federal, and Industrial applied weed research programs. ARS could and should assist in fulfilling this need.

The Universities, and especially the Land-Grant Colleges of Agriculture, have a special role to fill in applied weed control research. In discussing these entities I purposefully elect to avoid dealing with them on the basis of the Experiment Station and Cooperative Extension Service components. Furthermore, I do not believe that Industry wishes to become involved in the petty distinctions between the two components. Our growers and others just want good work and good answers and good service from our Colleges of Agriculture. And yet, within our Colleges there seems to be great concern as to whether Extension or Experiment Station personnel should do the applied weed research. This anxiety has been heightened by reports that federal auditors frown on Extension doing applied weed research. There is a solution to this problem based on the professionals involved.

Professionals who do weed work in the Universities are well trained, imaginative and self-motivated. They know more about what needs to be done in applied weed research in their respective states than anyone else. In the case of Arizona, I know our weed scientists to be hard working and highly productive people. I trust them to make most of the decisions about what needs to be done without administrative guidance. It can be fairly argued that too much administrative attention to this process will be counterproductive. My principal conclusion is that our University professionals should get on with the job of doing what needs to be done in applied weed research regardless of their appointment to Experiment Station or Extension Service. I feel strongly that a federal auditor should have zero influence on this decision making process.

What then is the role of the University administrator? While the administrators should stay out of the way of the professionals as much as possible, it is best that the professionals and the administrators share responsibility for broad and far-reaching decisions. Administrators must have some understanding of the program in order to be as supportive as possible. Administrators do control yearly allocation of local resources, they do control reallocations among programs and they do impact on the question of requests to the legislature. Finally, it should be up to the administrators concerned to adjust sources of salary, operations and travel funds for each professional in keeping with the nature of their agreed upon activities so that the ultimate providers of the funds will be satisfied if an audit is conducted.

State Departments of Agriculture (SDA) have several important roles to play in the area of weed control. The regulatory function is properly theirs when it is decreed to be needed. I do not think it helpful for SDA to enter the field of applied weed research. However, if University professionals and administrators do not get their act together they may increasingly find that SDA personnel will appear to fill a void.

In conclusion, Industry, ARS, and the Universities should all play a role in applied weed control research. Of these, the Universities have the most flexibility to help keep the program balanced and ARS has the greatest potential to provide a national focus. In the States and University, professionals in the Extension Service and the Experiment Station should decide what needs to be done and get on with the job, irrespective of their current source of funds. These University professionals and their administrators should work together to make sure that funds are expended on proper legal and ethical grounds.

RESPONSIBILITIES FOR PRACTICAL RESEARCH

Gary A. Lee[1]

I am pleased and honored to be invited to participate in this panel discussion. The views and policies related to the mechanics of obtaining efficacious data vary widely among institutions from state to state. Therefore, my comments will deal with the general problems associated with the question of "who should be doing the practical or applied research in the future" from a departmental vantage point.

As Head of the Department of Plant and Soil Sciences at the University of Idaho, I am responsible for the programs and efforts of 60 professional scientists and 115 support personnel. Considerable emphasis has been focused on the development of total production management systems for each commodity produced in the state. Producers of these commodities continue to identify pest problems as major obstacles to efficient and profitable production of most crops.

There is extreme pressure on the limited resources of public institutions today. Special interest groups, commodity organizations and individuals continue to demand that universities be a prime resource for information. We have been quite effective in convincing producers that weed control practices are an essential part of their management program, and in turn, they request up-to-date information in reaching the decisions in selecting herbicides.

In addition, we must be responsive in helping growers reduce the impact of weeds. Unwanted species cost American agriculture over $18 billion each year. In Idaho alone, the cost is estimated to be $500 million annually. We cannot ignore factors that have an astronomical impact on the state's economy. On this basis, it is quite evident that tax support resources can be justifiably assigned to address this problem.

As a departmental administrator, I am responsible to manage change in priorities and direct resources to aid the agricultural industry in the state.

The responsibility for generating efficacy data to support the development of herbicides must be shared between private industry and public institutions. A cooperative effort is essential for several reasons and thus the basis for my remarks today.

Perhaps the most important reason for University participation is the necessity to maintain a source of information from a neutral or unbiased party. Support data generated through experiment station testing programs does nullify the perception of self interest on the part of industry. The Environmental Protection Agency and State Department of Agriculture in states rely on public institution information extensively. In many states, university faculty are asked to review and approve requests for Section 18 and 24-C's prior to the granting of the label. Without first-hand knowledge of the herbicide, these scientists would be severly restricted in

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[1]Department of Plant and Soil Sciences, University of Idaho, Moscow

their judgment of the label. In other states where cost-sharing funds are available for noxious weed control, only compounds that are approved by the university can qualify for user payment. A sound base of information is essential in these instances.

A second justification for applied research to be conducted in the University system is the need for practical knowledge to base and direct fundamental research programs. I firmly believe that research should be goal oriented. Scientists attempting to define the mode-of-action, degradation, or soil residual must have some practical knowledge of how the herbicide performs. Without some purpose for an investigation, the effort can easily lose direction. Agricultural colleges do possess both facilities and expertise to aide in generating information from a practical to basic level. The Experiment Station is a powerful resource that has an obligation to the tax payers of the state.

There is, however, a trend within public insitutions towards "Users Pay." This policy has permeated throughout the system--from research to Extension. A fee is assessed for activities from special research requests to attending Extension pet obedience classes. The agriculture chemical industry is no different and must be prepared to increase financial support for the services provided by public institutions. We need each other and should be willing to enter into a closer working mode to accomplish an essential task.

As a contribution, the universities should be willing to waive any "overhead" or "indirect" costs on grants for applied research on herbicides. Institutions may withhold 15 to 45% of the grant-in-aide leaving minimal funds for the support of intended research. The tax payers are the beneficiaries of these activities and the administrators of those institutions should recognize to whom the herbicide testing program is directed.

Without a practical reseach program actively generating information for extension specialists, county agents, and fieldmen in each state there will be ever expanding information gaps for producers. I often feel that we have insufficient information to base our recommendations or develop use guides at the present time. If the burden of generating all the efficacy data was placed back with the industry, the problem would become even more acute. Personnel in public institutions must have the opportunity to evaluate herbicides under the cultural practices and climatic conditions of their state.

I have, thus far, presented an idealistic view of the situation, but let us look at some very real practical problems facing scientists in universities today.

The Federal Extension Service has adopted a hard line on the policy for use of Smith-Lever funds. The intent of Extension funds is for the purpose of education, demonstration, and implementation of information. Applied research or creation of information does not fit within the definition or spirit of the Federal Extension Service. Extension specialists supported on federal funds will no longer be able to participate in activities construed as research. These mandates originate at the national level and must be enforced through administrative policy.

Who, then, should provide information to satisfy the requirements for a pesticide to be registered so that tax payers of the state can benefit? The question seems rather obvious. If Extension personnel cannot participate, then researchers should be responsible for the development of practical programs. This, however, is where the problem exists. All but a handful of energy-rich states are facing serious economic problems. The tax base for higher education and maintenance of current operations has eroded significantly. Many institutions have or are presently reducing the scope of their efforts by eliminating personnel and programs. Those efforts that have maintained a high degree of productivity and are capable of attracting extramural funding are most likely to survive.

How does this situation influence the activities of a researcher? The results of applied research most often do not qualify for publication in refereed journals. There is no effective way to reward the researcher for his or her efforts in developing practical information for the support of label registration needed by the industry or performance data essential for the extension specialist or agent to make intelligent recommendations. Individuals engaged in primarily applied research programs have little or no change for promotion or tenure with the University system today.

What, then, is the role of the University in developing information on a new herbicide or expanding labels for registered compounds? The land grant system was established on the premise that the Experiment Station or research portion of the College of Agriculture could and should meet the local needs of agriculture within each state. The creation of information for proper use of herbicides should be the responsibility of research scientists within each state.

I believe a solution does exist. Scientists must approach practical research responsibilities as a project manager with a minimum of direct personal involvement in the execution of the work. Proctoring the activities of well trained, qualified technical support personnel will provide the desired results necessary for meaningful evaluation of herbicides. Through supervision of the practical research by professional scientists, the quality of work can be maintained. The scientist will then have the freedom to pursue activities that will allow academic recognition.

Collective grants-in-aid from agricultural chemical companies must be sufficient to support the cost of the practical research efforts. Some states may be willing to supplement the programs, others may not have the resources. In most cases the scope of the program will be in relation to the extramural funds generated.

In order to maintain a viable evaluation and education network in the future, industry and public institutions must rededicate themselves to a mutual cooperative effort.

WHO WILL DO THE APPLIED RESEARCH IN THE FUTURE?

James V. Parochetti[1]

Overview

The Extension Service, U.S. Department of Agriculture, provides approximately 40 percent of the funds for the State Cooperative Extension Service under authority of the Smith-Lever Act of 1914. The Act sets forth Extension's function as "...diffusing amont the people of the United States useful and practical information on subjects relating to agriculture,

[1]Program Leader, Pesticides, Applicator Training & Weed Science, Extension Service, U.S. Department of Agriculture, Washington, D.C.

uses of solar energy with respect to agriculture, home economics, and to encourage the application of the same.." One of the primary methods noted in the Smith-Lever Act to accomplish this objective is through "...giving of instruction and practical demonstrations...(and) publications...." The Smith-Lever Act as currently interpreted does not allow Extension specialists funded completely by federal funds and/or matching State funds to conduct research. Such specialists can, however, adapt research to local conditions by "...practical demonstration..." work which can be replicated and, if adequately documented, published.

Many State Cooperative Extension Services offer joint appointments most often with the State Agricultural Experiment Stations. These joint positions offer the possibility of research beyond the demonstration and adaptive stage of development. This paper contains data regarding full time equivalents and numbers of individuals involved in plant disciplines in Extension in the United States for 1980-1981, statistics on the sale of pesticides by category for 1980, and a discussion of the role of Extension specialists with regard to weed science.

Discussion

There is a need to continue a strong research, teaching, and Extension activity in weed science in the future. Evidence for this is easily documented when one looks at the current losses due to weeds and the farmers' expenditures to control weeds. In the United States, weeds cause, conservatively, a ten percent crop loss equalling $18 billion annually. Weed control costs are estimated at $7.0 billion annually; that is partitioned into $3.1 billion spent for herbicides and the remaining $3.9 billion for non-chemical weed control such as tillage. Herbicide usage is more than double for all other pesticides used in 1980 (Table 1).

Table 1. U.S. sales of pesticides for 1980.[a]

	($1,000's)	% of Total
Herbicides	3,100	53
Insecticides	1,600	28
Fungicides	520	9
Other	580	10
Total	$5,800	100

[a]Compiled by U.S. Environmental Protection Agency

Historical Role of Extension in Demonstration/Applied Research

The State Cooperative Extension Services owe their origin to practical on-farm demonstations of current knowledge that was obtained from research and demonstrating it to farmers. Seaman A. Knapp was over 60 years old when he first organized cotton pest control demonstrations in Texas at the beginning of the century. He is credited with the start of the State Cooperative Extension Services. His applied research/demonstration activities showed farmers the importance of applying current research information to local conditions. Today, the Extension Service in every State prides itself on practical demonstrations as a teaching tool. These demonstrations can be replicated and, if carefully documented, can be published.

An Extension specialist who is funded completely by federal funds and/or matching State funds for Extension activities can conduct only "...practical demonstrations..." The legislation that resulted in the Smith-Level Act followed more than 30 years after the establishment of the State Agricultural Experiment Stations. The State Agricultural Experiment Stations are charged to conduct research. The primary responsibility of the Smith-Level Act of 1914 is to disseminate information. One of the primary methods of disseminating this information is through "...giving of instruction and practical demonstrations ...(and) publication..." (quoted from the Smith-Level Act).

Philosophy and Interpretation

There are some 14 States in the western region of the United States and the philosophy and administrative appointments that Extension personnel hold varies from State to State. Some Extension Services encourage a joint appointment so that an individual has both research and Extension responsibilities. My own personal philosophy is that a joint appointment between research and Extension results in an outstanding knowledgeable Extension specialist. I am such a product of the joint appointment. I worked for 12 years at the University of Maryland on such an appointment with the Maryland Agricultural Experiment Station and the Maryland Cooperative Extension Service. Such joint appointments are very demanding. In my opinion the results are an individual who has a sound basis by which to speak to farmers. Farmers are quite sophisticated; they perceive and understand when a speaker really does or does not have complete knowledge of the information he is presenting. Even a relatively young staff member will gain the confidence of farmers and others when his presentation is based upon accurate information, geared, in part, by personal experiences.

U.S. Agricultural Productivity

In preparing for this presentation, I asked Dr. Donald E. Davis, President of the Weed Science Society of America during 1981, for the following data that he presented in his presidential address at the February 1981 meeting of the Society (Table 2).

Table 2. Support of agricultural research.[a]

Item	U.S.A.	U.S.S.R.
Percent gross national product from agriculture	2.2	3.4
Research scientists (number)	12,000	60,000
Support personnel (number)	13,000	150,000

[a]Donald E. Davis, President, Weed Science Soc. America

U.S. agriculture is the most productive in the world. U.S. agriculture produces food and fiber for more than 230 million Americans, and supplies nearly $50 billion of agricultural products for exports. Clearly, the U.S. agricultural industry is number one in food production in the world. The data in Table 2 does not list the number of research people in industry. The continued success of the U.S.A. as the leader in agriculture depends upon the continued applied research that industry contributes to the agricultural economy.

Agriculture's success in the United States also depends upon the continued strong support to the Land Grant University system involving research, teaching, and Extension. This unique public investment in agricultural science and technology which has involved federal, State, and local governments as well as the private sector, is the reason for agriculture's unheralded success in the United States.

Statistics of Manpower Involved in Extension's Pest Control

I compiled data regarding the number of Extension workers in the major pest control disciplines. In Table 3 are listed the number of Extension specialists and their full time equivalents by pest control disciplines at the Land Grant Universities. This does not include county agent's time. The data are for 1980.

Table 3. Number of Extension Specialists and full time equivalents by pest control discipline at the Land Grant Universities (excluding County Agents) for 1980.

	Extension Specialists	
Pest Control Discipline	Number	FTE
Entomology	401	258
Plant Pathology & Nematology	250	145
Weed Science	281	121

There has been an improvement in the number of individuals appointed as Extension weed science specialists, but the number of full time equivalents is still the lowest of the three pest control disciplines. With regard to the western regional States, I summarized the personnel data for the number of Extension specialists and their full time equivalents and a similar number for the total weed scientists (including Extension specialists) and the the full time equivalents devoted to weed science including Extension, teaching, and research at Land Grant Universities and federal agencies such as the USDA's Agricultural Research Service and Forest Service.

There are 22.45 full time equivalents in Extension weed science in the western region represented by 40 individuals. In the combined pool of weed scientists, Extension specialists are out numbered three to one (Table 4). I speculate that the same proportion exists nationwide; yet Extension specialists play a vital role in adapting research findings to local conditions. They do this in many cases by the classical demonstration work which can be replicated and reported in publications, in the State as well as reference journals.

Extension specialists have a great deal of responsibility in their States. Among their responsibilities are to:

...seek the best information no matter what its source;
...be receptive to new knowledge no matter what its source;
...interpret research for local conditions; and
...dispense the best information.

Extension specialists know how impartant *minor crop/minor use* information for pesticides is to their clientele; often this area is not adequately addressed by industry.

Table 4. Number and full time equivalents (FTE) of Extension Specialists and total number of weed scientists at Land Grant Universities.

State	Extension Weed Specialists		Total Weed Scientists [a]	
	Individuals (no.)	FTE	Individuals (no.)	FTE
Alaska	3	0.15	-	-
Arizona	2	1.25	5	4.8
California	9	6.6	33	25.8
Colorado	2	1.1	8	4.5
Hawaii	3	0.95	8	2.75
Idaho	1	1.0	5	3.75
Montana	3	2.1	9	4.8
Nevada	4	0.4	6	3.5
New Mexico	6	1.8	8	4.1
Oregon	1	1.0	18	11.7
Utah	1	1.0	14	9.7
Washington	7	3.6	17	10.7
Wyoming	2	1.2	2	3.0
Guam	1	0.3	-	-
Total	40	22.45	119	89.1

[a]Includes Extension, teaching, and research professions; includes federal agencies but not county agents nor regulatory professions.

With decreasing regulatory activities there will be a great need for education by Extension specialists. This educational effort must be substantiated by documented evidence. As one example, EPA is considering waiver of efficacy for domestic use of pesticides. EPA has already implemented efficacy waiver for agricultural pesticides. If EPA undertakes this action, this will put greater pressure on Extension specialists and researchers at the Land Grant Universities, USDA, and private consulting industries to provide unbiased comparisons in home use pesticide products.

Future funding appears to be, at best, barely keeping pace with inflation. This will hold true for both State and federal funding. There are some ways to generate the necessary funds to do specific research such as by support of commodity groups and with the aid of special grants form industry. Many academic departments have benefited from special commodity check off or commodity taxes to do specific research and Extension activities utilizing these types of funds. What also is needed is the support of use groups and producer and marketing organizations who can tell the success story of how research and Extension has benefited agriculture.

Acknowledgements

I wish to acknowledge the following sources of information from which data were compiled.

With regard to the number of Extension specialists and the full time equivalents of Extension specialists in the following pest control disciplines:

Dr. Paul Bergman, Extension Service, USDA, for entomology; Dr. Harlan Smith, Extension Service, USDA, Washington, D.C., for Plant Pathology and nematology; and Dr. Clifford Nolan, Clemson University (information compiled while on assignment at USDA, Extension Service, Washington, D.C.), for weed science.

The data for the number of weed scientists in federal and State agencies were compiled from data listed in the 1981 Weed Science Society of America Directory entitled "North American Directory of Federal, Provincial, State, and Industrial Weed Scientists;" those individuals listed by each of the western regional States were critically reviewed by the author and only those individuals affiliated with the Land Grant Universities (excluding county agents) and federal research agencies are listed.

The data on U.S. sales of pesticides for 1981 were compiled by the Economic Analysis Branch, Benefits and Field Studies Division, Office of Pesticide Programs, U.S. Environmental Protection Agency, Washington, D.C.

Finally, I wish to acknowledge the data that was presented by Dr. Donald E. Davis, President of the Weed Science Society of America at the 1981 meeting.

FIRE PROTECTION AND FOREST IMPROVEMENT PROGRAMS IN CALIFORNIA'S WILDLANDS

Peter C. Passof[1]

Introduction

There are currently two State supported programs underway in California that are addressing fire protection in the brushland types and forest improvement in the timber types that should be of interest to you today as weed workers representative of the Western States.

Let's begin by giving you some basics of the two programs, results to date, and some conclusions that look to the future for similar programs that might be implemented in your own States.

The Chaparral Management Program was signed into law in 1980 and became effective in July, 1981. The program focuses on the brushlands of the States that owned by private landowners. The program offers public assistance, funded by tideland oil revenues for prescribed fire to be used as a vegetative management tool in these previously unmanaged shrub formations. It is not exclusive to the chaparral type as suggested by the program's title. It so happens that the Governor's Office felt the name, "Chaparral Management" had more public acceptance than some alternatives that were offerred.

California has developed a serious brushland fuels problem because of past fire suppressive policies that were perceived to be in the public interest. An extremely effective and well financed fire suppression program and an unwillingness to control burn by ranchers because of liability problems from excapes has lead to a current buildup of fuels that

[1]Extension Forest Advisor, University of California, Mendocino County

many feel are approaching disasterous proportions.

The second program, referred to as the California Forest Improvement Program (CFIP) was signed into law in 1978 and became effective one year prior to the funding of the Chap. Mgnt. Program, 1980. It, therefore, has had twelve more months to demonstrate progress. The program focuses on the commercial forest lands of the State that like Chap. Mgnt. are owned by the private sector. The eligibility criteria restricts programs to those ownerships between 5 and 5000 acres of commercial forest land, while the Chap. Mgnt. Program sets no specific acreage limit in terms of eligibility criteria.

The program offers public assistance, funded from timber sales receipts from State-owned forest for two types of forestry practices.... planting and stand improvement, as well as other, land, fish, and wildlife conservation measures.

California has developed problems of understocking on many thousands of acres of non-industrial private forest land. The California Forest Productivity Report, prepared in 1980 as a cooperative effort of many organizations, indicates there are about 1.5 million acres of land in this category. Wildfires and conversion attempts to change forest land into range use has resulted in very low timber productivity in many parts.

In contrast, better sites have an overabundance of commercial species of timber which will require thinning to achieve optimum growth. The Forest Productivity Report estimates there are 441 thousand acres of land in this category. However, the Report's economic analysis suggests that the 1.96 million total acres are reduced to 846,000 acres if you project a 10 percent rate of return after taxes.

I want to point out at the start that these two programs are administered entirely by the California Department of Forestry. The University of California Cooperative Extension role during the development stages has mainly been advisory in terms of providing insight into problems and potential solutions. Technical information has been provided upon request. We in Extension are now at the stage of explaining program details to landowners and assisting in exposing the general public to the purposes and objectives of each program.

In giving you a brief perspective of these two programs, I hope to be able to provide you with some insight into California's current policies in terms of publicly-funded, cost sharing assistance in what are basically vegetation management programs aimed at the privately owned wildland sector.

If you accept the definition of a weed as a "plant out of place," then much of the thrust of these two public programs is aimed at controlling undesireable vegetation that is either competing against valuable timber and grass or had grown and aged beyond the point where it is a potential immediate threat to humans, livestock, wildlife, fisheries, soil, and water resources.

Before we get into the subject of how well these programs have been received by landowners and the general public, let's first look at some aspects of the two programs that should interest you as professional weed workers, whether you are research scientists, educators, or are employed in the private sector, or work for a governmental agency or educational institution.

In a State of 22 million people, with the great majority living in urbanized areas, it is indeed remarkable to find broad political support for programs that directly benefit the wildland resource. Considering the fact that these two programs were launched after Californian's overwhelmingly passed their tax limitation act (Proposition 13) which caused a rash of belt tightening by politicians, it is indeed remarkable.

Perhaps we have not had enough time to adequately measure the public acceptance of the programs that have been pre-occupied with bureaucratic details such as preparing Environmental Analysis, Program E.I.R.'s, regulation writing, and recruiting personnel.

I think the important point, and perhaps the reason why I have been invited here today, is to show that you can be successful in mounting favorable public opinion that supports a vegetation management program if you can clearly show the public how they will benefit indirectly.

Greening up California by planting trees today for tomorrow's timber had a lot of appeal. The fact that areas would have to be site prepared and followed up with additional measures to ensure good success in growth and survival was not given center stage for obvious reasons.

In the Chap. Mgnt. Program, the public's attention was focused heavily on those values that people feel closer to. A conflagration detroying homes and property in the late summer and casuing flooding and mud slides in the winter definitely gets public attention.

To the credit of the top management people in the Department of Forestry and their ability in finding excellent allies among the several special interest groups and agencies, the CDF successfully lobbied their legislation and got the funds to get the job done.

That is the good news! But the bad news is that some critical political concessions had to be made that you as weed workers should find interesting.

In the CFIP program, dispute arose between those that saw great benefits of increasing forest productivity and hence the public's timber supply through the silvicultural practice known as conifer release. Foresters argued that the most cost effective means of reducing the inventory of hardwood dominated conifer lands was by selective phenoxy herbicides, aerially applied.

Opposing that viewpoint was another force that argued for hand techniques, using chainsaws. Although more costly, it would aid employment in timbered areas that were starting to see the early signs of reduced demand for lumber because of inflation and escalating interest rates.

The State sought a compromise on the issue and wrote a policy specifically not allowing CFIP funds to be used for any conifer release activities although their regulations recognized that some competitive weeds would have to be controlled during the process of stand improvement. It was quite apparent that Governor Brown's Administration was not going to be a party to the use of taxpayer dollars on aerial applications of pesticides. That issue surfaced again last summer when the Medfly resisted the alternative of fruit stripping and hand spraying fruit trees in several countied in the Bay area.

As a matter of interest, the Forest Productivity Report claims that there are 250,000 acres of commercial forest land that would profit from conifer release at the 10% rate of return. This acreage figure only pertains to lands owned by the nonindustrial forest landowner who would only be eligible for cost sharing assistance.

In terms of the Chap. Mgnt. Program, the main thrust is clearly favoring the tool, prescribed fire rather than the use of chemicals which they candidly admit are "controversial." Mechanical methods such as crushing, brush raking, discing, etc., are expensive and have their limitations.

So here we have two relatively new programs getting started with a combined annual budget of approximately $6,000,000 that are being promoted as an "Investment for Prosperity," the Governor's 20 year program to revitalize the State's renewable resources. Vegetation management is the key ingredient although the use of pesticides as a tool to that end is presently not receiving very much attention.

Results

How are the two programs coming along? The Chaparral Management Program, although only launched last summer, is gaining some impressive momentum in its formative stages. The CDF has placed preference on winter/spring burning for various good reasons so actual prescribed fire projects are just now getting underway. The Program managers have set an ambitious annual goal of 120-150,000 acres although their first year projection is set at 80,000 acres.

They have projected a total goal of about 5 million acres of brushland in need of management. To date, 28 projects are underway with signed contracts amounting to about 20,494 acres of prescribed burning.

The CFIP program has more impressive results because of their time advantage. Statistics up to the end of 1981 indicate a total of 352 projects underway that are impacting more than 13,000 acres. Over 8,600 acres are scheduled or have completed reforestation projects with the remainder of the acreage in precommercial thinning. In the five north coastal group of counties of Del Norte, Humbolt, Mendocine, Lake, and Sonoma, a total of 144 projects have been approved or 40% of the total. This comes as no surprise since a landowner survey conducted 3 years ago indicated a great concern and priority for protecting property against wildfire and improving tree growth.

Since some of you in the audience today may be agricultural field consultants or pest control advisors, it is worth noting that both programs require written management plans before any projects can be carried out. State law mandates that Forest Management Plans must be prepared by registered Professional Foresters; thus, many consultants are finding new employment opportunities. A total of 276 management plans have been written for more than 84,000 acres of wildlands. The Chap. Mgnt. Program does not specify who may write the plans, and thus the plan preparation can and is often done by public agency assistance under a provision of coordinated resource management planning.

Although the programs have been plagued with the normally expected amount of bureaucratic red tape that invariably creates frustrations for landowers, consultants, contractors, etc., it is my opinion that acceptance has been increasing as experience is gained. Both programs have had to make substantial cuts in funding as sources have diminished due to the state of the economy.

Conclusions

What kinds of conclusions can be drawn from these two public programs that are still very young but are pioneering some new and innovative approaches toward land and vegetation management on privately owned wildlands?

There are some very important advantages:

1. The programs have motivated several landowners who in turn have provided leadership for others to follow. This educational system has worked very successfully in traditional agricultural areas and is now being applied to the upland or wildland sector in California.

2. Our total resource base will be improved by virtue of improved stocking, increased timber growth, prevention of high-intensity wildland fires, and improved ranges, wildlife habitats, and our vital watersheds.
3. The Chaparral Management Program introduces the new concept of liability insurance that protects the State and private landowners against financial losses from fire, if there was negligence by either party.

Naturally, there are some disadvantages:

1. Segments of the private sector may become more dependent upon the government at a time when many are calling for less involvement in the interest of saving tax dollars.
2. Some question whether the programs have any linkage. Remember, they are purely voluntary in terms of participation and therefore the lands that may have the best potential also stand the risk of being avoided because of an individual landowner objectives not meshing with others.

It is my observation that the real test for the programs will come as the Administration of the State changes at the end of this year.

The programs will have to undergo some financial scrutiny in terms of favorable benefit/cost ratios. Program managers will have to work very hard selling politicians on the social and economic advantages of a massive six million dollar "weed abatement program."

The fact that the programs are underway at all, is ample evidence of their very capable leadership starting at the grass roots level and working their way up to Sacramento. I would ask in these days of recession and economic pessimism, how else could you possibly get so many acres treated and back into production and protection without a little government grease?

If your State has a back log of such lands, perhaps it is time to investigate the possibilities of implementing similar programs.

It may be that professional weed workers as practitioners can visualize the opportunities in clearer detail than the resource managers who are always prone to see the obstacles lurking in the shadows.

My appreciation goes to the program managers in the CFIP and Chaparral Management programs, Audley Davidson and Len Newell, for supplying me background information. I also appreciate the review assistance of others in the Department of Forestry.

GRADUATE STUDENT TRAINGING -- THE STUDENT'S VIEWPOINT

Arnold P. Appleby[1]

When I was asked to participate in this symposium and offer the student's viewpoint, I agreed readily. After all, I had been a student myself, right? What I had forgotten was that it has been 20 years since I was a student and I don't think like a student anymore. However, I will do my best to discuss graduate student training from the student's viewpoint but I cannot refrain from including some of my own philosophy as a major professor.

1. *Students want to be marketable.* At least eventually, students

[1]Crop Science Department, Oregon State University, Corvallis OR

come around to that viewpoint. The outlook varies from student to student and sometimes in the beginning, personal interests are uppermost. The major professor must be firm and insist that the student participate in activities that the professor knows are valuable, even if the student is not interested. Almost always, the student will come to realize that some of the tough course work, the field trips, the meetings, etc., will make him a better employee and therefore more marketable to potential employers.

2. *Students want to be treated as if their opinions are important.* After all, these are college graduates and they have obviously done reasonable well or they would not be in a graduate program. If I could offer some advice, I would urge new students to curb that impulse to straighten out the whole project the first two weeks. Even when you are right, maybe *especially* when you are right, you can be a pain in the neck! There will be plenty of time *after* you become part of the team to contribute ideas without sounding critical. To the major professor, I would urge you to curb that impulse to hit him with a chair when there is a stream of unsolicited suggestions. After all, there are often some good ideas which could benefit the program. A high percentage of the good ideas generated in our program in the last 20 years have come from the students. And one more thing, major professors, students don't like it much when you dismiss their suggestion out-of-hand, then propose it three months later as your own idea.

3. *Students want someone to be interested in their progress.* I do not believe that students need or want someone looking over their shoulder all the time. Give them a chance to make their own mistakes. Good judgement come from experience, and experience come from poor judgement. Students should be allowed to learn through experience, but try to head off those fatal mistakes that cannot really be remedied in the time available. Students *do* generally need and appreciate your overall perspective and they *do* appreciate someone being excited at their successes, sympathetic with their failures, and just generally paying attention to them.

4. *Students want the opportunity to interact with colleagues and persons outside the university.* They like to feel part of a group. At Oregon State, we have regular meetings of the weed group in which we discuss thesis problems, reports from meetings, field research programs, new label changes, etc.

Students also like to interact with persons outside the university. These can include industry representatives, county agents, farmers, extension agents, and others. This keeps their outlook from getting too "ivory towered." As all of you experienced weed workers know, even the worst farmer can ask more questions in five minutes than the best professor can answer in a lifetime. The students need to know that.

Now, from a professor's view, how do you produce good students? Other members of the panel will discuss that in more detail, but I would like to offer three suggestions:

1. *Pick good students!* The only thing that I have done well in my career is to pick good people. My personal preferences are as follows:

a. *If* all else is equal, pick the one with a high GPA. This means that he/she is smart, a very hard worker, or is good enough at psychology to figure out the system. All of these are desireable characteristics. But do not select on the basis of high grades to the exclusion of other characteristics.

b. I like to *telephone* the references. This gives you a much better evaluation than a letter. People are more apt to lie on paper than on the phone. Does the student have initiative? Tendency to put personal preferences aside for the benefit of the group? Or is he/she a chronic complainer? A straight "A" student who is unanimously hated, even by his mother? Time spent in the selection process can save hundreds of hours later.

2. *Provide learning opportunities.* It is the responsibility of the major professor to make learning opportunities available to his graduate students. We consider that our training program is directed in four ways: involvement in the field program, a strong course program, the thesis research and writing, and other activities. The other activities include group field trips, attendance at various conferences, participation in grower meetings, including serving as a speaker, and in meetings of the weed science group. It is true, in this case, that a person should not let his schooling interfere too much with his education.

3. If you have done a good job of steps 1 and 2, then step number 3 is *STAY OUT OF THEIR WAY*! Let them go! Chances are, they will surprise you and you will *both* be better for it.

TRAINING GRADUATE STUDENTS FOR WEED SCIENCE

K. C. Hamilton[1]

We are considering the training of graduate students for careers in Weed Science from the view point of the student, the professor, and the employer. We do not consider what is often the most critical influence on a student's success or failure, the wife, the husband, or more often today, the friend. I, from the Professor's view point, will discuss some problems in training graduate students.

First, the student must be found. The best way to select good graduate students is from the best undergrads you know. Many departments have a list of applicants for graduate study of unkown quality. Most university administrators encourage you to select graduate students who have $45,000.00 deposited in a U.S. bank. The standards you set for accepting students are firm, but flexible. When you have no graduate students the standards relax, when you ahve 6 or 10, the standards are rigid.

Students must be funded. This may be from their government, their family, their labor, or assistantships. More and more in Weed Science we must go the way of Engineering where industry will pay the full cost, and more, of the graduate training for the top students they hire after the B.S. degree.

Students need guidance in their program. This can be from a book from the Graduate College, the advise of a technician, the wisdom of their major professor, but I believe the Graduate Student Grapevine of each department is the best source of information.

Graduate students should select good courses in Crop Production, Botany, Entomology, Plant Pathology, Soils, and Statistics, as well as Weed Science if the University has them. However, three of the best courses will be taught only at 9:00 on Tueday and Thursday during the fall semester.

[1]Department of Plant Sciences, University of Arizona, Tucson AZ

Graduate students should be encouraged to select a thesis problem as soon as possible. It should be a problem of interest to the student, the professor, and the state. If the student is funded by industry, selection of the thesis problem is quite easy.

Most graduate students must develop a work ethic. Few have acquired a passion for working 12 to 16 hours per day. If you set a good example, they may try to work with you. Many graduate students are surprised that my pick-up truck leaves for work at 4:30 or 5:30 a.m. If they are working with me, they will be at the storage area before that time. Certain students have an aversion to certain aspects of the job, washing pots, writing reports, work before 10:00. This must be overcome.

Many graduate students will not finish their programs. They will be removed from the University by lack of interest, changing to a better career, the draft board, or family needs. The most difficult way to lose a graduate student is to have to tell one you are both wasting your time in attempting to continue their training.

Many students can not or will not attempt course work and research at the same time. A good graduate student must be able to keep two balls in the air at the same time.

Graduate students should get as much field experience as possible. This is not possible when they have classes five days per week and the agriculture is 100 miles from the school. The field experience should include hand weeded or hoed check. This instills some interest in finding a better way of life.

Most students do not realize job hunting starts the day they enter college not when they finish. If they have been professional from the day they start, industry will be waiting for them to finish.

Whenever possible graduate students should be allowed to meet representatives of the chemical industry in the field and for lunch. Most students will go to work for industry and both should meet each other as early as possible. The student must rid himself of the idea often expressed by University teachers that industry is evil. Meeting industry people may change the students' views of sales and research. Industrial research is best suited for prople that enjoy long hours of hard labor.

Many students should have some teaching experience during their graduate program. They can help teach or prepare the Weed Science course. One might consider how government auditors view the use of research funds for teaching.

As the student finishes course work and completes the research, a thesis must be written. This will take more time than the student can believe. If the student makes an error, indicate the type of error, but resist the temptation to correct the error. By the sixth revision, there should be improvement. For most types of field research make graduate students analyze their own data, not feed it to a computer. They might learn something. The student should be encouraged to prepare and present a paper on his or her research at a regional or national meeting to display the finished product. To do this they will need careful coaching on the preparation of use of slides.

At some time in the training of graduate students they should be forced to travel with an extension weed specialist. This may or may not correct his impression that talking with farmers is a waste of time.

One of the things we should do, but often fail to do, is to teach graduate students where to obtain the supplies and equipment needed in Weed Science. The many tools, fittings, and spare parts used in weed research to not breed in a tool box in the back of pick-up trucks.

The students we train will in many ways be like us. But they can not be us, they must be better. And after 1 or 2 years they must leave the nest. Some will not like this, and some will not adjust to wealth and responsibility in the real world.

If possible, just before students leave they should have a last breakfast; I call it a "Cowboy Breakfast." After bourbon and steak at some special spot in the desert it may be possible to obtain a frank evaluation of your training program.

The training of graduate students probably should, but does not end, with graduation or finding a job. The phone will ring with their problems for years in the future, but the person calling is now a frient not a student.

HOW TO TRAIN GRADUATE STUDENTS FOR FUTURE CAREERS IN WEED SCIENCE

J. E. Dorr[1]

When Stan asked if I would be willing to serve on this illustrious panel, I accepted with the understanding that I include more than, and not limit my comments to, "Training Graduate Students for Future Careers in *Weed Control*." The reason is that the chemical industry is a multi-disciplined industry not limited to herbicides, which would utilize more of the agronomists than the other disciplines. To get me thinking down the line Stan thought would bear fruit, he sent me a list of questions to consider when putting together this presentation. So, I have decided to utilize them and add along the way some personal observations.

The first question has to do with farm background, "Since students today have little or no agricultural background, has this changed anything in our training program?" While there is no question about it, it is an asset in our industry to have an agricultural-farm background--whether it be from a dairy farm, as my background is, a multi-crop vegetable or field crop operation, or a deciduous fruit and nut or citrus growing operation. A farm background is something hard to measure other than the fact that those who have had this experience are more well rounded; they seem to be able to relate ideas to actual practice easier. In defense of the "non-farm" background student, however, CIBA-GEIGY, as well other chemical companies, compensates for the "lack" by structuring the training program with emphasis on practical experience.

The desireable attributes of a farm background for those going into industry really are no different for those going into Extension. The Extension position certainly will be made a whole lot easier if the Extension Agent could pull experience from his or her farm background when attempting to solve grower problems.

I strongly feel the area of farm background could be strengthened at the University by incorporating practical farm experience into the students' curriculum.

With reference to Stan"s second question, "How well should a weed scientist be trained in other areas?" let me first comment on the training needs in Weed Science. While there certainly is a need to have a good weed identification background, we are looking at just that--a good background, not a taxonomist. To my way of thinking, a more broad training

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[1]CIBA-GEIGY Corporation, Covina, CA

rather than a pinpoint-type training would be more useful. At the University, weed identification coupled with the practical, real world would be desireable. This could be accomplished through field trips where the keying out could be done under natural conditions. My perspective on this question is from a field biologist point of view; that is, as an industry representative in Field Research and Development. Under this job description, a specialist in taxonomy or herbicide dissipation has little practical application. This doesn't mean that these areas are unimportant to industry; on the contrary, our analytical lab, residue chemistry, and to some extent our staff scientists are vitally interested in these specializations.

Again, my perspective is from a Field Research point of view--that is, the screening of pesticides in the field or working on designated research stations that a company would operate.

The need for basics of other disciplines is important since the likelihood of being only in weed control with a chemical company is very slim. Therefore, I feel it is imperative that the student has a good understanding of Plant Pathology, Entomology, and Plant Plysiology. Other areas we definitely look for when we read a resumé or interview candidate are things such as Statistics, Chemistry (Organic and Inorganic), Microbiology, and Soils, as far as the sciences are concerned. Besides the science area, I would like to see the student have good, basic, practical background in field plot techniques--not just book learning, but actual field application. A recent hire who has been weaned away from the University and now has had time to reflect over the company time experience indicated to me that more important than knowing how to analyze data statistically is how to design field plots so the data one gets is valid statistically. I agree from a practical, industry point of view. Many statistics courses emphasize the end result--numbers--rather than how to design.

As with Statistics and Plot Design, field equipment is equally important. This extends from small plot sprayers to larger pieces of equipment, which are utilized by both Field R&D Representatives and our research stations. Coupled with this is the importance of basics and calibration. It is extremely important that one can calibrate any type of field equipment he comes across.

Background in crop production is important and should include courses in vegetables, fruits, nuts, citrus, forage crops, ornamentals, and all the rest, expecially for those without a farm background. Coupled with crop production, it would be of real benefit to have someone who knows common fertilizers that would be used for a particular crop in a particular area. It is true that you can't learn all this for the whole United States; but to have the background of the how, the why, and the wherefore on the practical use of fertilizers is important.

I again suggest that it would be desirable to have students involved in field trips and seminars where they can get out and see multi-disciplined research, rub elbows with professors in other departments; and further I recommend rubbing elbows with industry representatives and research station personnel. With reference to the last point, we have been very successful at CIBA-GEIGY in hiring summer technicians and then hiring them as full-time employees upon graduation. I feel this intern-type program is very beneficial to the university and idustry and most importantly, the student.

Other areas where training is needed is in the ability to communicate in both written and oral forms--good report writing, not just thesis-type,

EPA - A BALANCED APPROACH

Steven Durham[1]

There's a battle being waged in this country today, a battle that receives almost daily attention from the news media. The battle is being waged by environmentalists, and the enemy to them is business. The environmentalists, on the one hand, try hard to present a public image of concern for the poor while portraying pro-development forces as caring little for poor people. Yet it's those very poor who are the casualties in this ongoing assault by the environmentalists on economic development and expansion.

The biggest problem with the environmental movement, it seems to me, is that it ignores one very basic public-policy question. That question is, "Is this program going to help people or hurt them?" The extreme environmentalist position is against all development and expansion of the economy. But do those environmentalists ever stop to think whom they are really hurting by taking that position? In a no-growth economy, all the people at the bottom are frozen in place. Just look at our situation in this country right now. Our unemployment rate is 8.5%, and most of those unemployed are in lower-paying jobs. That means those who can least afford it are out of work.

What we need to be doing is looking for ways to make more jobs, not put people out of them. But the environmentalist just does not consider what's going to happen to the people in the ghetto or to the people in rural, economically depressed areas, as a result of his fanaticism. A good example is the current debate over Reagan Administration-backed revisions to the Federal Clean Air Act. Predictably, the environmentalists are vehemently opposed to the revisions, although they have no evidence to back up their claims that they would worsen air pollution. The environmentalists refuse to consider, however, that the revisions offer substantial relief to the troubled auto industry, and that translates into jobs for auto workers. We at the Environmental Protection Agency are in business to achieve environmental results, not to make it so hard on business that they have to lay off employees or even close.

The followers of Ralph Nader and the environmentalists try hard to convince the public of their concern for the poor. But sometimes the mask slips. One of the most revealing "slips" was an article by Joseph Brecher, a lawyer for the Native American Rights Fund, published several years ago in the Ecology Law Quarterly. He wrote that publicity was a key concern in environmental suits and that the actual litigation was often of secondary importance. And since political decisions are formed from public pressure, Brecher said, it was better to bring suit in the District of Columbia Federal Circuit because the national press are there, not in Idaho or New Mexico.

A study done by the Capital Legal Foundation last summer found that five major environmental groups--the Sierra Club, Friends of the Earth, Natural Resources Defense Council, The Wilderness Society, and The Center For The Study of Responsible Law--filed 37 percent of their cases in the District of Columbia federal courts. Of those cases, the groups won 63 percent, as opposed to a 25 percent victory rate elsewhere. This means they indulge in forum shopping with a vengeance.

But there was more in the Brecher article that revealed the real indifference of environmentalists to the economic well-being of poor people. Let me read part of it to you:

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[1]Environmental Protection Agency Regional Office, Denver, CO

and a basic knowledge of public speaking. In research we are not selling a product to a customer, but we are definitely selling our research ideas to others. Therefore, being able to communicate to those on a positive plane is very important.

On a personal basis, characteristics such as integrity, willingness to work long hours, independence, or being a self-starter, and the confidence in one's own ability to handle a situation, many times on your own, is most important.

While CIBA-GEIGY, as with other companies, have many internal training programs from technical to computer operations, from goal-setting to the art of positive thinking, it's still up to the individual employee to plot his or her own destiny.

Lastly, Stan asked the question, "With the increasing number of graduate students being women, does this require any special preparation for a future in weed science?" My answer to this is "No" with respect to training or coursework offered by the University within the curriculum. With respect to the industry, again, I do not see any major alterations to our basic philosophy with the exception of *attitude*. Our industry and for that matter, the science departments of the universities have been dominated by men, and now we see women taking an active role in many of these male-dominated areas. Our attitude, the males, must adjust to this change by accepting women as professionally equal.

However, I feel the special preparation for a future in weed control, or in this industry, is with the woman herself. She must be prepared to wrestle heavy equipment, hoist 75 pound residue boxes, work with materials which might be considered hazardous until toxicology is completed, and during the "testing" season, work long hours under many times undesireable climatic conditions with the end result becoming dirty and sweaty with a less than desirable appearance. But, in all fairness, coupled with this description, if you are looking for a career which after 10 years of testing a compound, you obtain a registration that in some way benefits mankind and makes life a little better and you can say you had a part in it, then industry could be for you.

What I want you to understand, attending these types of meetings in grand hotels and beautiful cities make up but a small part of our business time.

In conclusion, as another employee related to me, a job in industry will involve almost immediate contact with people on an equal basis. Therefore, he suggests any exposure during his/her education to these situations will build *confidence*.

In recalling an in-house training seminar I attended, a discussion was led by a well-known motivational speaker, Mr. Ed Forman, on the ability to accomplish tasks which seem overwhelming and insurmountable all related to confidence in oneself. He used the analogy of the bumble bee. According to recognized aeronautical tests, the bumble bee cannot fly because of the shape and weight of his body in relation to his total wing area. However, the bumble bee doesn't know this, so he flies anyway!

I propose and point out to the students that academic and personal requirements for success with industry are no different than with academia.

"Local residents and newspapers are apt to favor projects in their locality....for two reasons. First, large federal landholdings or depressed economic conditions often make the local tax base extremely small, thus residents see the construction of new projects in terms of upgraded schools, libraries, roads, and other public facilities. Second, public leaders in the affected area often support such projects because of the new jobs and economic expansion associated with them. Judges and juries in the affected areas are likely, therefore, to feel that the public interest lies in building a project, rather than in preserving the environment."

There you have it. Local people want development because they are poor and need jobs, an expanding economy, and opportunity. They want to use the resulting tax money for schools and public libraries, But to the extreme environmentalist, all of this is bad. So well-financed public interest concerns go to court in Washington, D.C., to block, for example, a new copper or coal mine that would provide jobs and expand the tax base.

It's interesting to note that the primary pressures against economic growth are being brought by certain segments of the wealthy and their idle-rich children. Let's face it, a poor family in rural Colorado or in a Cleveland slum is a lot more concerned about jobs and cheap electricity than about a camping vacation in the wilderness. Where's the sensitivity of the environmentalist elite to these people?

In short, the environmental movement is concerned with only one thing--advancing its own rather idealistic goals at the expense of everything else. Certainly the economic considerations of unemployed Americans is of no concern to environmentalists. But under the Reagan Administration, we as Feceral Government officials *are* concerned about unemployment and we intend to do everything possible to see that it doesn't occur unnecessarily. A good way to begin doing that is by returning some rationality to our environmental laws and their enforcement.

FIGHTING TO SAVE 2,4-D

Ted H. Meredith[1]

Today I want to talk to you about the National Coalition for a Reasonable 2,4-D Policy. The 2,4-D Coalition is a non-profit-making organization incorporated in Texas with headquarters in Chicago, Illinois. In my talk today I'm first going to review the 2,4-D issue for those of you who are not very familiar with this issue. We'll then look at the background on why this coalition was formed. We'll examine the concepts that are contained in the organizational by-laws. We'll explore the organization's objectives, structures, and financing. And finally we'll consider why you should join the National Coalition for a reasonable 2,4-D Policy.

In reviewing the 2,4-D issue, we'll examine three broader subjects that cause 2,4-D to be embroiled in a great deal of controversy. First we'll review the Pesticide Controversy, the Agent Orange Issue, the Dioxin Issue, and last we'll look at the specific attacks upon 2,4-D as a result of these three greater controversies.

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[1]Manager, Environmental & Government Affairs, Land Resources Portland Division, Georgia-Pacific Corporation, Portland, OR

The Pesticide Controversy: Banned or Restricted Products

In 1962 a rather nice young lady by the name of Rachel Carson wrote a book entitled *Silent Spring*. The publishing of this book launched an assault upon the use of pesticides in the United States. The first casualty occurred in 1972 when the EPA banned most uses of DDT within the United States. You may recall that predeeding that action there were some rather lengthy hearings in Washington at the conclusion of which the administrative law judge ruled that there was no unreasonable risk to people or the environment as a result of the use of DDT. It is unfortunate that the administrator of the EPA at the time overturned that ruling and banned the use of the product.

From that initial restriction, the list of banned or restricted products has grown and grown to most recently include two recent casualties of interest to us: 2,4,5-T and silvex. These products are cousins of 2,4-D and were restricted as a result of the EPA's Alsea II, Oregon study. This study has subsequently been reviewed by a number of scientific organizations within the United States and other countries and found to be flawed and discredited as a basis for EPA's position to restrict these products.

In addition to restrictions on products, we also find that pesticides opponents have attacked the application of the products. Of the list of applications under attack I can imagine in every case there could be some sort of reasonable regulatory action. However, it is not the intent of individuals to obtain that result. We find that in most cases, by these types of restrictions, they seek to make it economically unfeasible if not impossible to utilize pesticides. The ultimate affect is to ban the use of the product. I might point out in the case of water standards that we have recently seen an action by the California Water Resources Control Board establishing standards for 2,4-D which are significantly below those established at the federal level. It is the opinion of forest products companies in California that these new regulations, if allowed to be enforced, would have the impact of banning the use of 2,4-D within the area of influence of the California Water Resources Control Board.

The next issue that I want to examine that causes 2,4-D to be embroiled in controversy is the Agent Orange issue. The reason 2,4-D is involved here is simply that Agent Orange was a 50-50 mixture of 2,4,5-T and 2,4-D butyl esters. These products were used by our forces in Vietnam to defoliate the jungles to reduce the possibility of ambush by hostile forces. This program was successful. If you are the North Vietnamese, you simply can't pick up the phone and call us and ask us to stop defoliating the jungle. But they did find another avenue to halt the use of Agent Orange in Vietnam, and that was by charging that the use of this product was the equivalent of chemical warfare.

They further charged that the primary impact was upon the civilian population and one of the major affects was an increase in the rate of birth defects.

Perhaps the most troublesome part of the Agent Orange issue is the Vietnam activists. The Vietnam veterans returned from an undeclared, unpopular war that we lost, to an American public that would prefer to forget the war and the veterans. I believe that Agent Orange has been used as a vehicle to obtain recognition by the veterans and as a possible answer for the health problems experienced by some veterans.

The Veterans Administration, in analyzing the available scientific data, has concluded that there is no cause/effect relationship between the health problems of veterans as a class and their exposure to Agent Orange in Vietnam.

The next issue I'd like to examine is the dioxin issue. The major problem here is the toxicity of a compound called 2,3,7,8-TCDD. This product is one of 75 theoretically possible dioxin isomers that can be formed or in certain combustion processes or during the production of chemicals such as 2,4,5-T. In laboratory experiments with this compound scientists have found that it is extremely toxic to animals.

2,4-D does not contain any 2,3,7,8-TCDD. It does contain some of the other 74 dioxin isomers. The problems we have experienced is that the news media and the public have been unable to distinguish between one dioxin and another dioxin. While 2,4-D does contain some dioxins, the dioxins in 2,4-D are present in parts per billion quantities. I'm not a technical person, and I have difficulty related to parts per billion, so I have to use some way to relate to this measurement. The easiest one for me is the following: One part per billion in a product is the equivalent of one second in the life of a 32-year-old person. In other words, we're talking about extremely small quantities. Furthermore, the toxicity of the dioxins that are found in 2,4-D are significantly different. If we examine the primary isomer that is found in 2,4-D on an acute toxicity basis as compared to the acute toxicity of 2,3,7,8-TCDD, we find that it is some one-million-fold less toxic.

Now let me return just a moment and talk about 2,3,7,8-TCDD. From my earlier description you would say that this is an extremely toxic compound, and it is, but we have to remember that the data also show that there are significant differences in the responses of various species of animals to this compound. In other words, there's a difference in the response of rats, and guinea pigs, and dogs, to the same quantity of this material. Furthermore, there have been some long-term reproductive studies in which it has been demonstrated that there are levels of this product which can be fed to animals over long periods of time and it does not have an adverse effect upon the organism. My point is, the mere presence of any quantity of 2,3,7,8-TCDD does not automatically mean that there's harm to man, animals, or the environment.

These three controversies resulted in attacks upon 2,4-D. The first, and perhaps the most noted in my mind, is the restrictions in Madison, Wisconsin. These restrictions resulted from an incident in which a child with a history of seizures had a seizure one day when a herbicide spray truck worked in the area. And from this incident we ultimately saw the city council ban the use of the product on all public lands.

Beyond this action we have seen activity by the Canadian government to restrict 2,4-D. There's been a bill in the State of Michigan to ban the product. The U.S. Park Service in 1980 restricted the use to a few thousand pounds in the national parks.

There's been a bill in Wisconsin and Louisiana to ban the product. Chicago has placed purchase restrictions of 2,4-D. Oregon has had too many initiatives to list. There's our friends the California Water Resources Control Board.

We've also seen a major TV series in the City of Tampa, Florida in which every charge imaginable was made against 2.4-D. There's also been activity in Maine, Massachusetts, New York, West Virginia, Tennessee, and Washington, to name a few. The point is that 2,4-D is a product that is under serious assaults throughout the United States.

The National Coalition for a Reasonable 2,4-D Policy

Let me turn now to the background on the formation of this coalition.

There are three points I'd like to explore. First of all, when Reagan was elected a number of activists who were political appointees in the EPA lost their jobs. Many activists announced that they would take their program of seeking to restrict the use of pesticides to the state and local level. They would make up for any decrease in federal effort with intensified state and local actions. Those of us who analyzed this shift in strategy concluded that the resources of any one company or existing alliance was unable to address an intensified state and local assault upon the use of pesticides. In other words, something new was needed.

At about the time that the 2,4-D Coalition was beginning to be conceptualized, another organization was somewhat underway. This was the 2,4-D Industry Task Force on Research Data. The 2,4-D Task Force is a group of producers and formulators who joined together to fulfill the EPA's data call-in on 2,4-D. What this means is that these people will run a number of toxicity tests to update information for the EPA on this compound. Unfortunately, several of these tests will not be completed for three to four years. And those of us who analyzed that activity said, "Does it make sense to spend the millions of dollars that it will take to generate these data to maintain the federal registration, and at the end of that effort find that the project is effectively unsaleable because state and local governments have banned its use?" We again concluded that something new was needed.

In seeking to bring into existence the 2,4-D Coalition, we sought to examine a number of concepts that would be embodied in the by-laws of such an organization. And there are four that I'd like to discuss with you today.

The first is to develop a rallying point for pro-pesticide forces. When we analyzed the activities of industry in the past, we saw that it was fundamentally a fragmented approach. A company handles its problems; some associations handle a broader perspective; local geographical groups handle problems within their areas. But there is really no collective broad-based effort to address the assault on our products. On the other hand, environmental groups have had more of a national effort. They have an excellent communications network, they have built upon the successes in one geographical area by exporting them into another. They have out-organized industry in this effort.

The second point is that in bringing together a group to act as a rallying point for pro-pesticide forces we construct an entity that is manageable. Third, build from collective strengths. When we bring this new organization into being, we should structure it to maximize the strength of the individuals involved. And last, we must recognize that the issue is not scientific and/or legal.

Let me further review each of these points.

When we were trying to decide on a product to use as a rallying point, we used the following criteria to select a product. We said, first of all, the product should represent no unreasonable risk to man or the environment. It should be a product with a long history of use and a sufficient data base to be able to defend its continued use. But we also need a product that is liked to a sexy issue. In other words, it should be a product that's under attack. Preferably the attack upon the product is multi-dimensional. It's an attack at the federal level, the state level, on the production of the product, and on the use of the product. As we seek to build that coalition, we would like a product with a large number of end-uses because that means that there's a large number of end-users that can be recruited to support the alliance.

Furthermore, we looked for these additional points:

The major use for the product should be on a food crop, so that we can build the argument of the link between pesticide use and food supply. There should also be several producers of the product so we don't defend the proprietary interst of one company. And last, it should be a major pesticide. It should really make a difference whether this product is or is not used in the United States. Using that criteria, we selected 2,4-D as a rallying point.

To meet the objective of constructing a manageable entity, we selected the single-issue coalition concept. What this means is simply that you cut a narrow slice out of a very broad controversy and then focus only upon the pieces in that narrow slice. We believe the advantages are that by limiting the focus you can clearly define the problems and opportunities in the controversy. Secondly, having indentified the problems and possible plans for impacting those, the limited focus reduces the amount of resources that have to be marshalled to impact the target problems. Another key advantage of the single issue coalition is concensus. It takes less time to develop concensus among the members than if you sought to deal with a very broad controversy in which all members of all sectors with all parts of the problem were represented. One of the major problems in alliances is many of them spend 80 percent of their time talking about what it is they're going to do, and only 20 percent of their time doing something.

The last point we think flows from the first three, with this limited focus and the ability to properly marshall resources and a shortened concensus time, the whole question of managing the coalition's efforts becomes much easier.

Build from collective strengths. Users are the foundation. Users bring to these alliances first of all, credibility. Credibility within their own political subdivision or their own public opinion environment. On a national basis, their great numbers increase the political clout of an organization. Collectively, users have a greater resource base than the four U.S. producers of 2,4-D.

Well, what do producers privide? They provide the scientific data needed to prove that the product does not represent an unreasonable risk to man or the environment. They can provide the Coalition's specific discipline expertise. And they can also provide a financial base in the formative stages of the Coalition and to assist the launch of the effort.

The issue is not scientific nor legal. Public opinion and politics are the name of the game. It is perhaps difficult for individuals from highly technical or scientific organizations to accept this concept. However, we need only to review the success stories of the environmental activists who have used public opinion and politics as their major weapons to conclude that they understand the dynamics of public issues. On the contrary, many of us from technical organizations, when dealing with public issues, seek to manage issues by running one more toxicology test or hiring one more lawyer. While we do not advocate an abandonment of scientific principles or data, or the reduction of our legal staff, we think we have to learn how to operate in the forums of public opinion and politics because this is how our opposition will be playing the game.

I'd like to now examine the objectives, organizational structure, and financing of the 2,4-D Coalition.

In the section on objectives, we want to look at three missions of the Coalition.

First is to ensure that scientific facts and risk benefit considerations are utilized in any regulatory action on 2,4-D, to obtain Congressional recognition of the benefits to industry and the public from the proper use of 2,4-D, and perhaps most important, to establish a network of pro-pesticide coalitions at the state and local level to defend 2,4-D from unreasonable regulatory or legislative action.

While the first two objectives are targeted specifically at 2,4-D, the last objective has a broader reach. If we are in fact successful in establishing a network of coalitions to defend 2,4-D, we will have also established the basic intrastructure at the state and local level to defend all pesticides from increased attack by environmental activists.

Let me now turn to the organizational structure of the Coalition, and here we discuss the board of directors, officers, committees, membership categories, and the management consultant firm that we've hired. The *Board of Directors* consists of ten members, six user members and four producer members. The key point is that users control the board. The board has broad authority to direct the Coalition's activity and policy. The key point is that we spend very little time on concensus building. The board does not go out and poll the membership of the Coalition on positions that will be taken on a given issue. The members elect their representatives to the board and entrust in them the authority to develop the Coalition's policies.

Coalition officers. Selection of officers follow the same logic as the board; the users have control. The chairman must be a senior executive of a user member. The treasurer and secretary are elected by the board.

While the board establishes policy, programs and plans are carried out by these five Coalition committees: Public Relations, Coalitions, Legislative, Legal, and Membership. I think all of you understand what we mean by membership, legal, and PR. Let me just say a few words about the coalitions and legislative committees.

Two of the primary missions of the coalitions committee are: 1) to ascertain the need for, and assist in the establishment of, coalitions at the state and local level; 2) to recommend to the board special funding to assist state and local coalitions. It is not our intent to diminish the commitment of local groups to solve their own problems. In fact, I believe that if we sought to finance such operations it would not be a very meaningful effort. In other words, when local groups have their own resources, time and talent, and dollars committed to solve a problem, and they find themselves in a battle which is beyond their resource capabilities at a given moment, then the National 2,4-D Coalition could offer assistance. We would not provide on-going funding for such action which would weaken the local initiative.

The Legislative Committee's key task is to identify members of Congress and their legislative staffs who are capable of impacting the 2,4-D issue. Having identified these individuals, the legislative committee should seek to develop programs to educate these individuals on the 2.4-D issue.

Membership categories. The membership in the Coalition was constructed so that anyone who wished to participate would have some avenue for participation. The primary membership categories are user members and producer members. It is these two groups that elect the board of directors and thereby participate in policy determination. Beyond these two primary categories we also have collective memberships, which is an avenue for national and state associations plus other coalitions to participate. And last, the special membership category. This category includes any individual or company who has an interest in this issue but does not have the capability to make either the financial or the time commitment necessary to participate at the full user level.

Let me now discuss the management consultants that we've hired: Bostrum Management Corporation in Chicago. You'll note it's Chicago, not Washington, D.C. In developing this Coalition we wanted to position ourselves to have more of a middle America flavor. You'll also note that the management consultants are our administrative and logistics arm. We felt very strongly that if our members were not willing to spend the time and effort to develop their own policies, programs, and plans, then we probably really weren't very serious about this effort, and our chances of success would be diminished significantly.

Coalition financing. Financing follows the same logic as control of the board. Users, who control 60 percent of the board, pay 60 percent of the bills. Producers pay 40 percent. The yearly dues are set by the board after determining the budget for the coming year. Once budgets are established the 60-40 splits are made, and then within those categories of user and producer, members pay equal shares within their given category. For example, in 1981 all user members paid $5,000 in dues.

Coalition financing special member fees. As we said earlier, those who are not capable of participating at the full user membership level have these avenues for participating. A company can participate as a supporting or as a sustaining member. Furthermore, individuals can participate. Individuals in government, academia, or even a concerned citizen may wish to personally participate, receive the Coalition newsletter, and be kept up to date on the activities of the 2,4-D Coalition. Collectives can participate in the same fashion as in the company special membership category. They can participate as either supporting or as sustaining members. In all cases, the individual association or company makes its own determination of its ability to support the Coalition's efforts.

I'd like to turn now to why you should join the 2,4-D Coalition. First of all, the anti-pesticide groups *have* been successful. In fact, the list of banned or restricted products that we showed you earlier is only a small monument to the success that they have had in limiting the use of safe and effective pesticides. Furthermore, they have the people, the dollars, the organization, and the commitment to continue to succeed. Their successes are your losses, whether you measure that in lost yields, lost sales, lost profits, or in the worst case, the loss of your business.

The 2,4-D Coalition concept can succeed. And the reason we can say this is that the concept has been practiced on a state-wide basis with tremendous success. The most notable examples of this are in Washington and Oregon with the Washington State Pest Management Alliance and the Oregonians for Food and Shelter. These groups have organized, committed their resources, and have been able to successfully turn back unreasonable regulatory and legislative action within their states.

We've looked at the 2,4-D issue. We have examined the background on the formation of this coalition. We've explored the concepts contained in the by-laws. We've looked at objectives, organizational structures, and financing. And we've even advanced some positions as to why you should join. There's really *only* one question I think yet to be answered, and that is:

Are you ready to draw the line on the unreasonable assault upon these vital agricultural chemical tools? If you are, the National Coalition for a Reasonable 2,4-D Policy can be a vehicle to assure the continued safe use of pesticides.

REHABILITATION OF SPOTTED KNAPWEED INFESTED RANGELAND IN NORTHEASTERN WASHINGTON

R. L. Sheley and B. F. Roche[1]

Abstract: Spotted knapweed (*Centaurea maculosa*), a serious range weed, is invading Pacific Northwest rangelands. A study was conducted in 1979 to determine a rehabilitation technique for spotted knapweed infested rangeland. Burning, cultivation, 16-20-0 NPK fertilizer at 112 kg/ha, picloram (4-amino-3,4,6-trichloropicolinic acid) at .28 kg/ha and seeding of smooth bromegrass (*Bromus inermus*) at 13 kg/ha were applied to a spotted knapweed infestation in a factorial arrangement within a randomized complete block design. Percent cover by species was estimated in the first and second year after application. Forage and weed productivity was measured the second year.

Treatments which did not include a herbicide generally yielded the greatest amount of weeds and least amount of forage. Whereas, inclusion of a herbicide significantly increased forage and decreased weed production. Percent forage cover increased while spotted knapweed and other broadleaf weeds decreased the first year after fertilization. Fertilization increased both forage and weed productivity in the second year after application. Herbicide-fertilizer combinations produced a synergistic effect on decreased weed productivity, however, they did not increase forage productivity. Further studies investigating efficacy of various rates of picloram and fertilizer singly and in combination, initially and as follow-up management practices, are needed.

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COMMON CRUPINA: ASSESSING THE PROBLEM IN IDAHO'S RANGELAND

D. L. Kambitsch, D. C. Thill, T. L. Miller, and G. A. Lee[1]

Abstract: Common crupina (*Crupina vulgaris* Cass.), an introduced weed species from the Mediterranean region in Europe, is extremely competitive and capable of producing solid stands that greatly reduce the forage production and carrying capacity of infested rangelands. Generally, cattle will not graze on common crupina.

In 1980, a cooperative program was initiated between the University of Idaho, the Idaho Department of Agriculture, and the Animal Plant and Health Inspection Service (APHIS) to determine the eradication feasibility of common crupina from rangelands in north central Idaho. The investigation included a delimiting survey, evaluation of herbicidal control of common crupina, and weed biology experiments.

An intensive, delimiting ground and aerial survey conducted in 1980 and 1981 indicated there are approximately 9,200 ha of rangeland within a 364,225 ha area infested with common crupina. The largest infestations are located near Kamiah, Kooskia, and along the South Fork of the Clearwater Rivers. Application of picloram (4-amino-3,5,6-trichloropicolinic

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acid) at 0.14, 0.28, and 0.56 kg/ha, dicamba (3,6-dichloro-*o*-anisic acid) at 0.56, 1.12, and 2.24 kg/ha, and tank mixtures of picloram or dicamba with 2,4-D amine [(2,4-dichlorophenoxy)acetic acid] applied either during the fall or spring resulted in excellent control of common crupina. Fall applications of picloram, dicamba, and their tank mixtures with 2,4-D amine, resulted in slightly better common crupina control and increased annual grass yields by approximately 1.5 times when compared to the spring applications. Allother herbicides tested significantly reduced the dry weight of common crupina when compared to the untreated check, but did not improve the forage production.

AN EVALUATION OF CONTROL STRATEGIES FOR DYERS WOAD IN CROP AND RANGELANDS

J. O. Evans and R. W. Gunnell[1]

Abstract: Dyers woad (*Isatis tinctoria*) has recently evolved into an extensive weed problem in several regions of the western United States. It is a problem in several areas of agriculture and land use where its infested acreage is increasing at an alarming rate and has doubled in the last decade.

A member of the mustard family, dyers woad was first officially identified in the intermountain area in 1932 when a specimen was taken near a railroad at Perry, Utah and identified. Wood is a native of the Russian steppes, where the climate is similar to that of the semiarid West. It is now found in many places world-wide, and nationally in Utah, Nevada, California, Oregon, Montana, Idaho, and Wyoming. In the east, woad is found as a weed in Virginia and neighboring states. Typically dyers woad first appears along roadsides and railroad right-of-ways, and from there spreads to rangelands and cultivated fields.

Dyers woad seed has no dormancy, but each seed is contained in a pod which has a water soluble germination inhibitor. This inhibitor acts by inhibiting the germination of dyers woad seeds and other seeds (especially mustards). It also has an inhibiting effect on root elongation of competing species. Some dyers woad seeds are able to germinate in the presence of this inhibitor. These seeds have a definite competitive advantage over other plants that are inhibited by the compound in the seed pod. Other woad seeds must wait until the inhibitor is leached from the pod before they can germinate. This process insures a prolonged seed supply in the soil. It has not been determined how long the seeds are viable in the soil.

At least three control approaches are being proposed due to the wide variety of habitats where this species is observed.

Several herbicides alone and in tank mix combinations were applied to dyers woad plants in the rosette to early bolt growth stages. Two weeks after treatment, plant injury for most compounds was quite uniform, while injury symptoms were, of course, different. Metribuzin [4-amino-6-*tert*-butyl-3-(methylthio)-*as*-triazin-5(4*H*)-one] at .25 lb. active per acre showed the least early injury. One month after treatment, differences in control became evident and by two months after application, several treatments had allowed dyers waod plants to flower and set seed. Escapes were most pronounced in metribuzin alone and dicamba (3,6-dichloro-*o*-anisic acid)

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alone and tank mix treatments. Amitrol (3-amino-*s*-triazole) plus 2,4-D [(2,4-dichlorophenoxy)acetic acid] appears to be especially promising to control this species. The activity of certain insects on dyers woad has been studied and several insects have been collected from natural infestations existing in Cache Valley of Utah and surrounding areas. Mechanical control by rogueing or tillage, where feasible, remains as an important deterrent to dyers woad spread.

EFFECTS OF TEBUTHIURON ON RANGE SPECIES COMPLEX AND FORAGE PRODUCTION

T. D. Whitson and H. P. Alley[1]

Abstract: Tebuthiuron {*N*-[5-(1,1-dimethylethyl)-1,3,4-thiadazol-2-yl]-*N*, *N*'-dimethyl urea} has shown promise for the control of big sagebrush (*Artemisia tridentata* Nutt.), however, specific grass species, growing in association with big sagebrush, have shown considerable sensitivity to the chemical. A field study was initiated on November 7, 1978, near Ten Sleep, Wyoming on sagebrush-infested rangeland.

The 20% granular formulation of tebuthiuron was aerially applied to 11 acre plots at application rates of 0, 0.31, 0.67, and 0.94 lb ai/A. Live canopy cover and forage production measurements were made on August 4, 1981, approximately three years following treatment. Live canopy cover determination measurements included 400 random points for each herbicide rate. Forage production was determined by clipping five, 4.9 ft^2 quadrats per treatment, oven-drying and computing yield per acre. Forage yields from untreated check plots and plots treated with tebuthiuron at 0.31, 0.67, and 0.94 lb ai/A were 308, 382, 715, and 552 lb/A, respectively. Sagebrush defoliation resulting from tebuthiuron applied at 0.31, 0.67, and 0.94 ai/A was 69.0, 96.0, and 99.5%, respectively. The predominant grass species, western wheatgrass (*Agropyron smithii* Rydb.) had a 397% greater live canopy cover than on the untreated control.

A greenhouse study was initiated August, 1980, to evaluate the tolerance of green needlegrass (*Stipa viricuta* Trin.), western wheatgrass, and needleandthread (*Stipia comata* Trin. & Rupr.) to various rate of tebuthiuron. Fifty transplants of each grass species were transplanted to 6-inch pots and moved to a greenhouse. All plants were clipped to a 50 mm height and treated with tebuthiuron at 0, 0.25, 0.50, 0.75, and 1.0 lb ai/A on January 6, 1981. Following treatment the grasses were clipped at 82-day intervals.

In the greenhouse study all grasses treated with tebuthiuron at 0.75 and 1.0 lb ai/A were chlorotic for approximately 160 days following treatment, after which time they recovered. Six western wheatgrass plants and four needleandthread plants died following treatment with tebuthiuron at the 1.0 lb ai/A rate as did one western wheatgrass plant that received 0.75 lb ai/A. Western wheatgrass plants treated with 0.75 and 1.0 lb ai/A (and grown on a loamy sand soil) produced significantly lower yields than plants receiving the 0, 0.25, and 0.50 lb ai/A treatments. Total production, per plant, from three clippings at the 0, 0.25, 0.50, 0.75, and 1.0 lb ai/A rates was 11,037, 9,894, 11,556, 5,269, and 4,527 mg/plant, respectively. Other species showed no consistant patterns of yield differences.

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CONTROL OF SPOTTED KNAPWEED (*CENTAUREA MACULOSA* LAM.) IN MONTANA

T. K. Chicoine, J. M. Story, and L. O. Baker[1]

Abstract: Since its introduction into the United States around 1906, spotted knapweed (*Centaurea maculosa* Lam.) has spread to threaten over 10 million acres in the United States and Canada. Its ability to infest injured lands coupled with the plant's growth habits are making spotted knapweed a serious problem in Montana rangelands. Research done in Montana has attributed declines in range production of more than 75% to spotted knapweed infestations.

Urophora affinis, a gall-producing diptera, was released as a biological control agent between 1973 and 1977. Population levels were closely monitored. By 1981 the flies' density had reached a point at the Missoula release site where it could be harvested and redistributed to a number of locations throughout Montana. This would aid the dissemination of the agent which is a naturally weak flier.

Reduction in seed production alone is often not adequate for immediate eradication of *Centaurea maculosa*. Plants have been observed with seed stalks from 3 to 4 different years producing new growth. Insinuating perennial growth abilities are possessed by the plant. Seed reduction therefore would not be that effective in immediately reducing an infestation.

Applications of picloram (4-amino-3,5,6-trichloropicolinic acid) have been made for such control. Applied at rates of 0.25 lb/A, picloram gave complete eradication of spotted knapweed. Control was carried on into the next year, giving a spotted knapweed-free area for 3 seasons. With the 0.25 lb/A rates, little injury was noticed on the grass species growing in the area.

With the combination of chemical control, biological control, and proper management of Montana rangelands, perhaps the spread of spotted knapweed can be checked, and grass production in the infested areas increased.

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YELLOW STARTHISTLE BIOLOGY AND MANAGEMENT

R. H. Callihan, R. L. Sheley, and D. C. Thill[1]

Abstract: A 1981 survey showed that yellow starthistle (*Centaurea solstitialis* L.), an introduced Eurasian weed, infests 185,000 acres of arid and semi-arid range in Idaho. Yellow starthistle, classified as a noxious weed in Idaho, has invaded an average of 6,000 acres per year in the state during the past 30 years. A facultative winter annual, it characteristically forms dense infestations that drastically reduce forage production by competitive exclusion of desirable species. Excessive consumption by horses, as well as some laboratory animals, has caused nigropallidal encephalomalacia, a form of permanent brain damage, the expression of which can be delayed until several weeks after consumption.

Research indicates that control practices for yellow starthistle are

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generally unsuccessful and uneconomical unless a well-planned IPM program is followed. Such a program should generally begin with early spring application of 1/4 lb/A picloram (4-amino,-3,5,6-trichloropicolinic acid) to yellow starthistle plants that are still in the rosette stage prior to bolting. Although less costly applications of phenoxy herbicides are lethal to yellow starthistle, picloram treatment normally provides residual control of seedlings for a year or more, minimizing the necessity for repeat treatments during the ensuing season. On difficult terrain, however, follow-up treatments are generally necessary to treat skips because of difficulties in making uniform applications. Current research includes investigations involving reseeding procedures, forage species evaluations, timing of herbicide applications, fertilization, grazing management, and yellow starthistle biology. Efforts to locate, import, and establish insects and pathogens of foreign origin are presently underway, but no biocontrol agent has yet been successfully used.

A SUMMARY OF LEAFY SPURGE (*EUPHORBIA ESULA* L.) CONTROL IN NORTH DAKOTA

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Abstract: Leafy spurge control by 2,4-D [(2,4-dichlorophenoxy)acetic acid], dicamba (3,6-dichoro-*o*-anisic acid), picloram (4-amino-3,5,6-trichloropicolinic acid), and glyphosate [*N*-(phosphonomethyl)glycine] in North Dakota was summarized for 60 experimental and 68 demonstrational sites established between 1963 and 1981. Data were summarized across years by herbicide formulations, rates, and season of application. Leafy spurge control by 2,4-D averaged less than 30% after 1 year at rates up to 4.0 lb/A. Control was not affected by 2,4-D formulation or time of year when applied. 2,4-D at 1.0 lb/A applied spring and fall annually provided 65% control after 27 months. Dicamba at 6.0 lb/A or more provided over 90% control the first year, but control decreased rapidly during the second year regardless of formulation used or time of year applied. Dicamba at 1.0 lb/A applied both spring and fall gave 79% leafy spurge control after four years but control declined rapidly after treatments were stopped. Dicamba at 0.75 lb/A plus 2,4-D at 4.0 lb/A applied twice per year gave 97% control after 3 years. Picloram at 2.0 lb/A gave over 90% leafy spurge control for two growing seasons. Control was similar when using liquid or granular picloram regardless of spring or fall application. Picloram at 0.25 lb/A applied both spring and fall annually provided 98% control after 3 years. The combination of picloram at 0.5 lb/A plus 2,4-D at 1.0 lb/A controlled leafy spurge similar to picloram at 2.0 lb/A alone. Fall applied glyphosate at 0.75 lb/A gave 87% control after 9 months, but a follow-up herbicide treatment was necessary for leafy spurge seedling control. Leafy spurge control was not improved by increasing the glyphosate rate.

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CONTROL OF RESPROUTING HARDWOOD CLUMPS WITH APPLICATIONS OF TRICLOPYR ESTER BY HOVERING HELICOPTER

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Several large hardwood species that are serious competitors to conifer production in Western forests resprout profusely after being cut or burned. Bigleaf maple (*Acer macrophyllum* Pursh) can grow 2 to 3 m per year (5) after cutting and in 30-40 years occupy an area 8 to 10 m in diameter. In Western Oregon and Washington, this space could contain 12 to 15 conifers. Other large hardwoods, such as tanoak [*Lithocarpus densiflorus* (Hook. & Arn.) Rehd.], myrtle (*Myrica* spp.), and black oak (*Quercus douglasii* Hook. & Arn.) resprout profusely and can also retard conifer regrowth (3). Selective broadcast applications of available herbicides kill the tops of these trees but root kill is seldom achieved and resprouting begins quickly.

Basal applications of 2,4,5-T [(2,4,5-trichlorophenoxy)acetic acid] or silvex [2-(2,4,5-trichlorophenoxy)propionic acid] low volatile ester at 1.5 to 6 kg/100 liters have been effective on these species (1,4), but brush, steep terrain, and logs often make it difficult to make basal treatments. Since resprouted bigleaf maple clumps are the most serious problem in cutover forest sites, research was initiated to find an improved method of control.

Field trials were initiated by Lauterbach (2) in which he applied silvex ester at 2.5 kg a.e. per 100 liters as an invert emulsion containing about 20% diesel oil to dormant bigleaf maple clumps with a hovering helicopter. The spray was directed to cover all the lower basal stems of each clump using 4 to 6 liters of solution per clump. One or two large jet nozzles directed down were suspended on a boom about 2 meters to the left of the helicopter toe to allow the pilot good visibility of the target. The invert emulsion provided good integrity of the spray stream to the clump base, prevented undesirable off-target damage to adjacent conifers, and provided a good white marker of treated clumps. The oil aided in penetration of the herbicide through the bark and good control was obtained.

On March 1, 1979, the use of silvex was suspended in forests by the Environmental Protection Agency and 2,4-DP [(2,4-dichlorophenoxy)propionic acid] was substituted temporarily for silvex ester in the hovering helicopter application. At this time, triclopyr {[(3,5,6-tricloro-2-pyridinyl) oxy]acetic acid} ester became available for evaluation. Warren (6) reported good control of several sprouting hardwoods including bigleaf maple with basal application of this product at 1% solution in oil. Several applications were made using the hovering helicopter technique described above with 1 to 2% solutions of a triclopyr formulation containing 0.48 kg/L. Low volatile ester of 2,4-DP at 1.9 to 2.4 kg a.e./100 L was included for comparison. Applications were made in February, 1979 and 1980 near Centralia, Washington; Springfield, Oregon; and Coos Bay, Oregon. Twenty to 30 clumps with two to five years' regrowth were treated at each rate. Additional applications were made from December, 1980 through February, 1981.

Bivert TME Inverting Agent was used initially with triclopyr and

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occasionally the inverting process failed. It was found that a mixture of Bivert TME with Bivert PH would produce consistent invert emulsions if the proper mixing sequence was followed. When the Bivert TME and Bivert PH, diesel oil, and triclopyr were mixed thoroughly in the tank and the water added with agitation, a good invert emulsion was produced.

Response of the treated maple clumps was evaluated in late summer at 1, 2, or 3 seasons after application. Ratings of top kill and basal sprouting were averaged and converted to percent control. The effects of the treatment on adjacent conifers was also evaluated.

Results and Discussion

Early applications of triclopyr at 1.8 and 1.3% generally were very effective although 1 or 2 stems of some clumps were not killed. These appeared to be misses resulting from variations in spray coverage. Complete coverage of the larger stems is difficult. Most of the treated clumps were completely killed after two years with triclopyr at 1.0 or 1.3% concentrations. Average control was approximately 95%. Several other hardwoods such as salal (*Gautheria shallon* Pursh), myrtle, huckleberry (*Vaccinium parvifolium* Smith), and hazel (*Corylus cornuta* Marsh.) under the maples were killed when sprayed fully with the herbicide solution.

Treatments with 2,4-DP ester at 5% solutions allowed more resprouting than did triclopyr at 1%. The chemical cost was less with triclopyr. There were no differences in other ingredients or application costs.

Small conifers sprayed directly were seriously injured or killed with both 2,4-DP and triclopyr, but the invert emulsion allowed precise targetting of the spray so that plants 0.33 to 0.67 m from the edge of the clump base were not noticeably affected.

Using 4 L of spray mix per clump, the cost of the hovering helicopter applications averaged approximately $3.50 to $4.50 per clump. Although this cost is somewhat higher than for ground-applied basal treatments on favorable terrain and vegetation cover, the difficulty of access on some sites and availability of personnel favors the helicopter technique.

There may be other thickening agents that could be used with triclopyr for this purpose, but the high oil content and excellent marking of treated clumps with the invert emulsion favor its use.

To date triclopyr applied in an invert emulsion by a hovering helicopter to control sprouted clumps of dormant bigleaf maple has been efficacious and is economically feasible.

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CONTROL OF BRUSH ON CONIFER PLANTATIONS WITH TRICLOPYR ESTER

L. E. Warren[1]

Brush in highly productive forest lands of the Pacific Northwest can seriously compete with conifers, especially young conifers. In the mild climate west of the Cascades in Oregon, Washington, and California, herbicide treatments to control brush can be applied during dormancy or during the growing season. Research (1,2) has shown that most conifers, except pine, will tolerate 2,4,5-T [(2,4,5-trichlorophenoxy)acetic acid] and 2,4-D [(2,4-dichorophenoxy)acetic acid] at rates that provide control of several brush species during late dormancy, after hardwoods begin to grow and before conifer bud break. All conifers can tolerate these sprays in late summer.

Oil carriers to aid in penetration of the herbicide through the bark are needed for dormant treatment of deciduous hardwoods. After bud swell of the conifers, a water carrier can be used, with a decreasing amount of diesel oil or oil substitutes as conifer bud break approaches. At or after conifer bud break and in late summer, oils or surfactants with the herbicides can produce unacceptable injury.

A new herbicide, triclopyr {[(3,5,6-trichloro-2-pyridinyl)oxy]acetic acid}, was recently introduced and is marketed as a low volatile ester formulation (3). It contains 0.48 kg of the butoxy ethyl ester per liter. Early trials indicated that selective control of several important brush species in conifer plantations was possible. This report presents results of research to establish efficacious rates of triclopyr, carriers, and additives for effective brush control during the tolerant growth stages of conifers.

Materials and Methods

Triclopyr was applied by helicopter at rates from 1.1 to 2.2 kg/ha in 93 L of total spray to young conifer plantations in Oregon and Washington, west of the Cascade Mountains.

Treatments in February or March during dormancy were applied in diesel oil carrier except for two sites where water carrier with oil or oil substitute (Atplus 411F or Mor-Act) was used. Previous tests had shown that triclopyr at 2.2 kg/ha in diesel oil on April 11 in the Coast Range seriously injured Sitka spruce, hemlock, and Douglas fir. Buds of the conifers probably were swelling which would make them more susceptible to injury.

The early foliar applications were made after conifer bud swell and before bud break. Atplus 411F at 2.4 L/ha was added to some treatments, but most were in water carrier without additives. Late summer applications, mid-August to September, were made in water carrier without additives. In some treatments, 2,4-D or 2,4-DP [(2,4-dichlorophenoxy)propionic acid] at 1.1 to 2.2 kg/ha was added to triclopyr at all three growth periods. Glyphosate [*N*-(phosphonomethyl)glycine] was added at 0.375 or 0.75 kg/ha

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to early foliar and late summer applications.

Species involved in these trials are listed in Table 1. Response of brush was evaluated by estimating kill of 5 to 15 individuals of pertinent

Table 1. Species chart.

Code	Common name	Scientific name
Weeds and brush		
BL	Blueblossom (E)[a]	*Ceanothus thrysiflorus* Esch.
BM	Bigleaf maple (D)	*Acer macrophyllum* Pursh
CB	Scotch broom (E)	*Cytisus scoparius* (L.) Link
CH	Cherry (D)	*Prunus* spp.
CP	Chinquapin (E)	*Castanopsis* spp.
DW	Pacific dogwood (D)	*Cornus nuttalli* Aud.
EB	Elderberry (D)	*Sambucus glauca* Nutt.
GS	Salal (E)	*Gaultheria shallon* Pursh
HA	Hazel (D)	*Corylus cornuta* Marsh.
HB	Huckleberry (D,E)	*Vaccinium* spp.
LO	Interior live oak (E)	*Quercus wislizenii* A.DC.
MD	Madrone (E)	*Arbutus menziesii* Pursh
MY	Myrtle (E)	*Umbellularia californica* Nutt.
OS	Oceanspray (D)	*Holodiscus discolor*
RA	Red alder (D)	*Alnus rubra* Bong.
RC	Redstem ceanothus (D)	*Ceanothus sanguineus* Pursh
RD	Pacific rhododendron (E)	*Rhododendron macrophyllum* D.Don
RH	Cascara (D)	*Rhamnus purshiana* DC.
SA	Willow (D)	*Salix* spp.
SB	Salmonberry (D)	*Rubus spectabilis* Pursh
SC	Snowbrush ceanothus (E)	*Ceanothus velutinus* Dougl.
TO	Tanoak (E)	*Lithocarpus densiflorus* (Hook & Arn.) Rehd.
VM	Vine maple	*Acer circinatum* Pursh
Crop trees		
C	Incense cedar (E)	*Libocedrus decurrens* Torr
D	Douglass fir (E)	*Pseudotsuga menziesii* (M9rb.) Franco
F	True firs (E)	*Abies* spp.
H	Western hemlock (E)	*Tsuga heterophylla* (Raf.) Sarg.
K	Sitka spruce (E)	*Picea sitchensis* (Bong.) Carr.
P	Ponderosa pine (E)	*Pinus ponderosa* Laws.
W	White pine (E)	*Pinus monticola* Dougl.

[a](D) refers to deciduous species, (E) to evergreen species.

species on a 0-to-10 scale, where 10 reflected dead tops with no resprouting by the end of the 1st to 3rd season after spraying. These figures were averaged and reported as percent control. Conifer response was based on percent burn and/or growth reduction of 10 to 20 individuals of each species.

Experimental treatments at several locations to evaluated the response of brush and conifers to triclopyr at each of the phenological stages are intemized in Tables 2, 3, and 4. The northern areas include most deciduous hardwoods whereas the southern portion has mostly evergreen species.

Table 2. Selected locations of dormant applications of triclopyr on conifer plantations

Triclopyr (kg a.e./ha)	Carrier	Additive-L/ha		Application date	Observation date	Location
2.2	oil	--	--	3/78	8/15/79	Alsea, OR
2.2	oil	--	--	3/2/78	8/14/79	Springfield OR
2.2	oil	--	--	3/22/79	8/14/79	Springfield OR
2.2	oil	--	--	2/27/81	10/81	Woodland WA
1.6	oil	--	--	2/27/81	10/81	Woodland WA
1.1 + 2,4-D @ 1.1	oil	--	--	2/27/81	10/81	Woodland WA
2.2	water	diesel	2.4	3/20/78	10/81	Roseburg OR
1.1	oil	--	--	2/27/81	10/81	Springfield OR
1.1	oil	--	--	2/7/81	10/81	Coos Bay OR
1.1	oil	--	--	4/7/81	10/81	Roseburg OR
1.6	oil	--	--	4/7/81	10/81	Roseburg OR
1.1	oil	--	--	3/11/81	10/81	Lebanon OR
1.1	water	Mor-Act	9.6	3/11/81	10/81	Lebanon OR
1.1 + 2,4-DP @ 2.2	oil	--	--	3/11/81	10/81	Lebanon OR

Table 3. Selected locations of early foliar applications of triclopyr on conifer plantations

Triclopyr (kg a.e./ha)	Carrier	Additive-L/ha		Application date	Observation date	Location
2.2	water	--	--	5/16/79	7/81	Forks WA
1.1 + 2,4-D @ 1.1	water	--	--	5/16/79	7/81	Forks WA
1.1	water	--	--	5/12/81	10/81	Morton WA
1.1 + 2,4-D @ 1.1	water	--	--	5/13/81	10/81	Woodland WA
1.6	water	--	--	5/13/81	10/81	Woodland WA
1.1	water	--	--	5/13/81	10/81	Mollala OR
1.4	water	Mor-Act	4.8	4/9/81	11/2/81	Gold Beach OR

Results and Discussion

The responses of several important brush and conifer species to the various treatments with triclopyr were averaged for each growth stage and are presented in Tables 5, 6, and 7.

During late dormancy good to excellent control of red alder, cascara, snowbush, madrone, chinquapin and Scotch broom was obtained with triclopyr at 1.1 to 2.2 kg ae/ha in oil carrier or in water with 10% Mor-Act. Big-leaf maple, vine maple, hazel, red huckleberry, and cherry were controlled satisfactorily. At this timing salmonberry, salal, oceanspray, elderberry, willow, and myrtle were poorly controlled. The addition of 2,4-D or 2,4-DP at 1.1 to 2.2 kg/ha did not improve control.

On the control of most brush species there was little difference

Table 4. Selected locations of late summer applications of triclopyr on conifer plantations

Triclopyr kg a.e./ha	Carrier	Additive-L/ha		Application date	Observation date	Location
1.1	water	oil	4.8	9/13/80	8/81	Troutlake WA
2.2	water	oil	4.8	9/13/80	8/81	Troutlake WA
1.1 + 2,4-D @ 1.1	water	oil	4.8	9/13/80	8/81	Troutlake WA
1.6	water			9/15/80	10/81	Estacada OR
1.1 + 2,4-D @ 1.1	water			9/15/80	10/81	Estacada OR
1.1 + glyphosate @ 0.375	water			9/15/80	10/81	Estacada OR
2.2	water			9/27/79	10/81	Butte Falls OR
1.6	water			9/17/80	9/81	Butte Falls OR
1.1 + glyphosate @ 0.375	water			9/29/80	9/81	Butte Falls OR
3.3	water			8/1/79	7/81	Cow Creek OR
1.6	water			8/15/80	11/81	Hunter Creek OR

between oil carrier and water carrier with 10% Mor-Act, but the effect on Douglas fir was less with the water carrier plus Mor-Act. Other conifers except pine were more tolerant of triclopyr than was Douglas fir. Even though conifers had some needle burn or were suppressed the first season, the buds were full and growth improved during the second season.

The control of alder and chinquapin was similar at dormancy and early foliar growth stages. Control of vine maple was better with dormany applications of triclopyr while salmonberry and elderberry responded better during the early foliar stage.

Control of most brush species at the late summer period was slightly less than at early foliar or dormant timing. Dry summers in southwestern Oregon may produce a serious soil moisture stress which can reduce the effectiveness of herbicides. Certain species senesce earlier than others. A combination of these factors may have been responsible for the poorer response of tanoak in late summer than in spring. To avoid dry weather, late summer applications should be made as soon as possible after conifer buds harden.

Generally, Douglas fir and true firs have been affected about equally by triclopyr; Western hemlock and Sitka spruce were more tolerant and western red cedar and incense cedar were affected very little. The long needle pines, such as ponderosa, were very susceptible to triclopyr at rates applied. Limited observations indicate that white pine (short needle) may tolerate sufficient triclopyr in late summer to give effective brush control.

Conclusions

Triclopyr at 1.1 to 1.6 kg/ha alone or combined with 2,4-D at 1.1 kg/ha is promising for conifer release at three phenological stages, except on pine. Short-needle pines may be sufficiently tolerant to allow use of triclopyr in late summer. Triclopyr in water carrier with oil substitutes may equal brush control with oil carrier during late dormancy, with less effect on conifers. Oils must be reduced or eliminated as

Table 5. Average control of brush in conifers with dormant applications of triclopyr

Treatment (kg/ha)[a]	Plant species (percent control-Sept./Nov., 1981)																	% injury[b]	
	Alder	Vine maple	Bigleaf maple	Cherry	Salmonberry	Willow	Cascara	Elderberry	Hazel	Huckleberry	Oceanspray	Chinquapin	Snowbrush	Salal	Scotch broom	Madrone	Myrtle	Douglas Fir	Hemlock
triclopyr 1.1 in oil	96	78	80			56	93	49	57	64	60	92		48	81	79	67	9	0
triclopyr 1.1 in water + Mor Act, 10%		85						75		85	65			45				4	0
triclopyr 1.6 in oil	92	85	70		52			10	82		55	95		56	99	93		8	0
triclopyr 2.2 in oil	96	78	76	85	52			15	90	90	52	98	98	50		90	75	11	0
triclopyr 2.2 in water + 10% oil, 1% surfactant						62					33	98	98			90		2	0
triclopyr 1.1 + 2,4-D or 2.4-DP @ 1.1 in oil or water + 10% Mor-Act	88	77	75	39	60	73	93	45	70		62	90		40				8	1

[a]Applications made in February and March

[b]Ponderosa pine had 60% burn

Table 6. Average control of brush in conifers with early foliar applications of triclopyr

Treatment (kg/ha)[a]	Plant species (percent control--Sept./Nov. 1981)																			Percent[b] injury	
	Alder	Vine maple	Bigleaf maple	Cherry	Salmonberry	Willow	Cascara	Elderberry	Hazel	Huckleberry	Oceanspray	Chinquapin	Snowbrush	Salal	Scotch broom	Madrone	Myrtle	Tanoak	Rhododendron	Douglas fir	Hemlock
triclopyr 1.1	93	61		44	67	78	81	90	74	73	63	92	92	50	93	92		82	72	5	1
triclopyr 1.6	92	70		50	85	78		90	53		65	94			88	98		81	81	7	2
triclopyr 2.2	98	57			92	95	80	85			95					58				16	5
triclopyr 1.1 + 2,4-D 1.1	95	73	68	55	75	82	75	93	74	60					93	55				6	1
triclopyr 1.1 + glyphosate 0.5	95	68	38	42		60	60	87	60		20									6	20

[a]Applications made in early may

[b]White pine had 20% injury at end of first season; Sitka spruce was essentially unaffected

Table 7. Average control of brush in conifers with late summer applications of triclopyr

Treatment (kg/ha)[a]	Plant species (percent control)																				
	Alder	Vine maple	Cherry	Salmonberry	Willow	Cascara	Elderberry	Hazel	Huckleberry	Oceanspray	Chinquapin	Snowbrush	Salal	Scotch broom	Madrone	Myrtle	Tanoak	True firs	White pine	Hemlock	Douglas fir
triclopyr 1.6	89	53	80	92	66	79	90	68		57	67	66	60		30	64	67			0	6
triclopyr 2.2		79	90		52	75	93	40			90	92				88		8	10		3
triclopyr 1.1 + 2,4-D 1.1	85	53	65	93	62	63	70	56	75	57		72	58	95						3	6
triclopyr 1.1 + glyphosate 0.5	60	60		94	62	93	95			80			45	93	10					4	6

[a] All applications made in September

conifer bud break is approached.

Susceptibility of certain brush species changes with the phenological stage and prescriptions for treatments should recognize these variations.

Acknowledgements

Paul Lauterback, Weyerhaeuser Company, Tacoma, WA; Dr. Michael Newton, Oregon State University, Corvallis, OR; Douglas Belz, Washington State Department of Natural Resources, Olympia, WA; and Hobart Jones, Wilbur-Ellis Company, Portland, OR; for their help in initiating these studies.

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DEPOSITS AND DEGRADATION OF HERBICIDES IN SCLEROPHYLL BRUSHFIELD FOLIAGE

Michael Newton, Adrianne Allen, Diane E. White, Bruce E. Kelpsas, and Fred Roberts[1]

A study of herbicide residues was conducted as part of a program for evaluating consequences of various vegetation management methods in southwest Oregon. Herbicide treatments for site preparation and conifer release included aerial application of 2,4-D [(2,4-dichlorophenoxy)acetic acid] ester, two rates of triclopyr {[(3,5,6-trichloro-2-pyridinyl)oxy]acetic acid} amine, two rates of triclopyr ester, and a mixture of 2,4-D ester with potassium salt of picloram (4-amino-3,5,6-trichloropicolinic acid).

Residues above ground were taken from foliage in upper crown of shrubs, from the browse layer in lower crowns of the same shrubs, and from litter under the same shrubs. Brushfields studied were 1-3 meters tall representing 6-8 years of development after clearcutting Douglas-fir [*Pseudotsuga menziesii* (Mirb.) Franco] or mixed conifer stands. Composition was dominated by tanoak [*Lithocarpus densiflorus* (Hook & Arn.) Rehd.] sprouts, but included major elements of manzanitas (*Arctostaphylos* spp.), madrone (*Arbutus menziesii* Pursh), golden chinkapin [*Castanopsis chrysophylla* (Doubl.) A.DC.], and varnishleaf ceanothus [*Ceanothus velutinus* var. *laevigatus* (Hook.) T. & G.].

Collection of samples was largely from tanoak. Twenty specimens were tagged in each of three replicated plots before treatment. Healthy twigs were color coded as to the date they would be clipped from overstory or understory locations. On the specific date of collection, the twenty twigs per plot were bulked for analysis and frozen. Litter samples were 100 percent collections from two of the twenty shrubs in each plot, selected at random. The litter collection included all organic material

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less than 1 cm in a half-meter square; most of the material was dead leaves. Dates of collection were 0, 18, 37, 79, 153, and 325 days after treating. Metal cups on each shrub were used to estimate absolute deposit rate.

Samples were analyzed by gas-liquid chromatography with a detection limit of about 0.1 part per million (ppm) wet weight basis.

Crown samples of all herbicides, as expected, contained higher levels than understory foliage. The lower foliage caught from one-half to one-sixth of the canopy deposits. Litter was highly variable, ranging downward from levels found in the canopy to less than one-tenth of crown deposits.

All herbicides showed substantial degradation with time (Tables 1, 2). Most rapid was picloram, with a half life of less than one month; 2,4-D, with a half-life close to six months, was the most persistent. Both formulations of triclopyr were intermediate in persistence, with initial half-lives somewhat more than one month, but a pattern of slow decline from the third month to the end of sampling. Between the triclopyr formulations, the amine salt showed more rapid decline initially than the ester, but rates were similar after two months.

Table 1. Concentrations of several herbicides in tanoak canopy foliage from 0 to 325 days after application in the Siskiyou Mountains of Oregon

Herbicide	Rate (kg/ha)	Concentration (mg/kg) Day 1	18	37	79	153	325
2,4-D ester	2.2	66	40	39	32	28	14
	3.3	157	107	88	60.0	53	52
Picloram, K salt	0.55	22	12	7.5	1.1	1.3	2.8
Triclopyr amine	2.2	141	122	32	21	16	17
	4.4	221	150	51	23	26	21
Triclopyr ester	1.65	69	54	35	24	24	23
	3.3	127	57	59	60	45	37

The rapid decline observed initially in residues occurred before significant fall rains, in a climate characterized by intense sunshine. We postulate that the dry environment of aerial parts of shrubs is not conducive to microbial degradation, and that photolytic destructive processes were active. We also note that ester forms of herbicides, which tend to absorb more readily in sclerophyll foliage than water-soluble salts, also did not redgrade as quickly. They are thus less exposed to ultraviolet radiation, and would be expected to be more persistent if photolysis were a major destructive process.

The treatments were applied by helicopter equipped with Raindrop nozzles, flying at about 40 feet above the canopy. The steel cups indicated targeting rates of chemical were more than 90 percent of nominal application rates, but that much variability occurred. Even more variability was observed in foliage concentrations, so that there was a poor correlation between chemical landing on target and concentration in target plants. The high degree of targeting was to be expected because of flagged plots and large droplet size. We have no explanation of the poor correlation of dosage with foliage concentration. Our findings indicate that this is commonplace. Apparently large numbers of replications are needed when using aerial applications for hebicide testing unless target shrubs have measured residues.

Table 2. Concentrations of herbicides in tanoak understory foliage from 0 to 325 days after application in the Siskiyou Mountains of Oregon

Herbicide	Rate (kg/ha)	Concentration (mg/kg) Day 1	18	37	79	153	325
2,4-D ester	2.2	26	--	10	6.3	9.0	5.8
	3.3	58	--	22	21	22	19
Picloram, K salt	0.55	11	--	9.3	1.0	0	1.1
Triclopyr amine	2.2	76	--	12	9.8	7.5	6.9
	4.4	49	--	18	14	14	11
Triclopyr ester	1.65	24	--	20	8.6	11	13
	3.3	33	--	29	17	18	11

INVERT EMULSIONS OF TRICLOPYR

E. J. King, R. D. Fears, and L. E. Warren[1]

Abstract: Experiments were conducted to generate the data necessary to obtain state and federal labeling for application of invert emulsions of triclopyr by hovering helicopters in order to control bigleaf maple (*Acer macrophyllum* Pursh) in forests in the Pacific Northwest. Experiments were also conducted to determine the feasibility of using commercially available inverting agents to produce invert emulsions of triclopyr {[(3,5,6-trichloro-2-pyridinyl)oxy]acetic acid} alone or in combination with various 2,4-D [(2,4-dichlorophenoxy)acetic acid] and picloram (4-amino-3,5,6-trichloropicolinic acid) products which would be thick enough to reduce spray drift when applied to electrical distribution line rights-of-way.

The data required for state and federal labeling were generated, and state labeling has been approved in Oregon and Washington. Excellent mixtures which were produced with all combinations of herbicide mixtures which were tested with a few exceptions. All combinations of ester products with other esters, all amines with other amines, amines with potassium salt, and esters plus potassium salt produced stable invert emulsions. However, combinations of amine salts with esters did not produce stable invert emulsions. Three of the four commercially available inverting agents tested produced satisfactory invert emulsions with the successful herbicide combinations tested.

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GROWTH RESPONSE OF DOUGLAS-FIR AFTER HERBICIDE APPLICATION AND HAND CLEARING

M. Newton, D. E. White, and B. R. Kelpsas[1]

Douglas-fir [*Pseudotsuga menziesii* (Mirb.) Franco] growth response was compared after manual release, control, and three herbicide treatments. Age of brush ranged from 15-25 years, and conifers ranged from dominant to suppressed. Herbicide treatments were made aerially and included the following chemicals and dosages: 2,4-D [(2,4-dichlorophenoxy)acetic acid] low valatile ester at 3.3 kg/ha, a mixture of 0.6 kg/ha picloram (4-amino-3,5,6-trichloropicolinic acid) and 2.2 kg/ha of 2,4-D as amine salts, and triclopyr {[(3,5,6-trichloro-2-pyridinyl)oxy]acetic acid} ester at 3.3 kg/ha. All chemicals were applied at two seasons, August 1-2 and October 7, 1979. All were applied as aqueous sprays at 98 liters/ha. In August 1979, shrubs in hand release plots were cut with chainsaws to within 2 dm of the ground. Shrub responses are reported for madrone (*Arbutus menziesii* Pursh), chinkapin [*Castanopsis chrysophylla* (Dougl.) A. DC.], canyon live oak (*Quercus chrysolepsis* Liebm.), whiteleaf manzanita (*Arctostaphylos viscida* Parry), hairy manzanita (*Arctostaphylos columbiana* Piper), and oceanspray (*Holodiscus discolor*). First year berbicide injury and second year shrub crown recovery were made up from the composite responses of these six shrub species.

Herbicide injury ratings showed no statistical differences between treatments. Analysis of variance showed statistical differences (5% level) between percent shrub crown recovery over all treatments (Table 1).

Table 1. Mean percent crown recovery to pretreatment levels.

Treatment	Percent crown recovery[a]
Control	108.5 ± 10.7
Hand release	39.0 ± 10.7
2,4-D August	72.5 ± 10.8
2,4-D October	44.7 ± 16.4
Triclopyr ester August	69.4 ± 12.8
Triclopyr ester October	65.3 ± 13.7
Picloram + 2,4-D August	72.8 ± 11.7
Picloram + 2,4-D October	89.0 ± 12.8

[a]With 95% confidence intervals

Conifer growth response is expressed as a ratio of the height growth two years after treatment divided by height growth two years before treatment. Table 2 shows the conifer growth ratio for all treatments.

Treatments fell into three categories: 1) those in which the conifers were not injured, i.e. control and triclopyr ester in October, 2) those in which injury was minor: 2,4-D and triclopyr ester in August, and 3) those in which injury was severe, such as the picloram and hand release treatments. The trees in the hand release plot have probably exhibited poor growth because of high sudden radiation exposure of the

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canopy in conjunction with continued below ground competition from sprouting shrubs. Currently, triclopyr ester at 3.3 kg/ha has good selectivity when applied in October. Several more years will be needed to evaluate release benefits from any of the treatments on a long-term reliable basis.

Table 2. Conifer growth ratio

Treatment	Growth ratio
Control	1.22
Hand release	0.80
2,4-D August	1.02
2,4-D October	1.12
Triclopyr ester August	1.04
Triclopyr ester October	1.22
Picloram + 2,4-D August	0.72
Picloram + 2,4-D October	0.76

PLANT COMMUNITY CHANGES AND CONIFER STOCK TYPE PERFORMANCE FOLLOWING BRUSHLAND CONVERSION

Bruce R. Kelpsas and Michael Newton[1]

A study was initiated in 1976 to compare four methods of site preparation in a deciduous brushfield in the Coast Range of Oregon, and how they affected plant communities and planted seedling performance. The treatments included: 1) Scarification by bulldozer, 2) Aerial application of glyphosate [*N*-(phosphonomethyl)glycine] at 1.5 lb AE/A, 3) Aerial application of 2,4,5-T [(2,4,5-trichlorophenoxy)acetic acid] and picloram (4-amino-3,5,6-trichloropicolinic acid) at 2 lb AE and 1 lb AI/A, respectively, followed by broadcast burning, and 4) Herbicides as in treatment 3, followed by broadcast crushing by bulldozer. All were performed after salvage logging of hardwoods.

Permanent sample points were established in each area before treatment and were revisited periodically to collect vegetation data. In addition, bare root seedlings of six stock type-species combinations were planted around each point after site preparation to determine optimum seeding environments created by the treatments. The stock types were: 1) and 2) small and medium sized 2-0 Douglas-fir (SF & MF), 3) large 2-1-2 Douglas-fir (LF), 4) 2-2 sitka spruce (SS), 5) 2-1-2 hemlock (HE), and 6) 2-2 grand fir (GF). Survival and height growth were recorded for four years after planting.

All treatments were successful in reducing both tree and shrub canopies to near-zero values. Five years after treatment the distribution of shrub and tree cover has yet to reach pretreatment levels.

Differences in survival of individually recorded shrubs and trees in each treatment are more pronounced. Table 1 shows that the scarification

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treatment initially killed the most woody plants (74%) and that shrub mortality remained nearly level for the succeeding five years. In contrast, the glyphosate applications initially reduced the total sample on only 30 percent but mortality continued throughout the five-year sampling period. Similar trends are exhibited by the burn and crush treatments.

Table 1. Attrition of sampled woody plants

Year	Treatment (percent remaining)			
	Scarify	Glyphosate	Burn	Crush
1976 (pretreatment)	100	100	100	100
1977	26	70	54	50
1978	26	55	44	40
1981	25	45	43	35

Survival of planted seedlings also differed by treatment (Table 2). This most noticeable in the small 2-0 Douglas-fir seedlings (SF) where four-year survival was 82 percent in the scarified treatment, but only 25 percent in the glyphosate treated areas. Large Douglas-fir (LF) and sitka spruce (SS), in contrast, survived well in all treatment areas.

Table 2. Average stock type survival after four growing seasons.

	Treatment (percent remaining)			
Stock type	Scarify	Glyphosate	2,4,5-T picloram burn	2,4,5-T picloram crush
SF	82	25	34	52
MF	68	56	58	72
LF	89	75	84	70
SS	89	88	91	93
HE	43	50	59	60
GF	56	59	68	45

These data suggest that land managers may have several options for regenerating brushfields of this type, depending on the combinations of site preparation and stock type chosen. Those treatments involving less energy-intensive clearing may require larger planting stock. In all treatments, large stock is performing well enough to shorten overall production cycles by several years relative to conventional 2-0 bare root Douglas-fir.

POST-ATTACHMENT CONTROL OF DODDER IN TOMATO

A. H. Lange and A. R. Saghir[1]

Abstract: Dodder (*Cuscuta campestris* Yunck.) was susceptible to glyphosate [*N*-(phosphonomethyl)glycine] at 0.05 + 0.05 kg/ha, and mefludidide [*N*-(2, 4-dimethyl-5-{[(trifluoromethyl)sulfonyl]amino}phenyl) acetamide] at 2.0 kg/ha when applied as foliar sprays after its attachment to tomato (*Lycopersicon esculentum* Mill.). Tomato was injured at high rates of glyphosate, and vigor response was different in the various cultivars used (cv. Peto 94, E 6203, NCX 3032, Murietta). Dodder regrowth was abnormal in the glyphosate treatments and was severely curtailed by mefluidide.

Dodder is a noxious stem parasite which infests several broadleaf crops of economic importance in the world. In California, dodder is becoming a serious problem on alfalfa and tomato. It is also widespread on sugarbeets, onions, ornamentals, and several herbaceous weeds and shrubs in non-cropped areas.

Tomato is considered one of the leading vegetable crops in California. Most of the weed problems on this crop have been solved by various control methods (10). Of the major weed species requiring more work, namely the nightshades (*Solanum nigrum* L. and *S. sarrachoides* Sendt.) and nutsedges (*Cyperus esculentus* L. and *C. rotundus* L.), dodder is considered one of the most difficult weeds to control. This is due to the intimate connection between the host and the parasite, the dormancy and longevity of its seeds, and the lack of available adequate selective herbicides and other means of control.

Several herbicides have been found to control dodder in alfalfa (3, 4, 5, 6, 7, 9); however, in tomatoes few chemicals have been reported to be effective (1, 8). The most commonly used chemical for the control of dodder in tomato is CDEC (*N*-*N*-diallyl-2-chloroacetamide) (2); however, this chemical is no longer available. Very often dodder is not observed in the field until after it is attached, and growing vigorously in and on top of the host plant. In most cases, such infestations are localized and are most effectively controlled postemergence before they are allowed to spread.

The demonstration that glyphosate and mefluidide effectively controlled *Orobanche*, a root parasite on tomato (11, 12), and that glyphosate was active on dodder in tomato and alfalfa (Lange; Dawson and Saghir, unpublished data) prompted this work. The objective of this study was to evaluate several postemergence herbicides and growth regulators for the selective control of dodder in tomato.

Segments of dodder shoot terminals were collected from potted tomatoes infested with dodder in the greenhouse. Four of these segments, each 15 to 20 cm in length, were placed upon the foliage of 'Peto 94' tomato seedlings grown in 20 cm pots, so that their tendrils could wrap around the tomato plants. On September 18, 1981, when the dodder was well attached on tomato, the following chemicals were sprayed on the parasite and host foliage: glyphosate, BAS 9052 {2-[1-(ethoxyimine)-butyl-5-2-(ethylthio)-propyl]-3 hydroxy-2-cyclohexen-1-one}, BAS 083-01W, and mefluidide. The rates listed in Table 1 were applied in water at 860 L/ha. These treatments were replicated four times in a randomized block design.

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Table 1. Response of dodder and tomato to foliar applications of chemicals in the greenhouse.

		Dodder		Tomato
Treatment	Rate (kg/ha)	Condition[z] (after 2 weeks)	Regrowth[y] (1 week after removal)	Phytotoxicity[x] (%, after 3 weeks)
Glyphosate	0.025	6.7	10.0	75.0
	0.075	5.0	6.0	50.0
	0.125	4.7	4.0	0.0
	0.175	7.5	4.7	25.0
	0.225	6.5	4.3	12.5
	0.275	4.0	3.2	0.0
BAS 9052	0.5	5.0	4.0	75.0
	2.0	5.5	10.0	75.0
BAS 083-01W	0.05	2.5	0.0	100.0
	0.20	5.7	0.0	100.0
Mefluidide	0.5	6.5	0.0	37.5
	2.0	7.5	0.0	25.0
Untreated	---	4.5	0.25	87.5

[z]Visual estimate where: 0 = no effect; 10 = good control.

[y]Visual extimate where: 0 = no regrowth; 10 = maximum regrowth.

[x]Visual evaluation of tomato phytotoxicity.

A second experiment using glyphosate at rates listed in table 2 was applied at 980 L/ha sequentially on the infested foliage, with the second application sprayed one week after the initial applications. These treatments plus an untreated check were replicated three times. Three tomato cultivars were used; namely 'E 6203', 'NCX 3032', and 'Murrieta.' The response of tomato and dodder were determined by visual ratings, and phytotoxicity symptoms were noted. Dodder regrowth and percent phytotoxicity to tomato were evaluated one week after removing all visible dodder from the host.

Dodder was susceptible to glyphosate at 0.175 kg/ha and mefluidide at 2.0 kg/ha (Table 1). Glyphosate reduced the diameter of stems and tendrils, and caused shriveling, browning, and cessation of dodder shoot growth. Mefluidide caused reduction in length of shoots and general growth of the parasite. One week after removal of dodder from tomato plants, vegetative regrowth of dodder shoots occurred in the glyphosate and BAS 9052 treated pots. In general, the extent of regrowth coincided with the rate of herbicide used. Normal stems and tendrils appeared from BAS 9052 and glyphosate at 0.025 kg/ha. However, as the rate of this herbicide was increased, less regrowth occurred. The regrowth was abnormally branching, stunted, and distorted.

Little or no regrowth was observed in the BAS 083-01W and mefluidide

Table 2. The effect of sequential treatment of glyphosate on dodder and tomato cultivars in the greenhouse

Glyphosate Treatment (kg/ha)	'E 6203'		'NCX 3032'	
	Dodder control[z]	Tomato vigor[y]	Dodder control[z]	Tomato vigor[y]
0.025 + 0.025	3.7	8.7	5.3	8.0
0.050 + 0.050	7.7	7.0	7.7	8.5
0.075 + 0.075	8.0	7.0	6.7	5.0
0.100 + 0.100	6.7	4.7	8.0	7.0
0.150 + 0.150	7.7	2.0	7.7	6.3
Untreated	2.0	7.7	4.3	6.0

[z]Visual estimate after 3 weeks, where: 0 = no effect; 10 = good control.

[y]Visual estimate after 3 weeks, where: 0 = dead plants; 10 = vigorous plant growth.

Little or no regrowth was observed in the BAS 083-01W and mefluidide treatments. This was due to the 100% kill of tomato in the BAS herbicide (Table 1) which evidently could not support the dodder and as such was not able to regrow; however, the effect was striking in the case of mefluidide where the haustoria were completely suppressed, and no dodder regrowth was evident in spite of the low percentage of tomato plants killed. Similar results occurred in glyphosate applications at 0.125 to 0.275 kg/ha where dodder regrowth was low and tomato plants were still growing vigorously.

Data in Table 2 show that sequential applications of glyphosate at 0.05 + 0.05 kg/ha and above were effective in controlling dodder; however, injury started to appear on tomato at rates above 0.1 + 0.1 kg/ha in 'E 6203' tomatoes. Slight to severe leaf variations occurred three days after treatment at the high rates of glyphosate. The cultivar 'NCX 3032' did not show striking effects due to glyphosate, whereas the cultivar 'Murietta' did not tolerate this herbicide at 0.075 + 0.075 kg/ha and above with most of the plants becoming chlorotic, shriveled and dead two weeks after treatments. Some of the damage to tomato was due to an interaction with what appeared to be *Phytophthora* root rot.

These results suggest that low rates of glyphosate, and optimum rates of mefluidide have potential use for dodder control in certain cultivars of tomato.

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THE USE OF OXYFLUORFEN IN ONIONS

J. T. Schlesselman[1]

The voluntary withdrawal of nitrofen (2,4-dichlorophenyl *p*-nitrophenyl ether) has resulted in the temporatry elimination of an effective herbicide which was registered in many vegetable crops. The impact of such a loss is especially evident in dry bulb onions, where limited herbicide options are available. Growers may spend upwards of $60.00 per acre for handweeding the weeds that are resistant to many of the currently used herbicides. Research began in California during the spring of 1981 to determine if oxyfluorfen [2-chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl)benzene] could be effectively used in dry bulb onions. The data presented here are results from the 2 lb ai/gallon emulsifiable concentrate formulation of oxyfluorfen. All trials were designed as complete randomized blocks with 4 replications.

1981 Direct-Seeded Onion Trials

Six replicated trials were conducted in Kern, Fresno, and Monterey Counties where oxyfluorfen at rates of 0.125 - 0.5 lb ai/A was compared to chloroxuron {3-[*p*-(*p*-chlorophenoxy)phenyl]-1,1-dimethylurea} and bromoxynil (3,5-dibromo-4-hydroxybenzonitrile) in applications which were postemergence

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to both onions and weeds. Applications were made to onions which were anywhere from flag-1 leaf stage to the 3-4 leaf stage. Crop response to oxyfluorfen was a typical necrosis of some leaf tissue, resulting in twisting or "pigtailing." Maximum effect was displayed 1-2 weeks after application, with no apparent lasting symptioms at 4-6 weeks.

The predominant weeds in these trials were common groundsel (*Senecio vulgaris* L.), London rocket (*Sisymbrium irio* L.), shepherdspurse [*Capsella bursa-pastoris* (L.) Medic.], and little mallow (*Malva parviflora* L.]. Most of these trials were not established until the weeds were greater than 3 inches in height. Even with a non-ionic surfactant, oxyfluorfen at rates of 0.25 lf ai/A and less were unable to sufficiently control most of the larger weeds. However, a split application of oxyfluorfen at 0.25 + 0.25 lb ai/A made at a 2 week interval did result in excellent control of most weeds. Table 1 shows the postemergence weed control evaluations taken of the 4 weed species. In most cases, the split application of oxyfluorfen at 0.25 + 0.25 lb ai/A resulted in much better weed control than a single 0.5 lb ai/A application. Chloroxuron showed erratic results in controlling groundsel, but did result in excellent activity on shepherdspurse and, for the most part, on London rocket. Bromoxynil gave complete control of groundsel and shepherdspurse at the 0.5 lb ai/A rate, as well as good control of small London rocket. Neither chloroxuron nor bromoxynil had much activity on little mallow.

Table 1. The effect of 3 herbicides on postemergence weeds in onions.

Herbicide lb ai/A	Postemergence weed control (%)[a]							
	Common Groundsel			London Rocket			Shepherds-purse	Little Mallow
	1"	5"	12"	3"	9"	12"	3"	3"
Oxyfluorfen 0.25+0.25[b]	98	80	79	90	-	72	79	100
Oxyfluorfen 0.5	-	70	68	100	88	58	48	100
Oxyfluorfen 0.5 + 0.5[b]	-	96	85	100	-	85	90	100
Chloroxuron 2.0 + 2.0[b]	60	64	100	-	-	95	100	19
Chloroxuron 4.0	-	77	90	100	81	40	100	20
Bromoxynil 0.25	-	81	-	33	70	-	78	10
Bromoxynil 0.5	-	100	-	90	68	-	100	18
Control 0	0	0	0	0	0	0	0	0

[a]Average control of 4 replications

[b]Split applications made at two week interval

Two of the trials were handweeded and evaluated for residual weed control activity 3 1/2 months after the initial application (Table 2). The overall preemergence activity of oxyfluorfen on hairy nightshade (*Solanum sarachoides* Sendt.), common lambsquarters (*Chenopodium album* L.), and little mallow was 88-98%. Overall weed control activity for chloroxuron as 72-78%.

Table 2. Activity of 2 herbicides on 3 weed species in onions 3 1/2 months after application

		Preeemergence Weed Control (%)[a]			
Herbicide	lb ai/A	Hairy Nightshade	Lambs-quarters	Little Mallow	Average Weed Control
Oxyfluorfen	0.25+0.25[b]	95	98	89	94
Oxyfluorfen	0.5	87	98	79	88
Oxyfluorfen	0.5+0.5[b]	97	100	96	98
Chloroxuron	2.0+2.0[b]	88	89	56	78
Chloroxuron	4.0	74	90	53	72
Control	0	48	60	20	43

[a]Average of 2 experiments; each having 4 replications

[b]Split applications made at two week interval

Five of the trials were harvested for yield data. Table 3 shows that oxyfluorfen did not reduce onion yields when compared to the untreated control or the other herbicide treatments.

Table 3. The effect of 3 herbicides on direct-seeded dry bulb onions.

		Onion Yield (Tons/Acre)[1]				
		Onion Stage at Application				
Herbicide	lb ai/A	3-4 leaf		2 leaf		Flag-1 leaf
Oxyfluorfen	0.25+0.25[2]	43 a	18 a	19 ab	20 a	21 a
Oxyfluorfen	0.5+0.5[2]	40 a	17 a	-	21 a	-
Chloroxuron	2.0+2.0[2]	-	16 a	-	18 bc	21 a
Chloroxuron	4.0	-	17 a	17 ab	20 a	1
Bromoxynil	0.25	-	-	18 ab	21 a	-
Bromoxynil	0.5	-	-	13 b	21 a	-
Control (handweeded)	0	41 a	17 a	-	20 a	-
Control (weedy)	0	-	-	17 ab	15 c	15 b

[1]Average of 4 replications; letters indicate statistical significance at P = 0.05

[2]Split applications made at two week interval

1982 Direct-Seeded Onion Trials

There are several ongoing onion trials in Imperial County. The first series of trials was established preemergence to the onions, where oxyfluorfen at 0.125, 0.25, and 0.5 lb ai/A was compared to DPCA (dimethyl tetrachloroterephthalate) at 10.5 lb ai/A and bensulide [*O*,*O*-diisopropyl phosphorodithioate *S*-ester with *N*-(2-mercaptoethyl)benzensulfonamide] at 6.0 lb ai/A. Evaluations taken 2-3 months after application (Table 4)

Table 4. Activity of 3 herbicides applied preemergence to direct-seeded dry bulb onions

Herbicide	Rate lb ai/A	% Stand Reduction[a]	Preemergence Weed Control (%)[b] Nettleleaf Goosefoot	London Rocket	Sweet Clover	Little Mallow	Rabbit-foot grass	Canary-grass
Oxyfluorfen	0.125	53	96	100	75	93	98	97
Oxyfluorfen	0.25	71	100	100	90	99	100	100
Oxyfluorfen	0.5	88	100	100	98	100	100	100
DCPA	10.5	8	95	82	70	55	100	98
Bensulide	6.0	29	77	64	57	50	98	84
Control	0	3	24	51	38	54	31	54

[a]Average of 3 experiments of 4 replications each. Evaluations taken 1 month after application.

[b]Evaluations taken 2-3 months after application.

resulted in all rates of oxyfluorfen giving 93-100% control of nettleleaf goosefoot (*Chenopodium murale* L.), London rocket, little mallow, rabbitfootgrass [*Polypogon monspeliensis* (L.) Desf.] and canarygrass (*Phalaris* sp.). Oxyfluorfen was also very active (75-98%) on annual yellow sweetclover [*Melilotus indica* (L.) All.]. DCPA gave outstanding grass and goosefoot control (95-100%) and to a lesser degree London rocket (82%) and sweetclover (70%). Bensulide was quite effective against the grasses (84-98%), but only marginally active on the broadleaves. Both DCPA and bensulide were ineffective in the preemergence control of little mallow.

Table 4 also shows the onion stand reduction as a result of the various treatments. It is obvious that oxyfluorfen should not be used preemergence to onions, since it controlled the onions almost as well as the weeds.

Several trials are currently being conducted to determine at what stage oxyfluorfen can safely be used postemergence in onions. These stages include loop, flag, 1-leaf, and several stages from 1-3 leaves. Oxyfluorfen at 0.125, 0.25, and 0.5 lb ai/A was applied with and without a non-ionic surfactant at 0.25%. Table 5 shows there was a significant margin of safety when oxyfluorfen was applied after the onion had reached the 1 leaf stage (the first leaf being at least at tall as the flag).

The best postemergence weed control was obtained when weeds were in the range of 0-2" tall (Table 6). This was especially true in regard to the rabbitfootgrass and canarygrass, which became quite tolerant of the lower rates of oxyfluorfen when they reached the 2-4" height.

Yield data will be taken from as many of these trials as possible to support the earlier findings of considerable crop tolerance to oxyfluorfen when onions are treated after reaching the 1 leaf stage.

1982 Transplanted Dry-Bulb Onion Trials

Several trials are currently being conducted in San Joaquin County to obtain information for the use of oxyfluorfen in transplanted dry-bulb onions. Oxyfluorfen at 0.25, 0.5, and 1.0 lb ai/A was applied to onions

Table 5. The effect of oxyfluorfen applied postemergence to various stages of dry-bulb onions.

Herbicide	lb ai/A	Phytotoxicity (%)[a] Loop	Flag	Flag-1 Leaf	1-3 Leaf
Oxyfluorfen	0.125	81	17	11	9
Oxyfluorfen	0.25	87	29	13	12
Oxyfluorfen	0.5	90	53	9	13
Oxyfluorfen+AG 98	0.125	79	33	12	12
Oxyfluorfen+AG 98	0.25	87	43	14	14
Oxyfluorfen+AG 98	0.5	95	64	-	-
Control	0	0	0	0	0

[a]Average of 4 replications. Evaluations taken 1 month after each application.

Table 6. Postemergence weed control activity with oxyfluorfen.

		Postemergence Weed Control (%)[a]							
		Nettleleaf Goosefoot			Sweet Clover		Grasses[b]		
Herbicide	Rate lb ai/A	0-2"	2-4"	4-8"	0-2"	2-4"	0-2"	2-4"	4-6"
Oxyfluorfen	0.125	91	87	63	39	33	66	33	23
Oxyfluorfen	0.25	99	95	69	85	49	96	49	39
Oxyfluorfen	0.5	100	99	81	-	60	-	89	47
Oxyfluorfen+AG 98	0.125	98	93	71	54	52	55	53	32
Oxyfluorfen+AG 98	0.25	99	99	78	96	66	88	79	54
Control	0	0	0	0	0	0	0	0	0

[a]Average of 4 replications

[b]Rabbitfootgrass and Canarygrass

at transplanting, with other onions being treated 3 and 6 weeks after transplanting. Evaluations taken 1 month after each application resulted in the onions being the least susceptible to oxyfluorfen immediately following transplanting (Table 7). Crop response to oxyfluorfen was definitely increased when application occurred 3 or 6 weeks after transplanting. The addition of a non-ionic surfactant with the later applications increased the crop response by no more than 5% compared to the same rate of oxyfluorfen without surfactant applied at the same time. The onions are under considerable stress at time of transplanting and therefore may be more tolerant of herbicide applications.

Applications made at time of transplanting were preemergence to the weeds. In these trials oxyfluorfen was compared to DCPA and bensulide for preemergence weed control activity. The predominant weeds in these trials were black mustard [*Brassica nigra* (L.) Koch], common chickweed [*Stellaria* *media* (L.) Cyrillo], shepherdspurse, and California burclover [*Medicago polymorpha* L. var. *vulgaris* (Benth) Shinners]. Evaluations taken 3 months after application resulted in oxyfluorfen giving 88-100% preemergence weed control (Table 8). DCPA gave good control of chickweed (86%) and burclover (70%), but was unable to obtain effective control of black mustard (56%) or shepherdspurse (61%). Bensulide was fairly active on burclover (73%) but missed shepherdspurse (63%) and chickweed (59%).

Table 7. The activity of oxyfluorfen in transplanted dry-bulb onions.

		Onion Phytotoxicity (%)[a]		
		Weeks between Transplant and Application		
Herbicide	lb ai/A	0	3	6
Oxyfluorfen	0.25	11	23	33
Oxyfluorfen	0.5	15	26	34
Oxyfluorfen	1.0	18	34	39
Control	0	7	8	10

[a]Average of 3 experiments, each with 4 replications. Evaluations made 1 month after each application.

Table 8. The effect of 3 herbicides being applied preemergence to the weeds in transplanted onions.

		Preemergence Weed Control (%)[a]			
Herbicide	Rate lb ai/A	Black Mustard	Common Chickweed	Shepherds-purse	California Burclover
Oxyfluorfen	0.25	89	88	100	99
Oxyfluorfen	0.5	100	91	100	98
Oxyfluorfen	1.0	100	99	100	100
DCPA	10.5	56	86	61	70
Bensulide	6.0	-	59	63	73
Control	0	34	46	45	63

[a]Average of 2 experiments, each with 4 replications. Evaluations taken 3 months after application.

The applications made 3 and 6 weeks after transplanting were post-emergence to weeds. In these trials oxyfluorfen was compared with chloroxuron at 4.0 lb ai/A and bromoxynil at 0.25 lb ai/A. All herbicides gave 100% control of black mustard (up to 6" tall) and shepherdspurse (up to 4" tall). Oxyfluorfen controlled 100% of the 0-2" chickweed and burclover, and 92-100% of those same weeds which were 2-4" tall. Chloroxuron gave 100% control of chickweed, but only 28-39% burclover control (Table 9). Bromoxynil was quite inactive on burclover and especially chickweed, indicating a higher rate should probably have been used (the onions would definitely have tolerated a rate of at least 0.5 lb ai/A).

Table 9. Activity of 3 herbicides applied postemergence to the weeds in transplanted onions.

Herbicide	Rate (lb ai/A)	Weed Control(%)[a]			
		Common Chickweed		California Burclover	
		0-2"	2-4"	0-2"	2-4"
Oxyfluorfen+AG 98	0.25	100	98	100	92
Oxyfluorfen+AG 98	0.5	100	100	100	100
Oxyfluorfen+AG 98	1.0	100	100	100	99
Chloroxuron	4.0	100	100	39	28
Bromoxynil	0.25	9	2	-	31
Control	0	0	0	0	0

[a]Average of 3 experiments, each with 4 replications.

Conclusions

Studies thus far have shown oxyfluorfen to be highly selective for controlling weeds in onion. Direct-seeded onions at the 1-leaf stage appear quite tolerant of rates up to 0.25 - 0.5 lb ai/A. At this time, the emerged weeds are very susceptible to oxyfluorfen. The residual activity of oxyfluorfen is resulting in season-long weed control.

The best results in transplanted onions appear to be the application of oxyfluorfen at time of transplanting, which will also be preemergence to the weeds. The residual preemergence activity of oxyfluorfen is giving outstanding weed control exceeding 3 months.

More work is planned this season for the use of oxyfluorfen in onions. The objective will be to better define the use rates and timing of applications, in hopes of accelerating registration. Currently Rohm and Haas Company has an Experimental Use Permit to evaluate a wettable powder formulation of oxyfluorfen to determine if the treatment window can be improved and also increase selectivity.

SELECTIVE HERBICIDES FOR USE IN CELERY (*APIUM GRAVEOLENS*)

W. J. Chism and M. J. Snyder[1]

In 1980 through 1981 six trials were conducted on transplanted celery (cultivar'5270R'). The herbicide applications were made with a CO_2 plot sprayer applying 40 gallons of mix per acre. The trials were arranged in a randomized complete block design with four replications on a sandy loam soil near Santa Maria, California. The applications were made either preemergence to the weeds, immediately following transplanting, or postemergence to the weeds, approximately two weeks after transplanting.

The preemergence experiments tested acifluorfen {5-[2-chloro-4-(trifluoromethyl)phenoxy]-2-nitrobenzoic acid} at 0.25 - 0.5 lb ai/A,

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prometryn [2,4-bis(isopropylamino)-6-(methylthio)-*s*-triazine] at 1.0 lb ai/A, oxyfluorfen [2-chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl) benzene] at 0.125 - 0.25 lb ai/A, bifenox [methyl 5-(2,4-dichlorophenoxy)-2-nitrobenzoate] at 2.0 lb ai/A, ethofumesate [(±)-2-ethoxy-2,3-dihydro-3, 3-dimethyl-5-benzofuranyl methanesulfonate] at 2.0 - 4.0 lb ai/A, pendimethalin [*N*-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine] at 1.0 - 2.0 lb ai/A, and nitrofen (2,4-dichlorophenyl *p*-nitrophenyl ether) at 4.0 lb ai/A. Of the materials tested at these rates, prometryn, ethofumesate, pendimethalin, and nitrofen displayed acceptable crop safety and weed control at the tested rates. Bifenox provides good weed control but may be too "hot" at the tested rates. Two materials, acricluorfen and oxyfluorfen, displayed poor crop selectivity and erratic weed control at the tested rates (Table 1).

Table 1. 1980-1981 celery weed control trials; pre-emergence treatments

				Weed Control[2]			
Treatment	Rates (lb ai/A)	Crop Injury[1]	Harvest Weights[3]	Chick-weed	Common Groundsel	Stinging Nettle	Sow Thistle
Acricluorfen	0.25-0.5	6-7	44-22	0	8	10	10
Prometryn	1.0	3.5	53	3	4	5	7
Oxyfluorfen	0.125-0.25	6-7	38-28	-	-	-	-
Bifenox	2.0	2.0	49-51	2	6	10	10
Ethofumesate	2.0-4.0	1.5	60-55	10	4	0	7
Pendimethalin	1.0-2.0	1.0	51-51	8	7	8	10
Nitrofen	4.0	2.0	53	2	6	9	8
Control			60				

[1]Crop phytotoxicity; 0 = no damage, 10 = dead plants

[2]Weed control; 0 = no control, 10 = 100% control

[3]Harvest weights for ten feet of bed

The post emergence trials tested acifluorfen (0.125 - 0.25 lb ai/A), prometryn(1.0 lb), metalochlor (1.0 - 2.0 lb), oxyfluorfen (0.0625 - 0.125 lb), terbutryn (2,6-di-*tert*-butyl-*p*-tolyl methylcarbamate) at 1.0 - 2.0 lb, bifenox (1.0 - 2.0 lb), ethofumesate (1.0 - 2.0 lb), and chloroxuron {3-[*p*-(*p*-chlorophenoxy)phenyl]-1,1-dimethylurea} at 2.0 - 4.0 lb. Of these materials prometryn, oxyfluorfen, terbutryn, bifenox, and chloroxuron provide good crop selectivity and a wide spectrum of weed control at the tested rates. Ethofumesate provides a wide margin of crop selectivity with a narrow spectrum of weed control. Metolachlor [2-chloro-*N*-(2-ethyl-6-methylphenyl)-*N*-(2-methoxy-1-methylethyl)acetamide] shows some crop sensitivity with limited weed control at the tested rates. Acifluorfen provided excellent weed control but severly limited crop growth.

Table 2. 1980-1981 celery weed control trials; post-emergence treatments

Treatment	Rates (lb ai/A)	Crop[1] Phytotoxicity	Harvest[3] Weights	Weed Control[2]					
				Chick-weed	Common Groundsel	Malva	Shepherds Purse	Sow Thistle	Stinging Nettle
Acifluorfen	0.125-0.25	6-7	48-40	--	9	--	--	10	10
Prometryn	1.0	3.0	64	10	9	6	10	8	9
Metolachlor	0.1-2.0	1.0-2.0	57-56	7	8	2.5	6	--	8.5
Oxyfluorfen	0.0625-0.125	5.0-6.0	64-60	6	9	10	9	10	10
Terbutryn	1.0-2.0	2-6	63-55	10	8	7	9	--	7
Bifenox	1.0-2.0	2-4	60-56	6	7	10	8	8	10
Ethofumesate	1.0-2.0	1-2	63-61	10	3	--	--	3	3
Chloroxuron	2-4	1.0-2.0		10	9	8	10	3	7
Control			60						

[1]Crop phytotoxicity, 0 = no damage, 10 = dead plants

[2]Weed control; 0 = no control, 10 = 100% control

[3]Harvest weights for ten feet of bed.

EFFICACY OF CHEMICAL AND MECHANICAL POTATO VINE KILL METHODS AND THEIR EFFECTS ON STORED TUBER QUALITY

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D. L. Corsini, and L. C. Haderlie[1]

Abstract. The effects of chemical and mechanical vine kill methods on the occurrence of stem end discoloration and specific gravities of Russet Burbank potatoes (*Solanum tuberosum*) were evaluated. Also, ratings were made to determine efficacy of the chemical methods. Treatments did not effect the occurrence of stem end discoloration, but at different locations stem end discoloration was significantly different.

Treatments effected specific gravity and the tubers from the hand-pulled vine treatments had significantly higher specific gravities than tubers whose vines were hand cut or treated with sulfuric acid or dinoseb (2-*sec*-butyl-4,6-dinitrophenol). Dinoseb, sulfuric acid, and diquat [6,7-dihydrodipyridol(1,2-α:2',1'-*c*)pyrazinediium ion] all provided acceptable 'fast' vine desiccation. Endothall [7-oxabicyclo(2,2,1)heptane-2,3-dicarboxylic acid] worked more slowly.

Introduction

Stem end discoloration is a physiological disease which discolors the vascular tissue in the stem end of potatoes contributing to a decrease in quality and thus economic loss. It is associated with speed of vine kill and water stress.

Materials and Methods

Experimental treatments for preharvest destruction of potato vines were applied to field grown, sprinkler irrigated 'Russet Burbank' potatoes at five locations in Idaho to investigate the influence of vine destruction methods on the occurrence of stem discoloration and specific gravity.

The destruction of potato vines was accomplished by mechanical methods of hand cutting and hand pulling vines; and by chemical vine destruction methods using dinoseb at 2.2 kg/ha, sulfuric acid at 336 kg/ha, and endothall at 1.12 kg/ha, which are all commercial rates of application. Diquat at 0.57 kg/ha was applied in a related experiment at one location to determine the effects of temperature at the time of application. An afternoon application of diquat was made when the temperature was 29.8 C and an evening application when the temperature was 19.4 C. Speed of kill of all chemical methods was rated. A subjective estimate of the amount of stem end discoloration was made after storing the tubers for two months.

Results and Discussion

There was no significant difference in occurrence of stem end discoloration between treatments summed over location (Table 1). However, there were significant differences between locations. Tetonia location, which has no history of disease problems, has a shorter growing season because of the higher elevation and, thus, lower yields, had significantly more potatoes in the rating 0-1 category (U.S. #1's) than the Kimberly site which has some disease problems, the longest growing season of the five sites, and higher yields (Table 2). The stem discoloration rating

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Table 1. Stem end discoloration as influenced by vine kill treatments summed over five locations in Idaho

Treatment	Rate (kg/ha)	Rating 0-1 (%)	Rating 2-4 (%)
Dinoseb	2.2 (2.5 lb/A)	37.1	62.9
Endothall	1.12(1.0 lb/A)	38.6	61.4
Sulfuric acid	336 (300 lb/A)	38.6	61.4
Hand pulled	---	38.6	61.4
Hand cut	---	36.4	63.6
Control	---	37.1	62.9
		N.S.	N.S.

Table 2. Stem end discoloration as influenced by location summer over treatments

Location	Rating 0-1	Rating 2-4
Tetonia	46.8 a[1]	53.2
Aberdeen (Early planting)	40.9 ab	59.1
Aberdeen (Late planting)	39.9 ab	60.1
Shelly	35.4 b	64.6
Kimberly	25.9 c	74.1

[1]Means followed by the same letter are not significantly different at the 5% level.

The data (Table 3) show percent leaf kill 5 and 12 days after application at the Tetonia site. Dinoseb and sulfuric acid did not differ in vine kill activity, whereas endothall provided slower kill rates at 5 days. At 12 days after treatment the effects of all chemical treatments were statistically the same. The control showed 16.8 and 50% frost damage after 5 days and 12 days, respectively. This frost damage is an uncontrollable variable.

Table 3. Influence of chemical vine killers on percent leaf kill (Tetonia, Idaho)

Treatment	Rate (kg/ha)	Days after application	
		Five	Twelve
Dinoseb	2.2	80.0 a[1]	99.3 a[1]
Sulfuric acid	3.36	72.5 a	99.0 a
Endothall	1.12	46.3 b	92.3 a
Control	---	16.8 c	50.0 b

[1]Means followed by the same letter are not significantly different at the 5% level.

At a lower elevation site, results of chemical treatments on percent leaf kill were not different after only 7 days (Table 4). This more rapid effect may be due to the higher temperatures at this elevation. For stem kill, similar results were found on all locations (Tables 5, 6). The data from the diquat experiment (Table 7) show no differences in rate of leaf or stem kill between the higher and lower temperature of the time and application. Rate of vine kill of diquat was similar to those of sulfuric acid and dinoseb.

Table 4. Influence of chemical vine kill methods on percent leaf kill (Shelly, Idaho)

Treatment	Rate (kg/ha)	Seven days after application
Dinoseb	2.2	99.8 a[1]
Sulfuric acid	3.36	97.8 a
Endothall	1.12	97.3 a
Control	---	18.8 b

[1]Means followed by the same letter are not significantly different at the 5% level.

Table 5. Influence of chemical vine killers on percent stem kill (Tetonia, Idaho)

Treatment	Rate (kg/ha)	Days after application	
		Five	Twelve
Dinoseb	2.2	61.3 a[1]	92.0 a[1]
Sulfuric acid	3.36	35.0 b	86.3 a
Endothall	1.12	18.8 bc	63.8 b
Control	---	3.3 c	10.0 c

[1]Means followed by the same letter are not significantly different at the 5% level.

Table 6. Influence of chemical vine killers on percent stem kill (Shelly, Idaho)

Treatment	Kill, seven days after application
Dinoseb	90.0 a[1]
Sulfuric acid	82.5 a
Endothall	70.0 a
Control	10.0 b

[1]Means followed by the same letter are not significantly different at the 5% level.

Table 7. Percent leaf and stem kill three days after diquat application

Treatment (time)	Rate (kg/ha)	Leaf kill (%)	Stem kill (%)
Afternoon[1]	.57 (0.5 lb/A)	75.0 a[3]	42.5 a[3]
Evening[2]	.57 (0.5 lb/A)	71.3 a	41.5 a
Untreated	---	25.0 b	10.0 b

[1]Early afternoon air temperature, 29.8 C
[2]Evening air temperature, 19.4 C
[3]Means followed by the same letter are not significantly different at the 5% level.

Specific gravity was determined for tuber samples (Table 8) taken from all locations. Tubers in which the vines were removed by hand pulling had a significantly higher specific gravity than either the tubers whose vines were hand cut or those whose vines were chemically treated with dinoseb or sulfuric acid.

Table 8. Treatment effects on specific gravity

Treatment	Specific gravity
Hand pulled vines	1.0846 a[1]
Control	1.0844 ab
Endothall	1.0827 ab
Dinoseb	1.0811 b
Sulfuric acid	1.0809 b
Hand cut vines	1.0789 b

[1]Means followed by the same letter are not significantly different at the 5% level.

Conclusions

The occurrence of stem end discoloration was not significantly increased or decreased by any of the vine kill treatments in a given location, but was significantly different among five different locations. We speculate the difference in occurrence of stem end discoloration at different locations to be due to the presence of leaf roll virus associated with those locations. The lack of differences between treatments may have been due to lack of significant stress on the potato plants to bring on this disorder.

Tubers whose vines were hand-pulled had significantly higher specific gravities than tubers whose vines were hand-cut or tubers whose vines were treated with sulfuric acid or dinoseb. Dinoseb, sulfuric acid, and diquat all provided acceptable 'fast' vine desiccation. Endothall worked more slowly.

WEEDS AFFECT CITRUS TREES AND FRUIT

Lowell S. Jordan, James L. Jordan, and Catalina M. Jordan

Abstract. 'Valencia' orange tree trunk and canopy growth, leaf nitrogen level, water potential, fruit yield, and fruit quality were decreased by competition from annual weeds and bermudagrass. Soil moisture levels were lower where weeds were present. The adverse effects of the weeds on the trees were related to the intensity of weed competition. Control of annual weeds and bermudagrass reduced the adverse effects of the trees in proportion to the amount of weed control.

Introduction

Many of the documented effects of weeds on citrus have been reviewed previously by Jordan (3, 4). It is widely believed that weeds compete with trees for water and nutrients. The extent of the competition varies with each orchard. The result of the competition is reduced tree growth and fruit yield. The reasons for the reduction have not often been documented. More published data is needed concerning effects of weeds on tree growth and physiololgy and on fruit quality and yield.

Materials and Methods

Research was performed to determine the effects of different weed populations, weed control, and irrigation methods on soil moisture and growth, leaf water, nitrogen and chlorophyll, fruit quality, and yield of 'Valencia' orange trees. Trees planted in 1965 were maintained 12 years under furrow irrigation; the orchard was kept weed-free with annual soil treatments using simazine [2-chloro-4,6-bis(ethylamino)-*s*-triazine] and postemergence applications of weed oil to weeds which had escaped simazine treatment. After 1976, one-half of the orchard was sprinkler irrigated and the other half was furrow irrigated. Each irrigated section was divided into blocks with two rows of nine trees.

To establish weedy plots, herbicide treatments were discontinued. The soil was rotary-tilled to 5-cm depth to prepare the seed bed, dilute simazine in the soil, and move annual weed seeds to the soil surface for germination. Naturally occurring annual broadleaf weeds, such as redroot pigweed (*Amaranthus retroflexus* L.), horseweed [*Conyza canadensis* (L.) Crong.], bullthistle [*Cirsium vulgare* (Savi) Tenore], pale smartweed (*Polygonum lapathifolium* L.), mixed annual grasses (*Bromus* L. and *Hordeum* L. sp.), and other species were allowed to germinate and grow. Bermudagrass [*Cynodon dactylon* (L.) Pers.], cv. Tifway, stolons were incorporated into the top 2 cm of soil. Ammonium nitrate at the rate of 121 kg N/ha was applied annually in each March. Annual and bermudagrass weed vegetation were allowed to become established for two years on all plots except those plots where no weeds were allowed to grow. Plots were then established in which weeds were completely controlled, partially controlled (avg. 50%), or left uncontrolled.

To achieve partial control, paraquat (1,1'-dimethyl-4 4'-bipyridinium ion) treatments (0.5 kg/ha) were begun in Spring 1979 to selected plots containing either mixtures of annual weeds or bermudagrass. Neithet annual weeds nor bermudagrass were eradicated but regrew after each treatment. Bermudagrass was resprayed when regrow reached about 50%; annual weeds were resprayed before regrowth was about 30 cm tall and covered 50% of the plot surface. Annual weeds were suppressed with 5

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paraquat treatments, while bermudagrass required 7 treatments at 0.6 kg/ha in 468 L/ha of water. Complete weed control was achieved during the experiment with simazine in the undisturbed soil, by the lack of viable weed seed in the surface soil, and by removal of the few seedlings that emerged. Annual weeds and bermudagrass covered more than 95% of the soil surface of plots where no weed control was practiced.

Tree, leaf, and fruit parameters were determined in six replicated single tree plots in blocks which were surrounded by border trees. There were three blocks of bermudagrass under sprinkler irrigation and three blocks of annual weeds under either furrow or sprinkler irrigation.

Soil moisture was measured at two-week intervals at 23, 46, and 92 cm depths midway between the trees in line with the trunks with a neutron moisture probe (6). Tree size was measured each October by determining the trunk circumference 10 cm above the bud union and by calculating the tree volume from the width and height of the tree canopy. The winter growth flush was evaluated by counting the number and length of new shoots formed on each tree during December. The total leaf area per tree was calculated by determining the number of leaves per tree and leaf area. Tree water status was determined by measuring the leaf water potential with a pressure chamber (5) two hours before sunrise (predawn) and at 1100 through 3100 hr (midday).

Photosynthesis was measured with a double isotope porometer (2, 7). Measurements were made at monthly intervals throughout the year on leaves one meter above the soil surface with uniform maturity, size, and illumination on the south side of the trees. Nitrogen content was determined for leaves on six-month-old, non-fruiting terminals from spring cycle growth by the micro-kjeldahl method (1). Chlorophyll content of leaves was determined monthly with a portable reflectance meter (8). At harvest, 18 fruit were picked at random from each tree for quality determinations.

Results and Discussion

Soil moisture. Increased control of either annual weeds or bermudagrass generally increased soil moisture at 23, 46, and 92 cm deep. In either sprinkler or furrow irrigation, soil moisture was greatest with complete weed control and least where there was no weed control; the only exception to this was the moisture level at 92 cm deep in furrow-irrigated blocks with annual weed competition. Soil moisture with partial weed control varied from being identical to either complete weed control or no weed control, depending upon the method of irrigation, kind of weeds present, and depth at which soil moisture samples were taken.

Tree size. Increased control of either annual weeds or bermudagrass resulted in more tree growth and larger trees. The increased volume with complete weed control was almost double that of trees in areas with no weed control. Trunk circumference was always greatest for trees with complete weed control, and the greatest benefit from weed control was derived when bermudagrass had been the competitive vegetation. Leaf area per tree was much less from trees in areas with no weed control. Trees grown with complete weed control had the largest leaf area. Bermudagrass reduced leaf area per tree more than annual weeds. Under sprinkler irrigation, bemudagrass reduced leaf area per tree by approximately 80% and annual weeds caused almost 70% reduction. Growth, as reflected by the number of new shoots per tree and new shoot length, was least for trees with the greatest amount of weed competition.

Partial control of weeds did not uniformly affect the factors representing tree growth. The results of partial weed control varied according to tree growth parameter measured, type of weedy vegetation, and method of irrigation. Generally, however, for each measurement, trees were largest with complete weed control, smaller with partial weed control, and smallest with no weed control.

Leaf conditions. Leaf water potential, a measure of water stress, generally increased (became less negative) with complete weed control in comparison to no weed control. Partial weed control did not significantly reduce midday leaf water potential when compared to no weed control. Chlorophyll content of the tree leaves was not altered by annual weeds (either under furrow or sprinkler irrigation); however, bermudagrass competition resulted in reduced chlorophyll content of tree leaves. The leaf nitrogen content was reduced by either annual weeds or bermudagrass which were not controlled.

In areas with annual weeds, photosynthesis was lower for tree leaves only where there was no weed control. When the competitive vegetation was bermudagrass, photosynthesis was reduced in leaves of trees in areas where bermudagrass ground cover was either partial or absent.

Fruit. Yield reduction from bermudagrass was greater than the yield reduction from annual weeds. Noncontrolled bermudagrass cover also resulted in increased size of the fewer fruit. Generally, the two types of vegetation did not influence internal fruit quality differently. Complete control of annual weeds and bermudagrass resulted in higher fruit yield but generally did not alter fruit quality, compared with partial control. Noncontrolled annual weed and bermudagrass cover reduced fruit yield and increased soluble solids and acid, while the solids/acid ratio was not affected. Differences in fruit quality appear to have resulted from the amount of competition from other vegetation for water and nutrients.

Multiple regression analysis established close correlations between soil moisture and each tree, leaf, and fruit parameter measured. Therefore, competition of the weeds with trees for water probably accounted for many of the differences observed in tree growth, and leaf and fruit characteristics between weedy and weed-controlled areas.

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THE COMPATABILITY OF TANK-MIXING CHLORSULFURON WITH WILD OAT (*AVENA FATUA*) HERBICIDES

Randy L. Anderson[1]

Introduction

Chlorsulfuron (2-chloro-*N*-{[(4-methoxy-6-methyl-1,3,5-triazin-2-yl) amino]carbonyl}benzenesulfonamide) is a new herbicide effective for control of most broadleaf weeds and several grass weeds. One weed which appears to be somewhat tolerant of chlorsulfuron is wild oats (*Avena fatua* L.). If chlorsulfuron can be tank-mixed with various wild oat herbicides without reducing herbicidal activity or increasing phytotoxicity to the crop, the chemicals could be applied in one field operation. The objectives of this experiment were:

A) To determine if tank-mixing chlorsulfuron with three wild oat herbicides reduces herbicidal activity of each herbicide.
B) To determine if phytotoxicity to durum wheat exists when chlorsulfuron alone and tank-mixed with wild oad herbicides is applied.

Method of Study

A durum wheat variety, 'Cando,' was planted May 6, 1981, at the rate of 67 kg PLS/ha. The herbicidal treatments were applied on May 20, when the durum was in the 2-leaf stage and the wild oats in the 1-3 leaf stage. The environment, crop culture, spraying system, and growing season variables are described in Table 1.

The agronomic data collected included visual weed control and stand counts of weed species, date of heading, height, visual injury, yield, and test weight of durum.

Chlorsulfuron was applied at two rates alone, 0.02 and 0.04 kg a.i./ha, and combined with barban (4-chloro-2-butynyl *m*-chlorocarbanilate), difenzoquat (1,2-dimethyl-3,5-diphenyl-1*H*-pyrazolium), and diclofop {2-[4-(2,4-dichlorophenoxy)phenyl]propanoic acid}. The rates for the wild oat herbicides were 0.42, 0.84, and 1.12 kg a.i./ha respectively, while chlorsulfuron was applied at 0.04 kg a.i./ha in the combinations. The experimental design was a randomized complete block with four replications. The soil type was a Williams loam, a fine-loamy, mixed Typic Agriboroll.

Analysis of Data

The agronomic data collected for this study is shown in Table 2. The application of chlorsulfuron alone or tank-mixes of chlorsulfuron and wild oad herbicides did not affect heading dates or heights, but visual injury, evaluating crop vigor, was significantly higher for both chlorsulfuron tank-mixed with diclofop and chlorsulfuron tank mixed with difenzoquat.

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Table 1. Operations log of chlorsulfuron and wild oat herbicides applied to 'Cando' durum.

Environmental conditions

	Temperature (°C)			Moisture (mm)	
	Ave.	1981		Ave.	1981
May	12.4	14.3	May	54.6	14.5
June	17.3	17.2	June	71.6	81.0
July	20.4	22.3*	July	44.5	64.5

* 17 days above 32.2°C

Spraying log

Date & time	May 20 - 3:30 pm	Wind speed	2 - 3.3 m/s
Air temperature	27.5°C	Nozzles	650067
Relative humidity	23%	Pressure	2,46 kg/cm^2
Cloud cover	clear	Carrier (water)	107 L/ha

Crop culture

Variety	'Cando' durum	Planting date	May 6
Rate of seedling	67 kg/ha	Emergence date	May 17

Plant growth stages

Durum (*Triticum durum*)	2 leaf
Wild oats (*Avena fatua* L.)	1-3 leaf
Lambsquarters (*Chenopodium album* L.)	4 leaves, 2 cm diameter
Redroot pigweed (*Amaranthus retroflexus* L.)	cotyledon

The injury symptoms were prevalent on both evaluation dates, June 10th and June 18th. The yield data showed a significant reduction for chlorsulfuron plus diclofop compared to the weed-free control. The durum treated with chlorsulfuron plus difenzoquat apparently compensated somewhat, as its yield did not differ from the weed-free control. The highest yield recorded was for the treatment, chlorsulfuron plus barban, yielding 12.5% more than the weed-free control.

Chlorsulfuron alone resulted in significantly more yield than the control infested with weeds, as did all treatments except chlorsulfuron plus diclofop. One possible explanation for the increase in yield for chlorsulfuron plus barban compared to the weed-free control is the timing of weed removal. The weed-free control was hoed and hand-weeded at time of spraying, and weeds which reinfested the area competed with the durum until the following hoeing, which occurred in late season.

All chemically treated grain had a significantly higher test weight when compared to the control infested with weeds. The highest test weight was recorded for chlorsulfuron plus diclofop, even significantly higher than the weed-free control. The chlorsulfuron plus diclofop possible had fewer plants, thus allowing more substrate to be stored in the grain due to less competition.

The control of broadleaf weeds such as lambsquarters was excellent

Table 2. Agronomic data of chlorsulfuron applied alone or in tank-mixes with wild oat herbicides to 'Cando' durum.

Herbicide	Rate (kg/ha)	Heading (days from Jan. 1)	Height (cm)	Visual injury (%)		Yield (kg/ha)	Test Weight (kg/ha)	Weed control	
				June 10	June 18			Wild oats[1]	Lambsquarters[2]
Chlorsulfuron	0.02	187	48.3	0	1.3	1110	70.7	7.5	0.0
Chlorsulfuron	0.04	187	48.3	2.5	11.3	1090	70.3	7.5	0.0
Chlorsulfuron + diclofop	0.04 + 1.12	188	44.5	12.5	22.5	942	71.0	74.0	0.0
Chlorsulfuron + barban	0.04 + 0.42	187	45.7	2.5	7.5	1271	70.0	88.0	0.0
Chlorsulfuron + difenzoquat	0.04 + 0.84	188	45.7	12.5	21.3	1117	70.3	85.0	0.0
Control (weed-free)	0.0	187	47.0	0	0	1130	69.8	100.0	0.0
Control (weed infested)	0.0	187	46.5	0	0	915	68.7	0.0	75.3
LSD .05		(NS)	(NS)	(8.9)	(19.9)	(81)	(0.8)	(41.8)	(48.4)

[1]% control

[2]number plants/m^2

with chlorsulfuron alone at either rate or in combination with other herbicides, as all treatments were free of broadleaf weeds. Wild oat control was not obtained by chlorsulfuron alone, but the physical mixing of chlorsulfuron with the wild oat herbicides did not inhibit wild oat control by barban, difenzoquat, or diclofop. The visual ratings for barban and difenzoquat were 85 and 88% control, while diclofop controlled 74% of the wild oats.

Summary

Chlorsulfuron does not injure 'Cando' durum. The combination of chlorsulfuron and diclofop appears to injure 'Cando' durum as yield loss occurred and visible symptoms were evident.

The combination of chlorsulfuron and difenzoquat caused visible injury, but yield loss did not occur.

The combination of chlorsulfuron and barban resulted in the highest yield of durum.

The herbicidal activity of the tested chemicals were not affected by the physical mixing of formulations.

HERBICIDE EFFECTIVENESS IN RESPONSE TO SEASON OF APPLICATION AND SHRUB PHYSIOLOGY

W. Thomas Lanini and Steven R. Radosevich[1]

Abstract. The selectivity of five foliage-applied herbicides, 2,4-D [(2, 4-dichlorophenoxy)acetic acid], dichlorprop [2-(2,4-dichlorophenoxy) propionic acid], glyphosate [*N*-(phosphonomethyl)glycine], fosamine [ethyl hydrogen (aminocarbonyl)phosphonate], and triclopyr{[(3,5,6-trichloro-2-pyridinyl)oxy]acetic acid} applied at three phenological stages of development to five Sierran shrub species, deerbrush [*Ceanothus integerrimus* var. *californicus* (Kell.) G.T. Benson.], greenleaf manzanita (*Arctostaphylos patula* Greene.), bearmat (*Chamaebatia foliolosa* Benth.), snowbush caenothus (*Ceanothus velutinus* Doubl. ex Hook.), and whiteleaf manzanita (*Arctostaphylos viscida* Parry.), was compared. Treatments in the summer and fall were less effective than spring applications. A relationship between shrub phenology, moisture stress, photosynthesis, and herbicide activity was observed. Periods of susceptibility generally corresponded to times when moisture stress was low and photosynthesis was high.

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DEVELOPING A BIOASSAY FOR CHLORSULFURON RESIDUES IN MONTANA SOILS

W. E. Dyer, P. K. Fay and R. H. Thompson[1]

Abstract. Chlorsulfuron {2-chloro-*N*-[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)aminocarbonyl]benzenesulfonamide} is a promising new herbicide for the control of annual and perennial weeds in small grains. The residual properties of this herbicide allow it to provide season-long broadleaf weed control. Studies were initiated to determine the expected degree of carryover in Montana soils because of the sensitivity of several alternate crops grown in Montana. Several bioassay techniques were compared to determine their potential as a rapid, efficient bioassay for chlorsulfuron residues in field soils.

The corn root bioassay, developed by the DuPont Company, was not sufficiently sensitive due to the high pH common to soils in Montana. A microbial bioassay utilizing 155 separate microorganisms isolated from soil showed little or no response to chlorsulfuron at levels ranging from 1 to 100 ppb in soil. The growth of the algae, *Chlorella sorokiniana*, was inhibited by chlorsulfuron at the levels of 5 to 50 ppm, but was not affected by levels below 1 ppm.

A Microtox toxicity analyzer using the fluorescent bacteria *Photobacterium phosphoreum* as an indicater species, measured an EC_{50} of 7.8 ppm. There was no response at levels below 900 ppb. Chlorsulfuron at 1 to 1000 ppb did not significantly affect cell division of hamster uterine cells (Strain BHK-21), nor the multiplication of mengovirus in BHK-21 cells.

Greenhouse studies using green foxtail [*Setaria viridis* (L.) Beauv.] and varieties of foxtail millet [*Setaria italica* (L.) Beauv.] as bioassay plants have shown promise. Both roots and shoots show linear response to practical levels of chlorsulfuron in field soils.

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TOXIC NITRO COMPOUNDS IN SPECIES OF *LOTUS*

M. C. Williams[1]

Abstract. Toxic aliphatic nitro compounds have been found in species of the genus *Lotus* (Fabaceae). Since some species of *Lotus* are used as forage, those that synthesize nitro compounds might be toxic to livestock. Therefore, a study was initiated to identify nitro-bearing species of *Lotus*, determine the type of nitro compound present, and study the toxicity of three cultivars of *Lotus pedunculatus* Cav. to one-week-old chicks.

Leaves of 83 species of *Lotus* were analyzed qualitatively for nitro compounds. Nineteen of these species were grown in the greenhouse. Leaves of 74 species were analyzed from samples taken from herbaria at the Intermountain Herbarium, Logan, Utah, and the New York Botanical Garden, Bronx, New York. Nitro-bearing species for which sufficient material was available were analyzed quantitatively for nitro compounds. Nitro compounds were hydrolyzed and separated by thin-layer chromatography to identify the nitro metabolite present. Three cultivars of *Lotus*

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pedunculatus Cav. (Marshfield, Kaiser, and Grasslands Maku) were grown in the greenhouse and fed as dried plant and extract to one-week-old chicks.

Nitro compounds were found in 17 of 83 species of *Lotus*. Only 3-nitropropionic acid (3-NPA) was found upon hydrolysis and chromatography in 12 nitro-bearing species. No nitro compounds were found in three cultivars of birdsfoot trefoil (*Lotus corniculatus* L.). The highest level of nitro compounds (25 to 28 mg NO_2/g of plant) was found in three cultivars of *Lotus pedunculatus*. One-week-old chicks died after consuming one gram of dried *Lotus pedunculatus* daily for 2 to 3 days. Single doses of extract produced toxic signs at an equivalent of 2 to 3 grams of plant and death at 4 to 5 grams. All three cultivars of *Lotus pedunculatus* were equally toxic.

INTERACTION OF KOCHIA (*KOCHIA SCOPARIA*) AND *RHIZOPUS* SP. ON SUGARBEET GERMINATION

R. B. Wiley[1], E. E. Schweizer[2], and E. G. Ruppel[2]

Abstract. In 1978 we observed that sugarbeet germination and emergence were reduced significantly in rows previously seeded with kochia [*Kochia scoparia* (L.) Schrad.]. Thus, laboratory studies were undertaken to determine whether kochia interference with sugarbeet emergence was allelopathic in nature. Sugarbeet seeds were germinated in soil in covered 9-cm diameter dishes to which kochia seed had been added at 0, 0.25, 0.5, 1.0, 2.0, 4.0, or 8.0 seed/cm^2. Sugarbeet germination was reduced significantly, 15 to 35%, at the 0.5 seed/cm^2 level, and 85 to 100% at the highest level. All dishes that contained kochia seed were contaminated with *Rhizopus* sp., a common soil-borne fungus, and mycelia growth increased as kochia levels increased. The combination of autoclaved soil and disinfested kochia seed eliminated both the fungus and the response of sugarbeet to kochia seed, whereas neither was influenced by the individual treatments. In additional studies, extracts were taken from soaked, ground, or germinated kochia seed; added to potato-dextrose-agar plates; and inoculated with *Rhizopus* sp. The extract from germinated kochia seed increased the fungal colony diameter by 15% over both the control and the other extracts. When blotters were soaked in extracts from *Rhizopus* sp., sugarbeet germination was reduced 30%, radicle elongation 86%, and root hair development inhibited visibly. These data suggest a secondary allelopathis effect of kochia on sugarbeet.

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THE EFFECTS OF SOME ENVIRONMENTAL CONDITIONS ON THE GERMINATION OF BLACK NIGHTSHADE AND IVYLEAF MORNINGGLORY

R. J. Thullen and P. E. Keeley[1]

Abstract. Ivyleaf morningglory [*Ipomoea hederacea* (L.) Jacq.] and black nightshade (*Solanum nigrum* L.) seed were germinated under some environmental conditions similar to those of the San Joaquin Valley. With a night/day temperature regime of 80/90° F, 73% scarified morningglory seed germinated in the light and 58% in the dark. This difference was not significant. Unscarified morningglory seed germinated 17 and 18% with light and dark treatments, respectively. In light, nightshade seed germinated equally well whether washed or unwashed. Nightshade seed, grown with a 13 hour light period per day, germinated significantly better than seed germinated in total darkness. At the coldest temperature regime, 50° F night and 60° F for 13 hours each day, morningglory seed had little or no germination while nightshade germination was between 40 and 50%. The optimum temperature for germination for both species was at or near the 80/90° F temperature regime. Fifty-two percent of the morningglory seed germinated from a 3-inch soil depth which was the deepest that seed was planted in the experiment. Nightshade seed germination was about 20% at 1/4 and 1/2-inch depths and 3% or less at 1 to 3 inches.

Introduction

Black nightshade and ivyleaf morningglory are difficult weeds to control and are becoming more prevalent in the San Joaquin Valley (4,5). Normally, both weeds are competitive later in the cotton growing season rather than at emergence of the crop. They usually emerge after the first irrigation. While there is some knowledge about seed germination of both species (1), we investigated the effects of some environmental conditions similar to those found in irrigated agriculture in the Western States. Experiments were conducted in growth chambers where tighter control of the conditions could be maintained and in the field where intense light and accompanying high temperatures existed.

Materials and Methods

Morningglory seed was separated from its capsule with little or no crushing of the capsule. The seed is easily separated from the debris in an air column. The seed was stored dry at room temperature.

The first nightshade seed was separated from its berries by a dry method. This was important because the effect of washing on germination was to be tested. The debris and light seed were separated from the seed in an air column. Other batches of seed were separated from the berries in water and the debris washed away. All nightshade seed was stored air-dry at room temperature.

The germination tests were run on filter paper in covered plastic cups in a growth chamber. Four replications were used per treatment with 25 morningglory or 50 black nightshade seed per replicate in 1979 and 25 seeds of each species per replicate in 1980.

To establish what were good conditions for germination, the first seed of both weeds was placed in light (160 microeinsteins m^{-2} S^{-2}) and dark with an 80° F night and a 90° day temperature regime (13 hours). In addition, some of the nightshade seed was washed under running water for 4

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hours. Some of the morningglory seed was scarified by rubbing the seed between two pieces of medium grit sandpaper. After these initial tests, all nightshade seed was separated by the water method and germinated with a 13 hour light period. All morningglory seed was germinated in the dark. Some morningglory seed was sanded ans some was not. Both species had a day temperature period of 13 hours. Night/day temperature regimes were 50/60, 60/70, 70/80, 80/90, and 90/100° F. The seedlings were counted periodically for 2 weeks, and the data was analyzed by Duncan's multiple range test.

In a field experiment, morningglory and nightshade were planted in single rows on 40 inch beds without a competing crop. The seeding rate was 17 seed per foot for morningglory and approximately 145 seed per foot for nightshade. The morningglory seed was counted, but a fixed weight of nightshade seed was planted. The planted beds were sprinkled until the seedlings were large enough to survive longer periods between irrigations and then the beds were furrow irrigated. The seedlings were counted each week for 3 weeks, and the data was analyzed by the Duncan's multiple range test.

The depth from which nightshade and morningglory will emerge was determined in a greenhouse experiment. Twelve replicates of both species (20 morningglory or 50 nightshade seed each) were planted in soil in quart containers to the depth of 0.25, 0.5, 1.0, 2.0, or 3.0 inches with soil. The number of seedlings was counted each week for 4 weeks.

Results and Discussion

Three and one-half times more morningglory seed germinated when sanded than when unsanded (Table 1). Sanded morningglory seed germination

Table 1. The effect of light and sanding on the germination of ivyleaf morningglory (80/90° night/day temperature).

Temperature	Germination
Light	%
Sanded	58 a[1]
Unsanded	17 b
Dark	
Sanded	73 a
Unsanded	18 b

[1]Numbers followed by the same letter are not significantly different at the 5% level.

was slightly better in the dark (73%) than in the light (58%), but the differences were not significant. The great variability in germination between the replicates of unsanded seed was probably the reason the difference in germination between light and dark treatments was not found to be significant.

Washing nightshade seed did not affect its germination when placed in light in comparison with unwashed (dry separated) seed (Table 2). When the seed was placed in the dark, washed seed had higher germination than unwashed seed. Washed seed, however, germinated better in light than washed seed placed in the dark. The above suggests that light is a

Table 2. The effect of light and washing on the germination of black nightshade (80/90° night/day temperature).

Treatment	Germination
Light	%
Washed	49 a[1]
Unwashed	48 a
Dark	
Washed	29 b
Unwashed	7 c

[1]Numbers followed by the same letter are not significantly different at the 5% level.

stronger stimulus for germination than washing. Under field conditions germination of buried seed should be better following a wet winter than a dry one.

When nightshade seed was planted about March 1 in field experiments it took between 2 and 3 weeks before seedlings emerged. When seed was planted on April 1, seedlings appeared between 1 and 2 weeks later. From May through October seedlings emerged in less than a week after planting. At the end of the third week after planting, the numbers of emerged seedlings were the same for all plantings.

In our field experiments, the number of nightshade seedlings decreased in August. It is very difficult to keep the upper inch of the soil moist in August because of the high soil temperature. Therefore, we believe the decrease in germination in August is an artifact. Under field conditions where cotton shades the ground, the soil will be cooler and the upper inch should stay moist long enough for nightshade to germinate. Cotton will shade the soil surface in about 16 weeks (Figure 1) after cotton emergence (3). If the cotton seedlings emerge the second week in April, full shade should occur by the last week in July. In such fields, conditions should be favorable for germination of nightshade in August.

Little or no morningglory seed germinated at the 50/60° F temperature regime (Figure 2). A 10° F increase in both the night and day temperatures resulted in 35 to 40% germination of the sanded seed. Also, germination of unsanded seed improved with an increase in temperature, but was variable.

Nightshade seed germinated well under cool temperatures (Figure 3). About 40-50% of the seed germinated under the 50/60° F night/day temperature regime.

As noted above, the field data for nightshade shows no emergence for the first 2 weeks of March. The soil temperatures are probably lower than the 50/60° F used in the growth chambers. Because cotton begins to germinate at about 63°F (2), this means that nightshade can emerge with cotton. As long as moisture is plentiful, nightshade could germinate and emerge any time beginning in the latter part of March through October, but the rapid drying of the upper inch of the soil profile with furrow irrigation during June and early July before the cotton canopy shades the ground inhibits continuous germination through the growing season. Using a type of irrigation system that would keep the soil moist through these hot months would be a disadvantage for nightshade control.

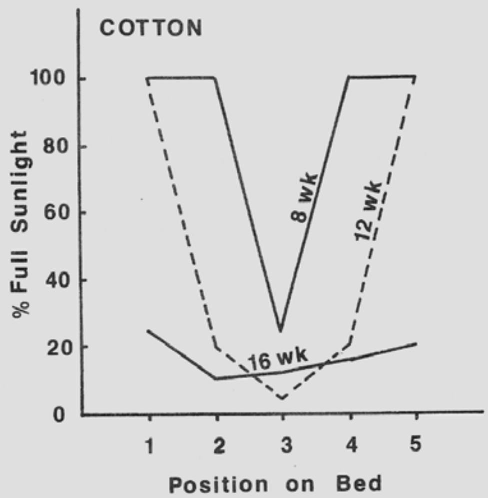

Figure 1. The interception of light by a cotton canopy with time measured at ground level. The distance is 40 inches between the center of the furrows, position 1 and 5. Position 3 is the cotton row and positions 2 and 4 are about half way between position 3 and positions 1 and 5.

The germination temperature curves for 1979 seed, both species, have difinite peaks at about 80/90° F temperature regime (Figures 2 and 3). Germinating 1980 seed, both species produced flat curves without well defined peaks. Because the growth chamber conditions were the same when germinating seed of both years, we suspect that differences in seed germination are real and not an artifact. However, what caused the seed to differ between the two years is not known.

The depth of planting data for morningglory can be seen in Table 3. Morningglory seedlings emerged from the 3 inch depth. While seedling emergence was less compared with the shallower depth, it was good emergence. Although some seed should have been planted at depths deeper than the maximum of 3 inches used in this experiment, results indicate that a soil-incorporated herbicide probably would have to be incorporated deeper than 3 inches to effectively control morningglory seedlings.

Nightshade germination as affected by the depth of planting can be seen in Table 4. Few nightshade seeds germinated from below 1/2 inch and about 20% germinated at 1/2- and 1/4-inch depths in a greenhouse experiment. Likewise, when nightshade was planted in the field 1/4 to /2 inch deep, 20% germination occurred. It is logical that a small seed that is light sensitive (Table 2) would germinate on the surface or when buried to a very shallow depth. Therefore, any soil-incorporated herbicide would not have to be incorporated very deep to be effective against nightshade seed.

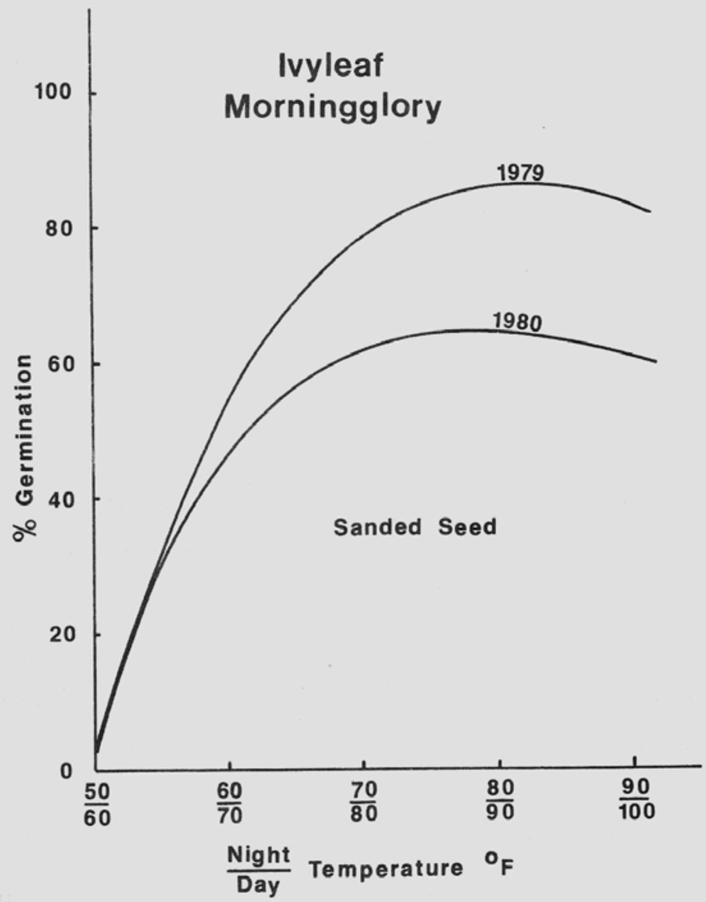

Figure 2. The effect of temperature on the germination of ivyleaf morningglory seed collected in 1979 and 1980.

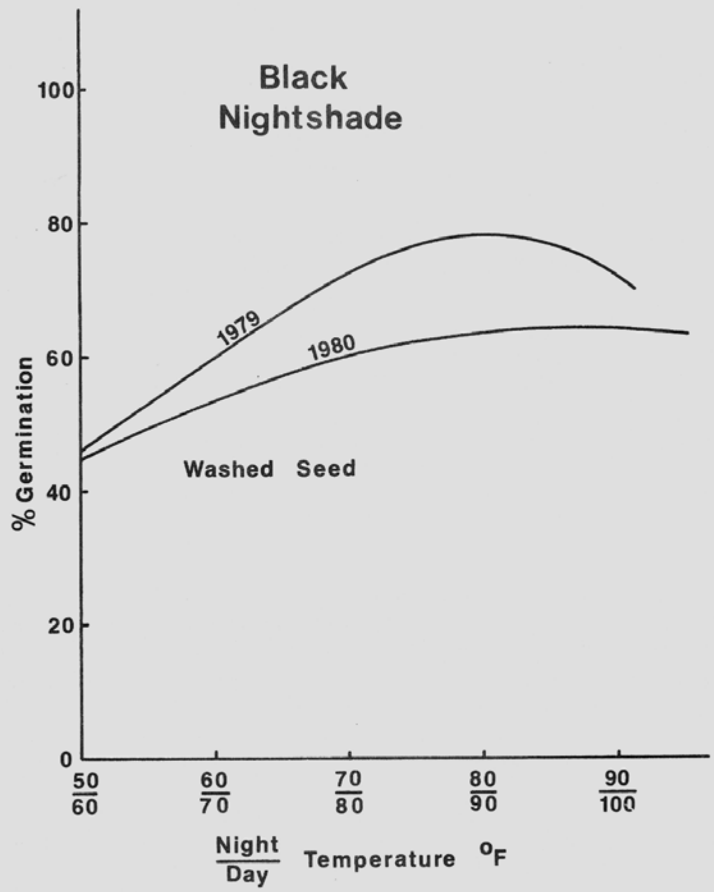

Figure 3. The effects of temperature on the germination of black nightshade seed collected in 1979 and 1980.

Table 3. Effect of depth of soil on the emergence of ivyleaf morningglory.

Soil Depth (inches)	Emergence (%)
0.5	78
1.0	66
3.0	52

Table 4. Effect of depth of soil on the emergence of black nightshade

Soil Depth (inches)	Emergence (%)
0.25	19
0.5	20
1.0	3
2.0	1
3.0	0

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BIOLOGY AND CONTROL OF HOUNDSTONGUE (*CYNOGLOSSUM OFFICINALE*)

J. R. Dickerson and P. K. Fay[1]

Introduction

Houndstongue (*Cynoglossum officinale* L.) is a biennial plant that is a native of Asia. It was accidentally introduced into the United States through Europe. Houndstongue is commonly found is disturbed areas including roadsides, barrow pits, and forested areas. Heavy infestations of houndstongue are commonly found in pastures and abandoned cropland in Montana.

Houndstongue seedlings emerge in the spring and early summer and produce a rosette plant during the first year of growth. The plants are easily identified by means of their heavily venated, oblanceolate leaves which are covered with a soft white pubescence, characteristics which led to the common name of houndstongue.

Houndstongue plants begin bolting in mid-May of the second growing season and produce an erect stem 20 to 75 cm in height which begins flowering in mid-June. Purple, or occasionally, white, flowers produce seed clusters containing 3 to 4 seeds. Each flat, tear drop-shaped seed is about 6 mm in length, and covered with a hard pericarp covered with protruding spines. Mature seed will remain attached to the plants until the abscission layer on the seed is disturbed. The protruding barbs on the seeds readily adhere to clothing, wool, and hair. It is at this time that the houndstongue plants become a problem, since infestations of the seeds reduce the value of wool, and can cause price docking of cattle.

Results and Discussion

Seed Production. A houndstongue seed production study was conducted at 8 locations in the state in 1980. A minimum of 14 plants were collected at each location and the average seed production per plant was calculated. Houndstongue seed production varied from 314 to 674 seeds per plant.

Seed Germination. Seed germination experiments were conducted during the winter of 1980. There was no germination is a standard seed germination test. A seed leaching study was conducted in which seeds were subjected to running water. There was 5% germination after a 96-hour leaching period. Mechanical scarification resulted in approximately 10% germination. No seed germination resulted when seeds were subjected to sulfuric acid for varying lengths of time. Results from these studies indicate that houndstongue seed hull damage will permit seed germination, therefore a study was conducted in which the hull was damaged by three methods. This included removing the tip of the pericarp, pricking the center of the seed with a pin, and cracking the seed hull. Pricking and cracking increased germination from 0% to 7% and 2%, respectively. Removal of the pericarp tip resulted in 37% germination in distilled water, and 53% in a solution of gibberellic acid (1000 ppm).

A final study was conducted in which the hull (pericarp) was completely removed from the seed. Dehulling increased germination from 9% to 93% germination is distilled water, and 95% germination in gibberellic acid (1000 ppm). The houndstongue seeds used in these studies were completely viable and the pericarp or hull of freshly harvested houndstongue seeds enforces the seed dormancy.

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Root Growth Studies. The root system produced by first-year houndstongue plants was observed at three locations near Bozeman, Montana at the end of the first season of growth. Soil pits 2 m long by 2 m deep by 2 m wide were excavated using a backhoe adjacent to plants in the rosette stage in mid-October, 1980. Houndstongue plants produced an extensive taproot system that branched several times while penetrating to a soil depth of over 100 cm.

Mechanical Control. One hundred and fifty-one second year plants in the flowering stage were cut 0 to 7 cm above the soil surface on June 23, 1980. Plant regrowth, plant height, and seed production was measured on September 27, 1980. Sixty percent of the plants did not regrow after cutting. The remaining plants regrew to an average height of 16.5 cm and produced 25 seeds per plant. Uncut plants were 75 cm tall and produced 364 seeds per plant. Mechanical control was an efficient means of reducing seed production, however, plant growth and seed production was not completely eliminated.

Chemical Control. Plants were sprayed at uniform intervals (Table 1) during the spring and early summer of 1981 with 2,4-D [(2,4-dichlorophenoxy)acetic acid] amine (0.56 and 1.12 kg/ha) and chlorsulfuron (2-chloro-*N*-{[(4-methoxy-6-methyl-1,3,5-triazine-2-yl)amino]carbonyl}benzenesulfonamide) (0.07 and 0.14 kg/ha). Plant control of first and second year plants was visually rated in August. Plants were harvested in October to determine the seed production of second-year plants.

Table 1. Percent control of first year plants on August 8, 1981. The plants were sprayed with 2,4-D amine or chlorsulfuron at 5 stages of development.

		Percent control				
		Date of application				
Herbicide	Rate (kg/ha)	5-15-82	5-25-82	5-29-82	6-21-82	7-7-82
2,4-D amine	0.56	45	32	60	92	20
2,4-D amine	1.12	45	45	98	88	40
Chlorsulfuron	0.07	100	100	100	100	62
Chlorsulfuron	0.14	98	100	100	100	97

First year houndstongue plants were most susceptible to 2,4-D amine on May 29 when 97% control was achieved with 1.12 kg/ha 2,4-D per ha (Table 1). Second year plants were most susceptible during the bloom stage; however, only 77% control was measured (Table 2). First and second year plants were extremely susceptible to chlorsulfuron at each stage of growth prior to early July (Tables 1 and 2).

In the same study the effects of herbicide application on houndstongue seed production was evaluated. The number of seeds produced per plant was calculated from second year plants harvested in October, 1980. The most effective time of application for 2,4-D amine is the 11" bolt stage since seed production by second-year plants was nearly eliminated (Table 3). Chlorsulfuron eliminated seed production when applied in the rosette stage, the 6" bolt stage, and the 11" bolt stage.

Table 2. Percent control of second year plants on August 8, 1981. The plants were sprayed with 2,4-D amine or chlorsulfuron at 5 stages of development.

		Percent control				
		Plant stage of growth				
Herbicide	Rate (kg/ha)	Rosette	6" bolt	11" bolt	Bloom	Seed set
2,4-D amine	0.56	35	40	48	57	26
2,4-D amine	1.12	38	20	48	73	30
Chlorsulfuron	0.07	100	98	100	98	48
Chlorsulfuron	0.14	97	100	100	100	93

Table 3. Seed production of plants sprayed with 2,4-D amine or chlorsulfuron at 5 stages of development.

		Number of seeds per plant				
		Plant stage of growth				
Herbicide	Rate (kg/ha)	Rosette	6" bolt	11" bolt	Bloom	Seed set
2,4-D amine	0.56	88	99	2	171	171
2,4-D amine	1.12	54	299	0	126	352
Chlorsulfuron	0.07	0	0	0	0	355
Chlorsulfuron	0.14	0	0	0	64	101

STUDIES ON THE BIOLOGY OF WILD OAT

L. A. Morrow and D. R. Gealy[1]

Abstract. A large portion of the wheat (*Triticum aestivum* L.) produced in the Northwest is heavily infested with wild oat (*Avena fatua* L.). Populations up to 200 plants/m^2 are common. Management practices and genotypic variations are likely responsible for this wild oat proliferation. Several studies were conducted in the field and greenhouse from 1978 to 1981 to determine seed production, seedling emergence, and developmental parameters of wild oat. Wild oat seed was planted at 5 cm intervals from

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0 to 30 cm in sterilized soil in the field. Each treatment consisted of one planting depth with the soil contained in 45-cm diameter cylinders. During the fall or winter months, no wild oat plants emerged from 10 cm or greater while emergence was about 6 and 12% at 5 and 0 cm (soil surface), respectively. In the spring, plants emerged from as deep as 15 cm, with the largest percentage emerging from 5 cm. No plants emerged at any time from depths of 20, 25, or 30 cm. These findings have been substantiated by greenhouse studies in which plants emerged from 17.5 cm or less.

Counts taken on field-grown plants in 1981 indicated that once emerged wild oats rapidly produced an average of 23 tillers and ultimately 1500 seed. Year-to-year weather and plant density variation affect these parameters as evidenced by the fact that only 14 tillers and 578 seed per plant were produced in 1978.

In greenhouse studies, wild oat seed were removed from plants at various times after anther exertion and germinated on moist filter paper in Petri dishes. Seed germinated 15% within 3 or 4 days after anther exertion, reached a peak of nearly 50% within 1 week, and then entered a phase of dormancy after 1 week in which germination was less than 15%. Although it is unclear what induces the observed dormancy, this phenomenon would serve as a survival mechanism for wild oat in preventing germination and possible death during cold winters in the Northwest.

Seed producing potential, the ability to emerge from as deep as 17.5 cm, immature seed germination potential, and established dormancy capability are at least partially responsible for wild oat being a severe problem in small grain-producing areas.

METRIBUZIN ACTIVITY AS RELATED TO SOIL MOISTURE AND CROP RESIDUE

S. K. Parrish, L. A. Morrow, and D. R. Gealy[1]

Abstract. A field study was established to quantify spring applied metribuzin [4-amino-6-*tert*-butyl-3-(methylthio)-*as*-triazin-5(4*H*)-one] injury to spring wheat (*Triticum aestivum* L. em Thell) grown under conservation tillage systems. The influence of soil moisture and crop residue levels on metribuzin activity was studied. Tillage included conventional, chisel plow, and standing stubble. The chisel plow and standing stubble treatments each had residue levels to resemble wheat crops of 2690 and 5380 kg/ha the previous year. Plots were planted to 'Dirkwin' spring wheat and were located in a 432 mm precipitation zone. Soil moisture increased with increasing crop residue. Yield and wheat stand ratings were increased with metribuzin applications of 0.56 kg/ha when soil moisture was 16% or less, but decreased when soil moisture was greater than 21% (Table 1). The high level of crop residue resulted in decreased yield. Yield reductions were due to decreases in the number of wheat plants (Table 1).

Greenhouse studies were established to evaluate soil moisture as a factor in the activity of metribuzin. Metribuzin was applied to soil in pots at 0.56 kg/ha. The soil surface was left bare or covered with 2 cm of chaff, straw, or perlite. Three days after receiving equal amounts of

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Table 1. The effect of tillage and metribuzin application on soil moisture and wheat growth.

Tillage[1]	% Soil Moisture[2]	Number of Wheat Plants[3]	Stand Ratings[4]	Yield (kg/ha)
Co	7.8	23.0	8.3	790
Co + M	7.6	27.7	8.6	1210
Ch	14.0	25.0	8.7	900
Ch + M	14.7	26.5	8.0	960
Ch + R	22.2	23.0	6.7	580
Ch + R + M	22.0	12.5	5.5	200
Ss	16.4	25.7	8.5	950
Ss + M	16.1	29.7	8.0	920
Ss + R	21.9	16.5	5.4	390
Ss + R + M	22.3	7.5	3.2	80

[1]Co = conventional, M = metribuzin, Ch = chisel plow (2690 kg/ha harvest previous year), Ss = standing stubble (2690 kg/ha harvest previous year), R = residue (5380 kg/ha harvest previous year)

[2]Percent soil moisture top 2 cm.

[3]Numver of wheat plants in a 7.5 meter by 1 cm belt transect.

[4]Ratings were from 1 to 10, 10 being best wheat stands.

water, the average soil moisture was: perlite, 22.7%; chaff, 21.9%; straw, 18.6%; bare, 7.6%; and check (bare soil, no metribuzin), 5.9%. Metribuzin injury was directly cottelated to soil moisture. Injury to plants also appeared earlier with increased soil moisture.

Results of these experiments indicate that increased soil moisture plays a major role in metribuzin activity. Conservation tillage systems, particularly where high levels of crop residue are present, could be expected to result in increased soil moisture and consequently, increased metribuzin activity on target as well as non-target plant species.

JOINTED GOATGRASS: EARLY GROWTH AND DEVELOPMENT

D. G. Flom and L. A. Morrow[1]

Abstract. Jointed goatgrass (*Aegilops cylindrica* Host.) is a winter annual grass that is becoming a serious weed in winter wheat (*Triticum aestivum* L.) growing areas of the Pacific Northwest. Because of similarities in growth habit between jointed goatgrass and winter wheat, selective control of this weed is difficult.

Jointed goatgrass is similar in appearance to wheat in the vegetative stages, but differences exist in the reproductive stages. Jointed goatgrass produces a tight spike in which the spikelets are arranged in a

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cylindrical manner around the rachis. The rachis disarticulates either below each spikelet or at the base of the spike. Each spikelet contains 2 to 5 flowers, and 1 to 3 seeds normally develop per spikelet. The seeds are not easily separated from the spikelet. Controlled temperature studies indicate that jointed goatgrass radicle and shoot emergence occurs rapidly at temperatures ranging from 5 to 30 C, but optimum germination temperature is about 15 C. Maximum coleoptile length is about 5 cm, as evidence by depth of emergence studies.

Selective chemical control of jointed goatgrass in winter wheat has not been effective, possibly due to the close genetic link between the *Aegilops* and *Triticum* genera. Further evidence of close linkage is the occurrence of hybrids in winter wheat-growing areas infested with jointed goatgrass. Non-selective herbicides and repeated tillage operations have been utilized to reduce jointed goatgrass. However, with the emphasis on reduced tillage, the option of using tillage as a weed control method has been reduced. Greenhouse studies indicate that low rates of glyphosate [*N*-(phosphonomethyl)glycine] will effectively control jointed goatgrass at the 1 to 2-leaf stages.

DETERMINATION OF THE MOVEMENT OF CHLORSULFURON IN RUNOFF WATER, SEDIMENT, AND SOIL PROFILE UNDER TWO TILLAGE SYSTEMS

D. W. Morishita, T. C. Sampson, D. C. Thill, and R. H. Callihan[1]

Abstract. The objectives of this study were to determine the movement and dissipation of chlorsulfuron (2-chloro-*N*-{[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]carbonyl}benzenesulfonamide) applied in the fall at 0.07 kg/ha in runoff water, sediment, and the soil profile under no-till and conventional tillage systems. The presence of chlorsulfuron in runoff water was determined using a water biological assay technique. Determination of the movement and dissipation of chlorsulfuron in sediment and the soil profile was also attempted using a biological assay, however, a reliable technique could not be developed. Weed control in all treated plots was excellent. Crop injury, crop height, density, and biomass were not different in any of the indicator crops when herbicide treated no-till and conventional tillage plots were compared except for peas (*Pisum sativa*) where an increased vigor reduction was observed in the no-till treatment.

Preliminary results indicate no evidence of chlorsulfuron in the collected runoff water. Detection was made down to a 1 ppb level. A soil bioassay technique developed by E.I. DuPont de Nemours and Company using field corn (*Zea mays*) as the indicator plant was tested, but resulted in extremely variable corn growth. Several other soil bioassay techniques were also tested. The four methods yielding the most consistent results were: an extraction of chlorsulfuron with an organic solvent, extraction with a TRIS buffer solution, addition of $CaCO_3$ to the soil, and addition of $Ca(OH)_2$ to the soil. A reduction in corn root length, weight, and ratio of root length to shoot length was evident with increasing concentrations of herbicide; however, growth of the indicator plant was variable. Repeatability of the more successful techniques was also a problem in the

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the development of a bioassay. The presence or absence of chlorsulfuron was the only reliable determination that could be made.

EFFECTS OF DELAYED INCORPORATION ON THE HERBICIDAL ACTIVITY OF TWO THIOCARBAMATE HERBICIDES

Wayne O. King and J. O. Evans[1]

Abstract. A two-year field study was conducted at Utah State University on the effects of delaying incorporation of vernolate (*S*-propyl dipropylthiocarbamate) and EPTC (*S*-ethyl dipropylthiocarbamate) applied to both dry and moist soil surfaces. Control of annual weeds in 1980 was not effected by time intervals up to 36 hours between herbicide application and incorporation. In 1981 reduced weed control was observed when incorporation followed application by 24 hours but not by 12 hours. No differences in efficacy was noted between the moist and dry soil surface applications in either year.

Introduction

The two thiocarbamate herbicides used in this study, EPTC and vernolate, are closely related; the only structural difference being one additional methylene group in the carbon chain attached to the sulfur atom in vernolate. Both compounds are volatile and are lost from the soil if not incorporated. EPTC has a vapor pressure of 34 x 10^{-3} mm at 25 C while that of vernolate is lower (10.4 x 10^{-3}). Label instructions prescribe immediate incorporation of EPTC and vernolate into the soil following application.

The objective of this study was to determine the loss of efficacy of EPTC and vernolate when incorporation of these compounds is delayed for varying intervals following soil surface application.

Materials and Methods

Experiments were conducted two years, 1980 and 1981, at North Logan, Utah on a silt loam soil containing 1.4% organic matter and having a pH of 7.9. In 1981 formulations which included the safener R25788 (*N*,*N*-diallyl-2,2-dichloroacetamide) were used. Dosage rates and intervals between application and incorporation varied between 1980 and 1981 as indicated in Table 1. All treatments were applied to both moist and dry soil surfaces. This was accomplished by tilling the moist soil surface plot areas with a spring-tine harrow immediately before application. The dry surface plots were tilled the same way one day before application to give a uniform soil texture and dry surface. Prior to tilling the entire plot areas were overseeded with 4.49 kg/ha of a weed seed mixture of green foxtail [*Setaria viridis* (L.) Beauv.) and redroot pigweed (*Amaranthus retroflexus* L.), two annual weeds sensitive to EPTC and vernolate. Herbicides were applied with a bicycle sprayer calibrated to deliver 30.6 L/ha. Layout was in a randomized complete block design with three replications. Plot sizes were 3.35 m x 7.62 m (1980) and 3.35 m x 9.14 m (1981). Following application, plots that were to be incorporated were tilled with a spring-tine harrow after the appropriate time interval. Sprinkler irrigation was applied as needed for good weed growth but not

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Table 1. Herbicides, rates, and intervals between herbicide application and incorporation in 1980 and 1981.

	1980	1981
Herbicides:	EPTC vernolate	EPTC + R25788 vernolate + R25788
Rates:	3.37 kg/ha 6.73 kg/ha	4.49 kg/ha
Interval between application and incorporation:	Immediate, 8 hours 12 hours, 24 hours 36 hours	Immediate, 12 hours 24 hours, not incorporated

sooner than three days following the final incorporation.

Results

Figure 1 shows percent control of green foxtail in 1980 with 3.37 kg/ha of both herbicides. No treatment gave less than 90% control regardless of compound, soil moisture, or length of interval between application and incorporation.

Figure 2 (redroot pigweed control in 1980 at 3.37 kg/ha rates) shows more variation than figure 1. Vernolate generally gave superior control compared to EPTC, but effects on herbicidal activity due to incorporation time and/or soil surface moisture were minimal. None of the treatments which were immediately incorporated showed the greatest level of weed control, this was especially apparent with EPTC which on the moist soil showed significantly less activity when incorporated immediately than when incorporation was delayed 24 hours. There is no known reason for this.

The 6.73 kg/ha rates used in 1980 will not be discussed at length because they produced higher percentages and more consistent weed control than the 3.37 kg/ha rates.

Figure 3 (green foxtail control, 1981) illustrates a reduction in EPTC + R25788 activity on dry soil after 24 hours. Figure 3 also shows a reduction in control when the compounds were not incorporated, but that reduction was not as great as might have been anticipated due to possible vaporization of the chemical from the soil. Vernolate + R25788 gave greater control than EPTC + R25788 on moist soil when not incorporated, but EPTC + R25788 was more effective when not incorporated on dry soil. These same differences appeared in pigweed control (Figure 4). There was a drop in EPTC + R25788 activity against pigweed after 24 hours on dry soil, and reduced activity of both compounds resulted when there was no incorporation. Again, vernolate + R25788 showed increased control on moist soil while EPTC + R25788 gave greater control on dry soil when not incorporated.

In 1981, soil samples within the plots were treated, then collected at the time of incorporation and analyzed for herbicide residues. Figure 5 shows residue analysis in parts per million soil dry weight (there are no data for the nonincorporated treatments). After 24 hours, there were reduced concentrations of both compounds. These were not statistically tested because samples were composited and only one composite sample per treatment was analyzed, but there was a general decrease in herbicide concentration over time.

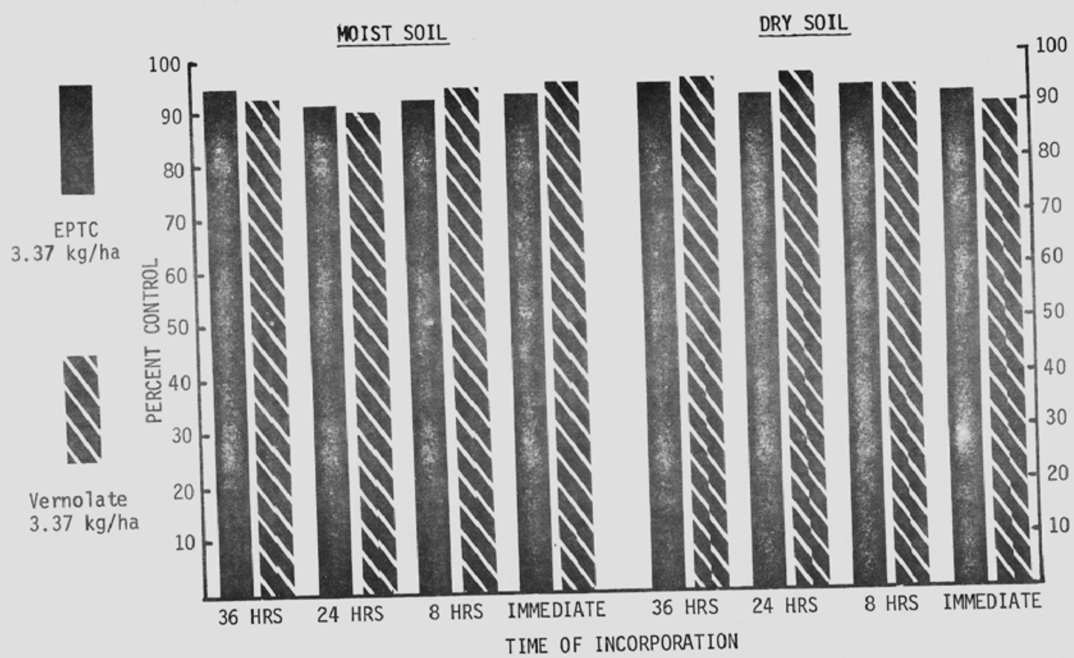

Figure 1. Effects of incorporation interval and soil surface moisture on activity of EPTC and vernolate against green foxtail, 1981.

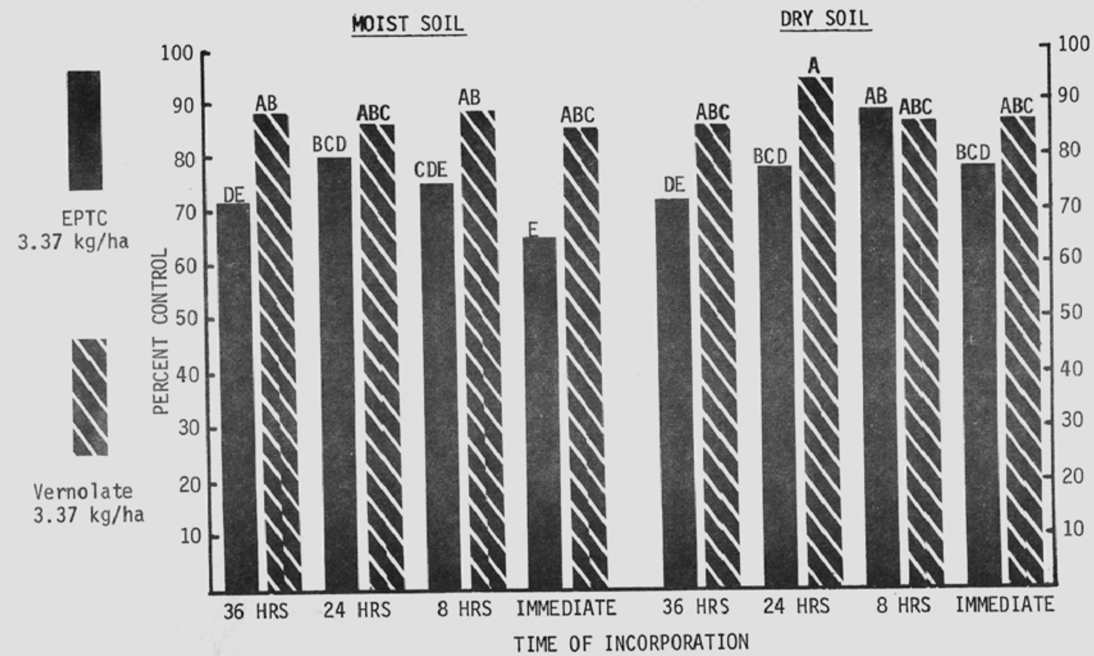

Figure 2. Effects of incorporation interval and soil durface moisture on activity of EPTC and vernolate against redroot pigweed, 1980. Treatments with the same letter are not significantly different at 5 percent LSD.

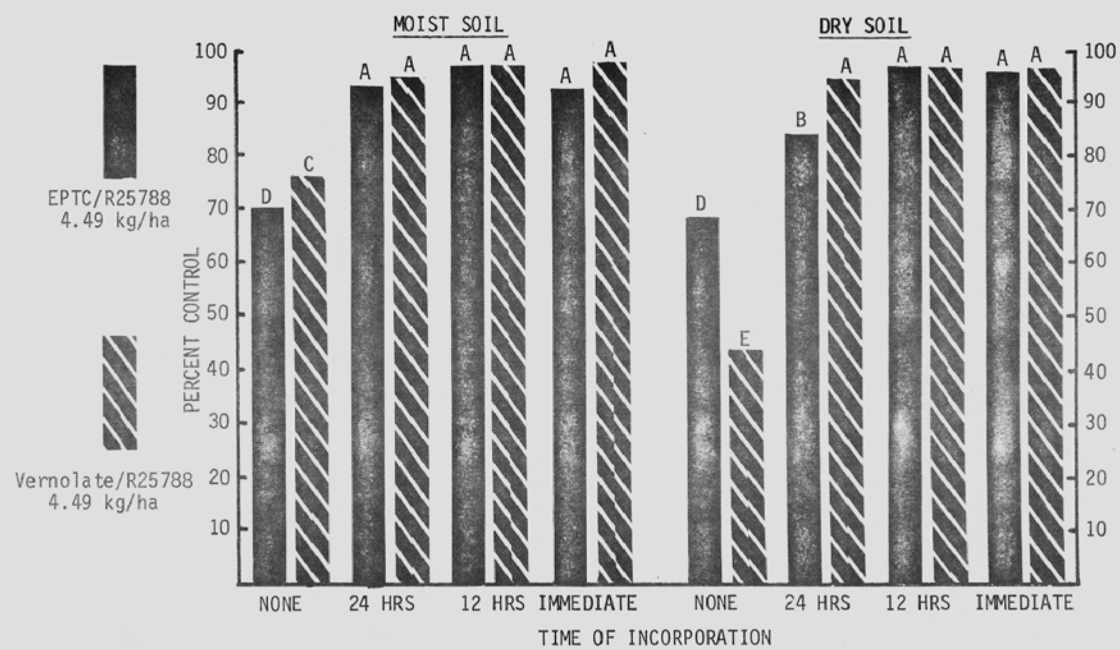

Figure 3. Effects of incorporation interval and soil surface moisture on activity of EPTC/R25788 and vernolate/R25788 against green foxtail, 1981. Treatments with the same letter are not significantly different at 5 percent LSD.

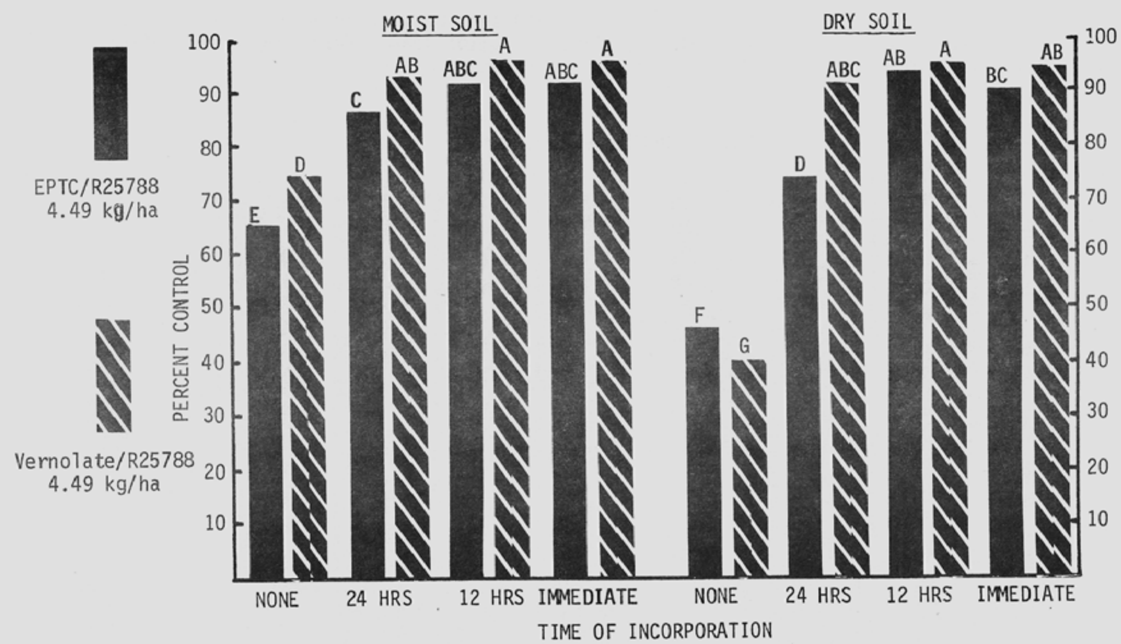

Figure 4. Effects of incorporation interval and soil surface moisture on activity of EPTC/R25788 and vernolate/R25788 against redroot pigweed, 1981. Treatments with the same letter are not significantly different at 5 percent, LSD.

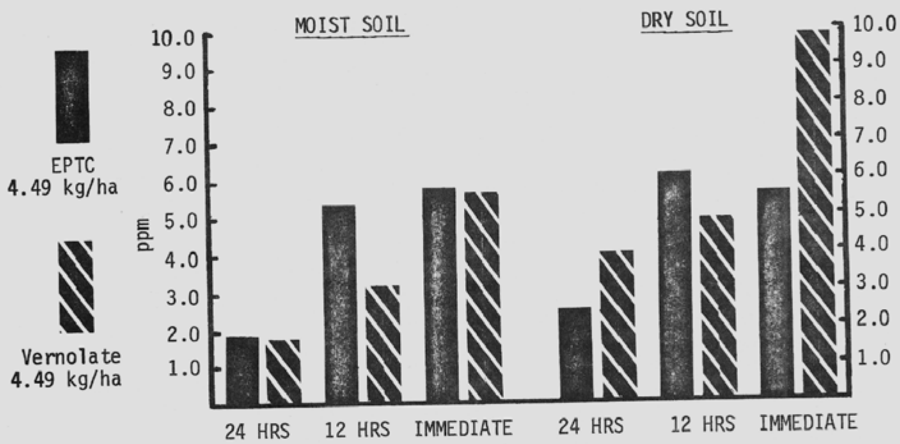

Figure 5. Residues of EPTC and vernolate in soil samples collected at three time intervals following application, 1981.

Summary

Weed control was not reduced when incorporation of EPTC was delayed 36 hours on moist soil

On dry soil, no reduction of weed control occurred when incorporation of EPTC was delayed 12 hours, but at 24 hours loss of activity up to 22% was noted.

In general, vernolate showed greated herbicidal activity than EPTC at similar rates except when applied to dry soil and not incorporated.

No loss of herbicidal activity was noted when incorporation of vernolate was delayed up to 36 hours on moist or dry soil.

Both EPTC and vernolate showed better weed control applied to moist soil than dry when not incorporated.

LOW TEMPERATURE (-196 C) EFFECTS ON WEED SEED GERMINATION

James L. Jordan[1], Lowell S. Jordan[1], and Catalina M. Jordan[2]

Abstract. Effects of low-temperature on storage of seed germplasm were investigated using scanning electron microscopy. Ultracooling to -196 C and subsequent thawing of *Echinochloa crus-galli* (L.) Beauv. and *Setaria lutescens* (Weigel) Hubb. seeds altered their germination. Scanning electron micrographs of the seeds reveal no fissures nor cracks in the seed coat, as predicted by previous research; therefore, other effects of ultralow temperature on seed germination are indicated.

Introduction

Ultra-low temperatures (e.g. -196 C) have been suggested for germplasm storage of seeds (5, 6, 8). Thus, research has been conducted to determine the effect of low temperature cooling (ultracooling) on seed germination (1 - 9). Ultracooling may decrease seed germinability [especially of seeds over 13% moisture content (7, 9)], not affect seed germinability (3, 5, 6, 8), or result in an increase in seed germinability (1, 2, 4). Increased seed germinability after ultracooling has been attributed to cracks forming in the seed coat (1, 2). Because ultracooling had been previously determined to increase germinability of barnyardgrass (*Echinochloa crus-galli*) and yellow foxtail (*Setaria lutescens*) seeds (4), scanning electron microscopy (SEM) was used to study the seed coats of *E. crus-galli* and *S. lutescens* to determine if ultracooling increased seed germinability by forming cracks in the seed coats. Although the correct botanical term for the dispersal unit investigated in this research is the floret and not a "seed," the term seed is used to maintain continuity between the previously published germination tests and the present SEM research. The term seed coat in this investigation refers only to the palea of the floret.

Materials and Methods

Barnyardgrass and yellow foxtail seeds were collected from plants in naturally growing populations in two maize fields in Iowa. The seeds from each site were pooled and stored in muslin bags in dry 24 C air. Before use, the glumes were removed from the seed by rubbing the seeds gently between the palms of two hands. Debris was separated by a seed cleaner.

Seeds were ultracooled by emmersing them into liquid nitrogen (-196 C); after ultracooling for 5 min, the liquid nitrogen was allowed to evaporate.

The seeds were thawed for 1 h in air at 24 C. After the ice on the outside of the beaker melted, the seeds were mixed and samples were removed for germination testing. The remaining seeds in the beaker were alternately ultracooled and thawed as above. Three groups of 5,000 seeds from each collection site were alternately ultracooled and thawed. Seeds were ultracooled up to 10 times. Three 100-seed replicates from each of the 10 ultracoolings were germinated by placing them between two pieces of moist 9-cm-diameter Whatman no. 1 filter paper in a 10-cm-diameter plastic petri dish; 5 ml of deionized water was used to moisten the filter paper.

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Deionized water (2 ml) was added to each petri dish 2, 4, and 6 days later to maintain adequate moisture in each petri dish. Germination was recorded daily for 1 wk; the number germinated for each ultracolling replication was averaged.

To determine the effect of ultracooling in the imbibition of water by seeds, seeds ultracooled 10 times and not ultracooled were allowed to imbibe water for 12 h at 35 C in the dark. Percentage of imbibition was based on the difference between initial weight and weight after water imbibition. To determine percentage of moisture, seeds were placed in a 105 C forced air oven for 24 h, and the difference between initial fresh weight and weight after drying in a forced air oven was calculated. Eighteen samples of 100 seeds ultracooled 10 times were used for both the water imbibition and percentage of moisture content. Nine samples of 100 seeds either not ultracooled or ultracooled 10 times were used from each collection site for both the water imbibition and percentage of moisture tests.

Seeds for SEM were processed for direct observation of the intact palea surface and cryofractured for a cross-sectional view of the seed coat. For observation of the seed coat surface, seeds, both not ultracooled and ultracooled 10 times, were mounted directly in silver paste previously applied to the upper surface of standard brass JEOL SEM stubs.

For cryofracture, seeds were wrapped in Parafilm, immersed in liquid nitrogen, and fractured with a razor blade across the midpoint of the seeds perpendicular to the longest axis. Cryofractured seeds were mounted in the same manner as non-cryofractured seeds. To ensure direct viewing of the seed coat, the cryofractured surface was mounted parallel to the surface of the stub. All seeds were coated with a 308 A thick layer of gold:palladium (60:40) in a sputter coater to improve the resolution of the surface. A JEOL JSM-35 scanning electron microscope was used to view the seeds. Photographs were taken with Polaroid type 665 film.

Results and Discussion

Ultracooling to -196 C affected the greminability of both barnyardgrass and yellow foxtail seeds. Germinability of barnyardgrass seeds increased after the seeds were repeatedly ultracooled with liquid nitrogen (-196 C) (Fig. 1). Germinability of yellow foxtail seeds increased with one ultracooling, but decreased with subsequent ultracoolings (-196 C) (Fig. 2).

Although germinability was affected by ultracooling, the amount of water imbibed and the seed dry weight was not affected by ultracooling for either barnyardgrass or yellow foxtail (Table 1). SEM investigations also revealed that the overall appearance of the seeds did not change by ultracooling for either barnyardgrass or yellow foxtail seeds. Closer views of the seed coats also did not show any cracks resulting from ultracooling of either barnyardgrass or yellow foxtail seeds. Cryofractured barnyardgrass and yellow foxtail seeds did not show any increase in cracks from 10 ultracoolings as compared to no ultracoolings. Although increased germinability of seeds has been suggested to result from increased seed coat cracking and water imbibition (1, 2), these investigations indicate that the changed germinability of barnyardgrass and yellow foxtail seeds probably did not result from either seed coat cracking of increased water imbibition. Ultracooling of these two species may therefore affect the embryos of the seed in a manner which has yet to be completely understood.

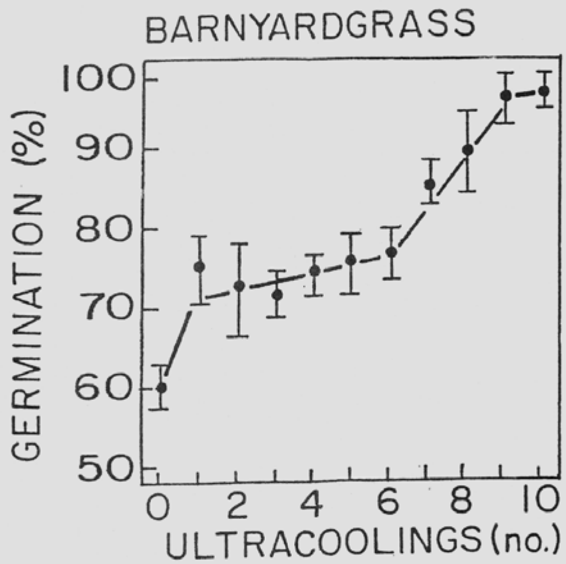

Figure 1. Percentage of germination of barnyardgrass seeds after 1 wk at 35 C versus number of ultracoolings with liquid nigrogen (-196 C).

Table 1. Fresh weight, percent moisture, and imbibition of barnyardgrass and yellow foxtail seeds ultracooled either 0 or 10 times in liquid nitrogen.[1]

Ultracoolings (no.)	Fresh weight[2] (g)	% Moisture (24 hr/105 C)	% Imbibition (12 hr/35 C)
Barnyardgrass			
0	0.231 ± 0.006	6.6 ± 1.6	18.6 ± 4.4
10	0.228 0.007	5.6 ± 2.0	18.7 ± 2.4
Yellow foxtail			
0	0.345 ± 0.007	5.4 ± 2.5	5.8 ± 3.2
10	0.336 ± 0.006	5.8 ± 1.7	6.3 ± 2.6

[1]After ultracooling at - 196 C for 5 min and thawing at 24 C for 1 hr.

[2]Data are means ± standard deviations for 100 seeds.

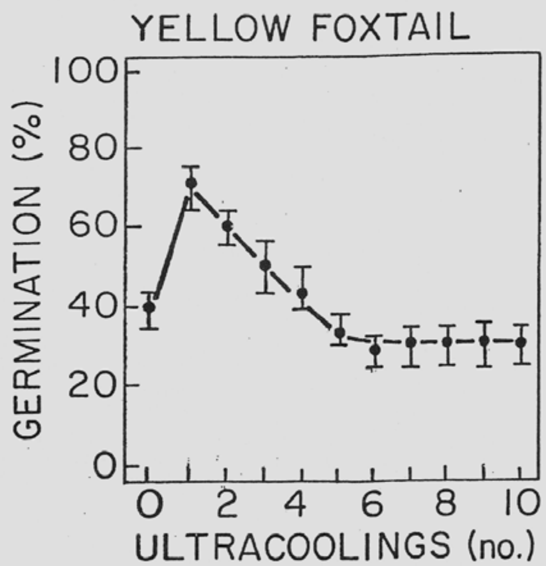

Figure 2. Percentages of germination of yellow foxtail seeds after 1 wk at 35 C versus number of ultracoolings with liquid nitrogen (- 196 C).

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WEED SEED SURFACE MORPHOLOGY

James L. Jordan[1], Lowell S. Jordan[1], and Catalina M. Jordan[2]

Abstract. Weed seed coat patterns are useful for weed taxonomy; therefore the spermoderm patterns of subclass Dicotyledoneae and the family Poaceae class Angiospermae were investigated with scanning electron microscopy. Approximately half of the patterns for both classes were simple reticulate. Other prominent patterns were: foveolate, lophate, papillose, psilate, regulate, verrucate, echinate, striate, substriate, and tuberculate. The multireticulate pattern occurred with the dicotyledons but not with the Poaceae seed observed.

Introduction

Seed characters are a relatively consistent characteristic for a plant species (2, 11); thus, they are useful in plant taxonomy. Because of the uniformity of seed characters within a species, it is possible to use scanning electron microscopy (SEM) to investigate surface structuring of seeds. To date, there have been articles in which SEM has been used to inventigate seeds by species (1, 2, 5, 6, 8), genus (2, 3, 4, 9), or family (7, 11). However, no research report has been located comparing the weed seed coat patterns of the Dicotyledoneae versus Poaceae (a family in the subclass, Monocotyledoneae); thus, research was conducted to determine the prominent weed seed coat pattern of Dicotyledoneae and Poaceae.

Materials and Methods

For scanning electron microscopy, dry, mature weed seeds were mounted on JEOL SEM stubs using double-stick tape, conductive silver paste, conductive silver liquid, or mikrostik. The specimens were sputter-coated with gold palladium. Specimens were examined on a JEOL JSM-35C scanning electron microscope. Photographs were taken using Polaroid 55 film. Most of the seed used in this investigation are from weedy species. Weed seeds were obtained from USDA Plant Introduction Centers and the Jordan Weed Seed Collection at the University of California, Riverside, Botany and Plant Sciences Department. Voucher specimens are kept either at the USDA Plant Interduction Centers or in the Jordan Weed Seed Collection at the University of California, Riverside, Botany and Plant Sciences Department.

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Results

Dicotyledoneae. Weed seeds from 25 families (38 genera, 64 species) of the class Angiospermae, subclass Dicotyledoneae, were used in this investigation (Table 1). Seven different spermoderm (seed coat) patterns were observed. The simple reticulate pattern was the most frequently occurring Dicotyledoneae spermoderm observed (49%) and the multi-reticulate pattern occurred in 11% of the seeds. The foveolate pattern was the most prominent nonreticulate spermoderm pattern (19%) of the Dicotyledoneae seed investigated. Other patterns and their percent occurrence were as follows: Lophate (5%), Papillose (2%), Psilate (2%), Regulate (10%), and Verrucate (6%).

Poaceae. Weed seeds from one family, Poaceae (60 genera, 122 species), of the class Angiospermae, subclass Monocotyledoneae, were used in this investigation (Table 2). Thirteen different spermoderm patterns were observed. The simple reticulate pattern with straight walls occurred in 49% of the seeds observed; the simple reticulate pattern with wavy walls occurred in 15% of the Poaceae seeds observed. The verrucate pattern was the second most prominent spermoderm pattern; it occurred in 12% of the Poaceae seed observed. Other patterns and their percent occurrence were as follows: echinate (2%), psilate (2%), regulate (2%), striate (9%), striate with pubescence (2%), substriate (7%), tuberculate (2%), foveolate (2%), lophate (1%), and verrucate with pubescence (2%).

Discussion

The simple reticulate pattern was the most common spermoderm pattern for both Dicotyledoneae and Poaceae weed seeds, possibly indicating a common evolutionary ancestor and for convergent evolution at least portions of the two subclasses. Although the multi-reticulate pattern was relatively common in Dicotyledoneae seeds, it was not seen in any of the Poaceae weed seeds investigated, possibly indicating a divergence in evolution of spermoderm patterns between the two subclasses. Spermoderm patterns observed in the Poaceae seeds, but not in the Dicotyledoneae seeds, include the echinate, striate, and tuberculate patterns. However, because of the infrequent occurrence of the latter three spermoderm patterns in Poaceae, more seeds need to be observed before generalizations about these spermoderm patterns can be made.

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Table 1. Prominent spermoderm patterns of the selected Dicotyledoneae seeds.

Family	Genus	Species	Authority	Prominent spermoderm pattern
Amaranthaceae	*Amaranthus*	*retroflexus*	L.	Psilate
Apocyanceae	*Apocynum*	*cannabimum*	L.	Simple reticulate
Asteraceae	*Arctium*	*minus*	(Hill) Bernh.	Multi-reticulate
	Cardus	*pymocephales*	L.	Simple reticulate
	Centaurea	*melitensis*	L.	Substriate
	Centaurea	*solstifialis*	L.	Substriate
	Cichorium	*intybus*	L.	Simple reticulate
	Conyza	*bonaviensis*	(L.) Cronq.	Simple reticulate
	Conyza	*canadensis*	(L.) Crong.	Simple reticulate
	Coreopsis	*bigelovii*	(Gray) Hall.	Regulate
	Eupatorium	*capillifolium*	(Lam.) Small	Simple reticulate
	Helianthus	*annuus*	L.	Simple reticulate
	Sonchus	*asper*	(L.) Hill	Simple reticulate
Betulaceae	*Amsinckia*	*intermedia*	Fisch. & Mey.	Verrucate (in clumps)
	Amsinckia	*douglasiana*	A. DC.	Verrucate (in clumps)
Brassicaceae	*Brassica*	*geniculata*	(Desf.) J. Ball.	Multi-reticulate
	Brassica	*kaber*	(DC.) Wheeler	Multi-reticulate
	Brassica	*napa*	L.	Multi-reticulate
	Brassica	*nigra*	(L.) Kock	Simple reticulate
	Capsella	*bursa-pastoris*	(L.) Medic.	Simple reticulate
	Lepidium	*latifolium*	L.	Simple reticulate
	Rhaphanus	*sativus*	L.	Simple reticulate
	Sisymbrium	*irio*	L.	Simple reticulate
Cannabinaceae	*Cannabis*	*sativa*	L.	Simple reticulate

Table 1. (cont.)

Family	Genus	Species	Authority	Prominent spermoderm pattern
Caryophyllaceae	*Cerastium*	*vicosum*	L.	Lophate
	Stellaria	*media*	(L.) Cyrillo	Lophate
Chenopodiaceae	*Chenopodium*	*alba*	L.	Slightly foveolate
	Chenopodium	*murale*	L.	Slightly foveolate
	Chenopodium	*urbicum*	L.	Slightly foveolate
	Kochia	*scoparia*	(L.) Schrad.	Rugulate
Concolculaceae	*Convolvulus*	*arvensis*	L.	Reticulate
Euphorbiaceae	*Eremocarpus*	*setigerus*	Benth.	Foveolate
	Euphorbia	*supina*	Raf.	Simple reticulate
Fabaceae	*Cassia*	*pymocephales*	L.	Simple reticulate
	Cassia	*obtusifolia*	L.	Foveolate
	Crotalaria	*spectabilis*	Roth	Rugulate
	Lactuca	*serriola*	L.	Foveolate
	Medicago	*sativa*	L.	Simple reticulate
	Sesbania	*exaltata*	(Raf.) Cory	Rugulate
Hypericaceae	*Hypericum*	*perforatum*	L.	Rugulate
Lamiaceae	*Lamium*	*amplexicaule*	L.	Papillose mixed with reticulate
Loasaceae	*Loasa*	*valcenicia*		Simple reticulate
Malvaceae	*Abutilon*	*theophrasti*	Medic.	Simple reticulate
	Hibiscus	*trionum*	L.	Simple reticulate
	Malva	*parviflora*	L.	Multi-reticulate
	Sida	*spinosa*	L.	Simple reticulate

Table 1. (cont.)

Family	Genus	Species	Authority	Prominent spermoderm pattern
Onagraceae	*Oenothera*	*hookeri*	T. & G.	Foveolate
Oxalidaceae	*Oxalis*	*corniculata*	L.	Verrucate
Papaveraceae	*Eschscholtzia*	*californica*	Cham.	Multi-reticulate
Plantaginaceae	*Plantago*	*lanceolata*	L.	Psilate
	Plantago	*major*	L.	Simple reticulate
Polygonaceae	*Rumex*	*altissimus*	Wood	Verrucate
	Rumex	*crispus*	L.	Simple reticulate
Portulacaceae	*Portulaca*	*oleraceae*	L.	Lophate
Sapindaceae	*Cardiospermum*	*halicacabum*	L.	Rugulate
Scrophulariaceae	*Kicksia*	*spuria*	(L.) Dumort.	Simple reticulate
Solanaceae	*Nicandra*	*physalodes*	Gaertn.	Simple reticulate
	Nicotiana	*bigelovii*	(Torr.) Wats.	Simple reticulate
	Nicotiana	*clevelandii*	Gray	Simple reticulate
	Nicotiana	*glauca*	Graham	Simple reticulate
	Solanum	*nigrum*	L.	Multi-reticulate
Urticaceae	*Urtica*	*urens*	L.	Multi-reticulate

Table 2. Prominent spermoderm patterns of the selected Poaceae seeds.

Genus	Species	Authority	Prominent spermoderm pattern
Agropyron	*desertotum*	(Fisch.) Schult.	Substriate
	junceum	(L.) Beauv.	Substriate
	repens	(L.) Beauv.	Striate
	smithii	Rydb.	Verrucate
Alopcerus	*geniculatus*	L.	Simple reticulate, walls wavy
	pratensis	L.	Substriate
Andropogon	*gerardii*	Vitman	Substriate
	scoparius	Michx.	Simple reticulate, walls wavy
	ternarius	Michx.	Sinple reticulate, walls wavy
Atropis	*distans*	Rouy	Simple reticulate
Avena	*fatua*	L.	Substriate
Axonopus	*compresus*	(Swartz) Beauv.	Verrucate
Bechmania	*erucaeformis*	(L.) Host	Simple reticulate, walls straight
Bothriochloa	*barbinodis*	(Lag.) Herter.	Simple reticulate, walls straight
	exaristata	Henr.	Simple reticulate, walls wavy
	laguroides	Herter	Simple reticulate, walls wavy
	perforata	Herter	Simple reticulate, walls wavy
Bouteloua	*curtipendula*	(Michx.) Torr.	Rugulate
	gracilis	(Willd.ex HBK.) Lag.	Simple reticulate, walls straight
	hirsuta	Lag.	Simple reticulate, walls straight
Brachiaria	*plataginea*	(Link.) A. Hitchc.	Simple reticulate, walls straight
	platyphylla	(Griseb.) Nash	Substriate
Brachypodium	*distachyon*	(L.) Beauv.	Simple reticulate, walls wavy
Briza	*media*	L.	Simple reticulate, walls straight
	minor	L.	Simple reticulate, walls straight
Bromus	*tectorum*	(L.) Host	Simple reticulate, walls straight
	wildenowii	Kunth	Simple reticulate, walls straight

Table 2. (cont.)

Genus	Species	Authority	Prominent spermoderm pattern
Cenchrus	*incertus*	M. A. Curtis	Rugulate
Chloris	*distichophylla*	Lag.	Simple reticulate, walls stright
	gayana	Kunth.	Striate
	ventricosa	R. Br.	Echinate
Cynosurus	*echinatus*	L.	Slightly foveolate
Cynodon	*dactylon*	(L.) Pers.	Echinate
Dactyloctenium	*aegypticum*	(L.) Beauv.	Simple reticulate, walls wavy
Dactylis	*glomerata*	L.	Simple reticulate, walls straight
Danthonia	*californica*	Bol.	Simple reticulate, walls straight
	pilosa	R. Br.	Verrucate
Digitaria	*adscendens*	(H.B.K.) Henr.	Verrucate
	decumbens	Stent.	Verrucate
	ischaemum	(Schreb.) Muhl.	Verrucate
	sanguinalis	(L.) Scop.	Verrucate
	violascens	Link	Verrucate
Deschampsia	*caepitosa*	(L.) Beauv.	Substriate
Distichlis	*stricta*	(Torr.) Rydb.	Substriate
Echinochloa	*colonum*	(L.) Link	Simple reticulate, walls straight
	crus-galli	(L.) Beauv.	Simple reticulate, walls straight
Eleusine	*coracana*	(L.) Gaertn.	Tuberculate
	indica	(L.) Gaertn.	Tuberculate
	tristachya	(Lam.) Lam.	Tuberculate
Elymus	*caput-medusae*	(Sim.) Nevski	Verrucate
	innovatus	Beal.	Simple reticulate, walls straight
Eragrostis	*cilianensis*	(All.) Nutati	Simple reticulate, walls straight
	curvula	(Schrad.) Ness	Simple reticulate, walls straight
	diffusa	Buckl.	Simple reticulate, walls straight
	mexicana	(Horneum) Link	Simple reticulate, walls straight
	pilosa	(L.) Beauv.	Simple reticulate, walls straight
	poaeoides	Beauv.	Simple reticulate, walls straight

Table 2. (cont.)

Genus	Species	Authority	Prominent spermoderm pattern
Erichloa	*villosa*	(Thunb.) Kunth	Simple reticulate, walls straight
Festuca	*arundinacea*	Schreb.	Simple reticulate, walls straight
	californica	Vasey	Simple reticulate, walls straight
	megalura	Nutt.	Verrucate
	myuros	L.	Simple reticulate, walls straight
	rubra	L.	Striate
Heteropogon	*contortus*	(L.) Beauv.	Psilate, with pubescence
Hordeum	*jubatum*	L.	Striate
	murinum	L.	Verrucate
	vulgare	L.	Simple reticulate, walls straight
Hyparrhenia	*hirta*	(L.) Stapf.	Simple reticulate, walls wavy
	rufa	(Nees) Stapf.	Striate
Lolium	*multiflorum*	Lam.	Simple reticulate, walls straight
	perenne	(Lam.) Husnot	Verrucate
	temulentum	L.	Substriate
Melica	*imperfecta*	Trin.	Slightly foveolate
Panicum	*dichotomiflorum*	Michx.	Psilate
	miliaceum	L.	Psilate
	texanicum	Buckl.	Simple reticulate, walls straight
Paspalum	*conjugatum*	Bergius	Lophate
	dilatatum	Poir.	Verrucate
	urvellei	Steud.	Verrucate
Pennisetum	*clandestinum*	Hochst.	Simple reticulate, walls straight
	purpureum	Schumach.	Simple reticulate, walls wavy
Phalaris	*arundinaceae*	L.	Simple reticulate, walls straight
	aquatica	L.	Simple reticulate, walls straight
	canariensis	L.	Simple reticulate, walls straight
	minor	L.	Simple reticulate, walls straight
	paradoxa	L.	Simple reticulate, walls straight

Table 2. (cont.)

Genus	Species	Authority	Prominent spermoderm pattern
Poa	*annua*	L.	Simple reticulate, walls wavy
	bulbosa	L.	Simple reticulate, walls straight
	nervosa	L.	Simple reticulate, walls straight
Polypogon	*monospeliensis*	(L) Desf.	Simple reticulate, walls straight
Puccinella	*distans*	(L.) Parl.	Simple reticulate, walls straight
Phynchelyteum	*repens*	(Willd.) C.E. Hubb	Simple reticulate, walls straight
	roseum	(Nees) Stapf & Hubb.	Simple reticulate, walls wavy
Secale	*montanum*	Guss.	Simple reticulate, walls wavy
Setaria	*faberi*	Herrm.	Simple reticulate, walls straight
	grisebachii	Fourn.	Simple reticulate, walls straight
	italica	(L.) Beauv.	Simple reticulate, walls straight
	lutescens	(Weigel) Hubb.	Simple reticulate, walls straight
	macrostachya	H.B.K.	Simple reticulate, walls straight
	sphacelata	(Schumacher) Stapf. & C.E.Hubb.	Simple reticulate, walls straight
Trichloris	*crinata*	(Lag.) Parodi	Simple reticulate, walls straight
	pluriflora	Fourn.	Simple reticulate, walls wavy
Tridens	*flavus*	(L.) Hitchc.	Simple reticulate, walls straight
Tripsacum	*lanceolatum*	Rupr.	Simple reticulate, walls wavy
Trisetum	*flavescens*	(L.) Beauv.	Striate
Triticum	*aestivum*	L.	Simple reticulate, walls straight
Vaseychloa	*multinervosa*	(Vasey) Hitchc.	Simple reticulate, walls straight
Vetiveria	*Zizanioides*	(L.) Nash.	Simple reticulate, walls straight

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WHO WILL DO APPLIED WEED CONTROL RESEARCH IN THE FUTURE?

Ken W. Dunster[1]

Abstract. Human health and environmental concerns prompt and often demand ever increasing assurance of pesticide need and improved standards of performance and safety. It is perhaps appropriate that we now consider and objectively evaluate the relative role of the private and public segments of the weed science community to better assure maintenance and future development of effective herbicide programs.

A review of resources currently available for applied weed control research as measured by the Western Society of Weed Science membership from 1971 to 1981 indicates a relative 12 percent decline in public sector participation during the 10 year period. A survey of selected agrichem industry representatives residing in our conference area tends to confirm this relationship. Seventy five percent of the respondents reported diminished participation of state and federal personnel in pesticide R&D activities of priority interest to industry. Decreased involvement may be attributed in part to a general lack of comprehensive administrative support, a shift in resource allocation to better consider IPM interest and urban or minor crop needs, and finally, absence of motivation or inability to respond to changing or increased industrial needs.

The industry survey indicated strong (80 percent) need and desire for public segment cooperation especially regarding comparative performance evaluation considering special needs and local conditions. The degree of continued cooperation will depend to some extent on the suitability and cost of cooperator programs as industry seeks the most efficient way to assure orderly progress of an investment which involves 8 to 10 years and 10 to 20 million dollars.

Introduction

Once upon a time - about 44 years ago - 24 dedicated men met in this city to establish the Western Weed Control Conference. The objectives set forth by that group reflected the need for communication and cooperation among agriculturists to nurture the development of an infant but much needed scientific discipline. I seriously doubt that public and private sector responsibility for the development of effective weed control

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programs was defined, assigned or even discussed.

Spectacular achievement has been recorded for weed science as an integral part of the most efficient agricultural production system in the world since that initial meeting of WSWS in June 1938. We are no longer debating the merit of scoop shovel quantities of borates, chlorates, or arsenicals to effectively smother weeds. Instead, we are in position to discuss the use of gram quantities of herbicide for increasingly safe, effective, and target specific weed control. Such progress has been made as a result of extensive cooperative efforts by the public and private components of the weed science community. While somewhat distressing, it is also encouraging that we recognize the need and are willing to objectively discuss our relative resources and role to better assure maintneance and future development of effective weed control programs.

It seems appropriate to review current herbicide promgram needs and relative efforts prior to discussing who will conduct what kind of applied weed control research in the future.

The Changing Nature and Scope of Herbicide Development Programs

Recent program analysis indicates that 8 to 10 years and 10 to 20 million dollars are often required to develop and register a new pesticide. It is important to realize that ever increasing amounts of this total package are devoted to assuring ourselves and a concerned public that a pesticide can be effectively used to maintain our exceptional standard of living without adverse impact on human health or the environment. Economical, effective weed control performance while fundamentally important is no longer the primary yardstick determining registration pursuit. In many instances public sector (experiment station, extension service, state and federal agency) personnel lack sufficient motivation, facilities, or opportunity for full participation in important development aspects other than biological efficacy.

Who Is Doing Applied Weed Control Research Now?

A component review of WSWS membership as presented in summary table form indicates a 12 percent decline in public segment participation (most notably government agency personnel) during the 1971 to 1981 period.

WSWS Membership By Category

	Percent	
Public Sector	1971	1981
University	29	26
Agency	25	15
Other	4	4
	57	45
Agrichem Industry		
Manuracturing Representatives	35	44
Service	8	11
	43	55

It should be recognized that these figures do not represent an actual reduction in numbers of academic personnel but rather reflect a corresponding increase in agrichem industry involvement in our Society functions. The trend toward increased involvement by industry service personnel including private consultants, application specialists, and chemical distributor representatives is expected to continue on an accelerated scale.

In an attempt to gain and present objective perspective regarding current involvement of university personnel in field R&D activities a questionnaire was circulated to 26 industry colleagues residing in the WSWS area and representing 17 major chemical firms. Response was received from 20 or 77 percent of those polled as follows:

The Primary Need or Justification for Public Sector Involvement is Impartial Evaluation of:

Field Performance	80%
Environmental Factors	40%
Other Aspects	20%

Without question research and extension personnel from the public segment are in excellent position to provide efficient, impartial evaluation of weed control performance under local conditions considering special interest areas and currently available standards.

The Interest and Ability of University Programs to Respond to Pesticide Registration Needs Has:

Increased	15%
Stabilized	30%
Decreased	55%

Individual exceptions are most apparent and it seems possible that the indicated decline may be due to the absence of growth commensurate with increased industry needs. Redirection of effort toward SLN 24(c) or IR-4 registration, IPM interest areas or training function activities may also dilute academic resources available for more direct participation in areas of priority interest to the agrichem industry.

Relative Involvement of Public Sector Personnel in Field R&D Activities Has:

Increased	5%
Stabilized	20%
Decreased	75%

It is interesting to note that university participation has apparently declined even more than interest or ability should allow. This may indicate that public programs are not adequately funded or are not acceptable to industry in terms of scope (specific, timely date) or relative economics. It is also apparent that performance evaluation and other industry needs may not coincide with standards for publication which is critical for professional advancement.

Financial Support of University Programs by Industry Has:

Increased	70%
Stabilized	20%
Decreased	10%

This trend probably reflects industry's need and desire for continued cooperative effort and recognition of inflationary aspects. On the flip side, it could mean that industry is spending more for less which could result in strong consideration of alternative action including further strenghening of in-house resources.

Who Will Do Applied Weed Control Research In The Future?

The need and desire for impartial, efficient evaluation of herbicide efficacy under local conditions should and will allow continued public and private sector partnership to some extent. The extent of such joint effort will necessarily depend upon the scope or suitability and ultimate cost of cooperative programs available.

It should be obvious that the agrichem industry has considerable financial commitment and obligation to assure the most efficient route of pesticide development and registration. If current trends continue, it appears likely, if not probably, that industry will accelerate the search for independent, accountable resources to supplement efforts directed toward problem solving weed control research.

We have accomplished much--Together. I happen to feel that the next 44 years can be equally productive if we adhere to the original goal of WSWS and continue to seek ways to foster communication and cooperation among agriculturists. Lets make sure we recognize and understand each other's needs and obligations as we go forward--Together.

EVALUATION OF GRASS HERBICIDES FOR BERMUDAGRASS CONTROL IN ESTABLISHED ALFALFA

C. E. Bell and J. Castro[1]

Abstract. Management of bermudagrass [*Cynodon dactylon* (L.) Pers.) in established alfalfa by two experimental herbicides, BASF 9052 {2[1-(ethoxyimino)butyl]-5-[2-(ethylthio)propyl]-3-hydroxy-2-cyclohexen-1-one} and fluazifop butyl {butyl 2-[4-(6-trifluormethyl-2-pyridyloxy)phenoxy] propionate} was studied in a field trial. The purpose of the study was to evaluate the efficacy of the two herbicides for control of bermudagrass under different applications. Both herbicides were applied twice to the same plots, four weeks between applications at 3 rates (0.25, 0.5, and 1.0 lb a.i./A). In addition, each herbicide was applied at each rate with a conventional CO_2 pressurized plot sprayer at approximately 30 gallons per acre (GPA) and with a controlled droplet application (CDA) Micron Herbie at approximately 5 GPA. Each treatment was replicated four times.

Control of bermudagrass failed to reach 100% with any treatment, however, economically acceptable suppression was evident with 0.5 and 1.0 lb a.i./A of either herbicide when applied with the conventional sprayer. Applications with the CDA sprayer were less than acceptable at 0.25 and 0.5 lb a.i./A and barely acceptable at 1.0 lb a.i./A. Two applications did not appear to increase the ability of either herbicide to control bermudagrass. There was no apparent injury to the crop from any treatment (Table 1).

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Table 1. Effects of grass herbicides on bermudagrass control.

Treatment	Rate (lb a.i./A)	Application (gal/A)	Weed Control (%)	
			8-21-81*	9-18-81+
BASF 9052	0.25	30	45	45
BASF 9052	0.25	5	5	20
BASF 9052	0.5	30	75	85
BASF 9052	0.5	5	52.5	60
BASF 9052	1.0	30	85	87.5
BASF 9052	1.0	5	50	47.5
Fluazifop butyl	0.25	30	40	37.5
Fluazifop butyl	0.25	5	15	5
Fluazifop butyl	0.5	30	67.5	70
Fluazifop butyl	0.5	5	7.5	15
Fluazifop butyl	1.0	30	85	82.5
Fluazifop butyl	1.0	5	65	47.5
Untreated control	-	-	0	0

*Rated four weeks after 1st treatment
+Rated four weeks after 2nd treatment

GROWTH REGULATOR EFFECTS OF EL-500 ON ESTABLISHED TURFGRASS SPECIES IN CALIFORNIA

L. G. Thompson[1]

EL-500 (formerly Compound 72500) {α-(1-methylethyl)-α-[4-(trifluoromethoxy)phenyl]-5-pyrimidinemethanol} is a new growth regulator for use on established turfgrass. Technical EL-500 is a non-volatile white crystalline solid with a melting point of 94° to 96°C. It is soluble in several organic solvents such as acetone, ethanol, methanol, dimethyl sulfoxide, and ethyl ether. EL-500 is currently formulated as a 1% granule and a 50% wettable powder.

Preliminary toxicological data indicate that EL-500 has a low order of mammalian toxicity. For example, the oral LD_0 is >500 mg/Kg for rats and the dermal LD_{50} is >2000 mg/Kg for rabbits.

Eli Lilly and Company field and greenhouse studies have shown EL-500 to have growth regulator activity on most commercially grown cool- and warm-season turfgrass species. Weed species, broadleaves and grasses, present in test plots have also exhibited similar growth retardant responses. The physiological response to EL-500 is manifested in new shoots as an internodal reduction in the subapical region. EL-500 does not inhibit flowering in plants nor does it restrict root development. Since EL-500 is primarily absorbed by the roots, adequate rainfall or irrigation is necessary to move the compound into the root zone of the turfgrass.

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Field research was conducted in California to determine the activity of EL-500 on several major warm- and cool-season turfgrass species. Data on growth inhibition, seedhead suppression, and turf tolerance from experiments conducted during 1977-1981 will be discussed. The effect of varying spray volumes and repeat applications will also be addressed.

Materials and Methods

Field turf trials were conducted in the San Joaquin Valley and the central coastal region of California and consisted of three replications in a randomized block design with each plot varying in size from 150 to 300 ft^2. Foliar treatments were applied using a CO_2 backpack sprayer with a conventional 3-nozzle hand-held spray boom. The granular treatments were applied with a hand shaker. EL-500 was evaluated at rates of 0.5 to 3 lb/A, depending on turf species. All the turf areas were uniformly mowed prior to treatment. Applications were made just after initiation of new turf growth in the spring. Immediately following application, 1 to 2 inches of sprinkler irrigation were applied to the trial sites.

Turf species evaluated included common bermudagrass, Santa Ana and Tifgreen hybrid bermudagrass and a cool-season mixed turf of 80% perennial ryegrass (Pennfine and Manhattan varieties) and 20% Kentucky bluegrass (Galaxy and Flyking varieties).

Evaluations were primarily made on a biweekly basis through the duration of each experiment. Growth response was determined by visual estimates in reference to unmowed control plots for growth inhibition, grass injury, turf color, turf density, and seedhead production.

Results

Common Bermudagrass. The average percent growth inhibition on common bermudagrass with surface applications of EL-500 are presented in Table 1.

Table. Average percent growth inhibition of common bermudagrass from surface applications of EL-500

Treatment	Rate (lb/A)	Percent growth inhibition			
		30 DAA[a]	45 DAA	60 DAA	90 DAA
EL-500 50W	0.5	22 (1)[b]	23 (1)	12 (1)	0 (1)
	0.75	29 (2)	13 (2)	23 (2)	- [c]
	1.0	46 (3)	42 (3)	41 (3)	10 (1)
	1.5	75 (3)	59 (3)	61 (3)	48 (1)
	2.0	79 (2)	78 (2)	79 (2)	63 (1)
	3.0	90 (1)	93 (1)	88 (1)	87 (1)
EL-500 1G	0.5	30 (2)	14 (2)	7 (2)	0 (2)
	1.0	43 (2)	36 (2)	28 (2)	5 (2)
	1.5	65 (2)	57 (2)	49 (2)	13 (2)
	2.0	80 (2)	79 (2)	75 (2)	39 (1)
	3.0	78 (1)	83 (1)	73 (1)	-

[a] DAA = Days after application.

[b] Number in parenthesis is the number of experiments from which data were collected.

[c] Dash indicates data were not taken or treatment not included in trial.

The percent inhibition was found to be directly related to the rate of EL-500 applied. Twenty-two to 90 percent growth suppression of common bemudagrass was observed 30 days after application with EL-500 50W at rates of 0.5-3 lb/A. Growth suppression with the 1G formulation at the same rates was 30-78% thirty days after application. The slightly better inhibition noted with the 50W formulation may be due to the inherent difficulty in uniformly applying a granular formulation. Growth inhibition decreased to 0-87% ninety days after application with EL-500 50W at 0.5 to 3 lb/A. There was a greater decrease in suppression at the lower rates (0.5-1 lb/A) compared to the higher rates (1.5-3 lb/A). Growth inhibition decreased more rapidly with the 1G formulation compared to the 50W. The percent growth inhibition with EL-500 at 0.5-2 lb/A ninety days after application was 0-39%. Seedhead suppression 45 days after treatment at rates of 0.5 to 3 lb/A ranged from 40-93% and 23-87% with EL-500 50W and 1G, respectively (Table 2). Seedhead suppression decreased rapidly with time, resulting in little or no effect at the lower rates ninety days after application. No significant differences in turf density or color were noted between the EL-500 treated bermudagrass and the mowed controls. Excellent turf tolerance to EL-500 was also observed except for reapplication treatments of EL-500 at 1.5 lb/A or higher applied 6 to 8 weeks after the initial treatment.

Table 2. Average percent seedhead suppression of common bermudagrass from surface applications of EL-500

Treatment	Rate (lb/A)	Seedhead Inhibition (%)			
		30 DAA[a]	45 DAA	60 DAA	90 DAA
EL-500 50W	0.5	-[c]	40 (1)[b]	7 (1)	0 (1)
	0.75	8 (2)	10 (2)	0 (2)	-
	1.0	27 (3)	48 (3)	23 (3)	0 (1)
	1.5	34 (3)	60 (3)	30 (3)	0 (1)
	2.0	-	77 (2)	50 (2)	8 (1)
	3.0	-	93 (1)	82 (1)	55 (1)
EL-500 1G	0.5	7 (2)	20 (2)	5 (2)	0 (2)
	1.0	30 (2)	32 (2)	13 (2)	0 (2)
	1.5	40 (2)	53 (2)	25 (2)	0 (2)
	2.0	70 (2)	74 (2)	44 (2)	40 (2)
	3.0	-	87 (1)	55 (1)	28 (1)

[a] DAA = Days after application

[b] Number in parenthesis is the number of experiments from which data were collected.

[c] Dash indicates data were not taken or treatment not included in trial.

Hybrid bermudagrass. EL-500 at rates of 0.75 and 1.5 lb/A provided 52 and 75% growth suppression, respectively, 30 days following treatment on the Santa Ana hybrid turf (Table 3). The inhibition of seedheads was less (33% and 67%) at these same rates. Evaluations taken through 90 days on the Santa Ana hybrid turf indicated acceptable growth and seedhead inhibition at the 1.5 lb/A rate. Seven and 22 percent leaf chlorosis/

necrosis was evident 30 days after application at 0.75 and 1.5 lb/A, respectively. Later evaluations indicated little or no turf phytotoxicity at either rate. Turf density and color were comparable to the weekly mowed controls.

Table 3. Percent growth and seedhead inhibition of Santa Ana hybrid bermudagrass from surface applications of EL-500

Treatment	Rate (lb/A)	Inhibition (%)							
		30 DAA[a]		49 DAA		75 DAA		90 DAA	
		GI	SI[b]	GI	SI	GI	SI	GI	SI
EL-500 50W	0.75	53	33	56	22	32	0	15	0
	1.5	75	67	90	82	67	40	66	40

[a] DAA = Days after application

[b] GI = Growth inhibition; SI = Seedhead inhibition.

The effect of various spray volumes of EL-500 on percent growth inhibition of Tifgreen hybrid bemudagrass is shown in Table 4. Varying the spray volume from 20 to 200 gal/A while maintaining a constant rate did not affect the growth response of this turf to EL-500. All rates (1 to 2 lb/A) of EL-500 provided excellent growth suppression regardless of the spray volume. However, Tifgreen bermudagrass exhibited limited tolerance to EL-500 at these rates (Table 5). In a separate trial, rates below 1 lb/A of EL-500 have shown adequate tolerance and growth response on this hybrid bermudagrass variety.

Table 4. Effect of various spray volumes of EL-500 on percent growth inhibition of Tifgreen hybrid bermudagrass

Treatment	Rate (lb/A)	Growth Inhibition (%)					
		20 gal/A		100 gal/A		200 gal/A	
		30 DAA[a]	60 DAA	30 DAA	60 DAA	30 DAA	60 DAA
EL-500 50W	1.0	70	38	70	37	78	32
	1.5	90	63	67	60	77	60
	2.0	95	72	90	55	96	77

[a] DAA = Days after application

Kentucky bluegrass/perennial ryegrass. Sixty-two to 91 percent inhibition of turf growth was observed 30 days after treating a cool-season mixed turf of Kentucky bluegrass and perennial ryegrass with EL-500 1G at rates of 0.5 to 2 lb/A (Table 6). The percent growth suppression was directly correlated to the rate of EL-500 applied. After 60 days, the percent growth inhibition decreased appreciably with all rates. Seedhead suppression ranged from 15-58% thirty days after application at these same rates and also decreased with time (Table 6). No turf phytotoxicity symptoms were observed from any of the EL-500 treatments.

Table 5. Effect of various spray volumes of EL-500 on Tifgreen hybrid bermudagrass tolerance

		Turf Injury (%)					
		20 gal/A		100 gal/A		200 gal/A	
Treatment	Rate (lb/A)	30 DAA[a]	60 DAA	30 DAA	60 DAA	30 DAA	60 DAA
EL-500 50W	1.0	23	5	23	0	27	0
	1.5	45	32	18	8	28	17
	2.0	53	35	47	20	58	32

[a] DAA = Days after application.

Table 6. Percent growth and seedhead inhibition of cool-season turf (Kentucky bluegrass & perennial ryegrass) from EL-500 applications

		Inhibition (%)									
Treatment	Rate (lb/A)	30 DAA[a]		45 DAA		60 DAA		75 DAA		90 DAA	
		GI	SI[b]	GI	SI	GI	SI	GI	SI	GI	SI
EL-500 1G	0.5	62	15	42	28	32	30	3	2	0	0
	1.0	74	25	60	40	50	48	38	27	23	15
	1.5	82	47	78	53	65	63	43	40	37	17
	2.0	91	58	85	65	80	75	67	58	58	55

[a] DAA = Days after application

[b] GI = Growth inhibition; SI = seedhead inhibition

Summary

Field research conducted on warm- and cool-season turf species in California has demonstrated the efficacy of EL-500 as a turf growth regulator. EL-500 was shown to be more efficacious in the suppression of vegetative growth than on seedhead inhibition. Applications of 0.5 to 3.0 lb/A of EL-500 provided 20 to 80% grow inhibition for periods up to 12 weeks following treatment. Turf tolerance was excellent on the turf species evaluated except for Tifgreen hybrid bermudagrass which exhibited marginal tolerance to EL-500 at rates of 1 lb/A and above. Additional research with EL-500 is being conducted throughout the U.S. so that the full potential use of this experimental growth regulator in turf management on various fine-bladed turf species can be determined.

THE EFFECT OF CHLORSULFURON ON WINTER WHEAT YIELD AND CANADA THISTLE [*CIRSIUM ARVENSE* (L.) SCOP.] CONTROL

M. A. Henson and R. L. Zimdahl[1]

Abstract. Efforts to use chlorsulfuron {2-chloro-*N*-[[(4-methoxy-6-methyl)-1,3,5-triazine-2-yl]aminocarbonyl]benzenesulfonamide} for Canada thistle control began in the fall of 1979 when the chemical was first introduced. The rates applied were 0.125, 0.25, and 0.50 lb ai/A using a 80% WP product. Evaluation of control was made by counts of live shoots/2 ft^2 and visual ratings. The initial Canada thistle population averaged 8.5 shoots/2 ft^2. Counts made on 5/27/80, the spring following application, showed no thistle present regardless of rate, and this was also true in spring of 1981. By October 1981 (two years after application), limited regrowth had occurred; count data averaged 2.0 shoots/2 ft^2 for all rates. The efficacy of chlorsulfuron proved to be greater than DOWCO 290 (3,6-dichloropicolinic acid), glyphosate [*N*-(phosphonomethyl)glycine], velpar or metribuzin [4-amino-6-*tert*-butyl-3-(methylthio)-*as*-triazin-5(4*H*)-one].

Studies of Canada thistle control with chlorsulfuron were continued in 1981. Chlorsulfuron (75% DF) was applied in one study when the thistle was in the rosette stage (mid-May). Visual ratings on 6/23/81 and stand counts on 9/21/81 showed almost complete control and reflected no differences between 0.25 and 1.0 oz ai/A. The second study was initiated to determine the lowest effective rate of chlorsulfuron needed to control thistle and the most effective application time. Applications of 0, 0.5, 1.0, and 2.0 oz ai/A were made at rosette (mid-May), pre-bud (early June), bud, or flower (late June) and in the fall. Summer field observations showed that all rates and all application times exhibited 90%+ control until mid-September. One-half ounce may not completely control regrowth beyond the season of application. Rates of 1.0 and 2.0 oz ai/A controlled regrowth regardless of growth stage applied. Control of Canada thistle regrowth is under study.

Two studies were conducted in 1981 to determine the effect of chlorsulfuron on winter wheat yields. The rates applied were 0, 0.25, 0.5, 1.0, and 1.5 oz ai/A. Application was made when the wheat was tillered (stage 4). Chlorsulfuron did not affect wheat yield.

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THE PHYTOTOXIC EFFECT OF TANK-MIXING BROMOXYNIL AND DICLOFOP ON TWO BARLEY (*HORDEUM VULGARE*) VARIETIES

Randy L. Anderson[1]

Bromoxynil (3,4-dibromo-4-hydroxybenzonitrile) controls certain broadleaf weeds when applied to small grain crops such as wheat and barley. The herbicide is applied post-emergent to the weed foliage at rates ranging from 0.42 to 1.12 kg a.i./ha. Diclofop {2-[-(2,4-dichlorophenoxy) phenoxy]propanoic acid} is selective for control of annual grasses such as

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(*Avena fatua* L.) and foxtails (*Setaria* spp.), generally applied post-emergent to the weed foliage. If bromoxynil and diclofop could be applied in a tank-mix without incompatability, the herbicides could be applied with one operation. The objective of this experiment was to determine if tank-mixing bromoxynil and diclofop resulted in herbicidal injury to two barley varieties, 'Hector' and 'Clark.'

Method of Experimentation

Two barley varieties, 'Clark' and 'Hector,' were planted on April 17, 1981 at the rate of 80 kg PLS/ha, and at a depth of 6-7.6 cm. The soil was a Williams loam, a fine-loamy, mixed Typic Agriboroll, with the soil temperature at 7 cm being 13°C at planting time. Ammonium nitrate was applied at the rate of 112 kg N/ha in the fall of 1980. The environmental conditions and spraying operation are shown in Table 1.

Table 1. Operations log for spraying barley with bromoxynil and diclofop

	Environment			
	Moisture (mm)		Temperature (C)	
	Average	1981	Average	1981
April	29.7	9.4	10.0	10.0
May	54.6	14.5	12.4	15.4
June	71.6	81.0	17.3	17.2
July	44.5	64.5	20.4	22.3*

* 17 days above 32.2°C

Spraying Log

Date	May 20, 1981 - 2:30 p.m.	Nozzles	650067
Air temperature	26.7°C	Pressure	2.8 kg/cm^2
Relative humidity	24%	Carrier (water)	118 L/ha
Cloud cover	clear		
Wind speed	2 - 3.2 m/s		

The chemicals were applied on May 20 at 3:00 p.m. The barley was in the early tillering stage. Date of heading, plant height, and lodging percentage were recorded as well as yields, test weights, and percentage of plump.

Interpretation of Evaluations

Table 2 shows the agronomic data collected for this study. The two varieties were analyzed separately, with no comparisons being made between the varieties.

'Clark' barley. The date of heading for 'Clark" was delayed 1.5 to 2.5 days compared to the control; however, the height at maturity was not significantly affected. The diclofop and diclofop-bromoxynil treatments resulted in severe lodging, ranging from 43.8 to 53.8%, and the yield data reflected the lodging damage, as these two treatments also produced the lowest yields. The application of bromoxynil and diclofop at 0.56 + 1.12 kg/ha reduced the yield of 'Clark' barley by 14.6% compared to the control.

Table 2. Phytotoxicity of bromoxynil and diclofop to two barley varieties.

Treatment	Rate (kg/ha)	Heading (days from Jan. 1)	Height (cm)	Lodging (%)	Yield (kg/ha)	Test weight (kg/hl)	Plump
'Clark' barley							
Bromoxynil	0.56	169.0a[1]	88.4a	13.8 b	3888 b	52.9 b	19 b
Diclofop	1.12	180.a	86.4a	43.8a	3720 c	51.6 bc	16 bc
Bromoxynil + Diclofop	0.56 + 1.12	170.a	85.1a	53.8a	3414 d	50.8 c	12 c
Control	-	167.5 b	88.4a	11.3 b	3996a	53.9a	25a
'Hector' Barley							
Bromoxynil	0.56	166a	89.7a	11.3a	4008 b	53.9 b	15 b
Diclofop	1.12	166a	90.2a	28.8a	3900 bc	52.9 bc	16 b
Bromoxynil + Diclofop	0.56 + 1.12	167a	87.6a	26.3a	3762 c	52.0 c	14 b
Control	-	166a	90.2a	1.3 b	4380a	55.6a	22a

[1]Numbers followed by identical letters are not significantly different as determined by Duncan's Multiple Range Test. (Camparisons were not made between varieties.)

The application of diclofop alone at 1.12 kg/ha reduced the grain yield by 7%. The test weights of all chemical treatments were significantly lower than the test weight of the control. The lowest test weight was produced by the combination of bromoxynil and diclofop, 50.8 kg/hl, compared to 53.9 kg/hl by the control. The number of plump kernels per 100 seeds also reflect the trend exhibited with the test weights, the lowest plump occurring when the barley was sprayed with bromoxynil and diclofop in combination.

'Hector' barley. The date of heading and plant height were not affected when 'Hector' was sprayed with either chemical, but lodging did occur. All chemical treatments lodged significantly more than the control, with the diclofop alone treatment lodging 28.8%. The yields, test weights, and plump were all significantly lower for chemically treated 'Hector' when compared to the untreated control. The combination of diclofop and bromoxynil reduced the yield 14.1% when compared to the control, while the yield reduction for diclofop alone was 9.0%. Bromoxynil at 0.56 kg/ha reduced the yield of 'Hector' 8.5%. The lowest test weight was recorded for the bromoxynil-diclofop treatment, 52.0 kg/hl, while the test weight for the control was 55.6 kg/hl. The separate applications of bromoxynil and diclofop also significantly reduced the test weight. The plump of 'Hector' seed was significantly reduced by all chemical treatments.

Summary

The combination of diclofop and bromoxynil injures 'Clark' and 'Hector' barley by reducing yield, test weight, and plump, while causing lodging to occur.

The application of either bromoxynil or diclofop also injures 'Clark' and 'Hector' barley, but to a lesser extent. Yield, test weight, and plump were reduced.

PERFORMANCE OF METRIBUZIN FOR WEED CONTROL IN WHEAT-FALLOW-WHEAT ROTATIONS

J. Fortino, J. E. Anderson, and H. L. Ramsey[1]

The importance of controlling weeds during the fallow period of cereal grain production has long been recognized. Utilizing herbicides to accomplish weed control in fallow has also been recognized for cereal grain production. Researchers have correlated the benefits of chemical fallowing versus mechanical tillage to factors such as reduced soil erosion, moisture conservation, increased yields, and a reduction of energy and labor.

Utilizing a combination herbicide and mechanical tillage program is presently the most effective method of fallowing in a cereal production.

The dryland grain producing areas of the Pacific Northwest, and Central Plains receive an annual rainfall ranging from 8 to 18 inches. Moisture is received sparingly either as snowfall or rainfall and, therefore, moisture conservation is important. Tillage operations utilizing rod weeders, sweeps, or V-blades are common tools used to control weeds and form a "dust mulch" to break the capillary action of the soil to reduce moisture loss.

[1]Mobay Chemical Corporation, Kansas City, MO

Metribuzin [4-amino-6-*tert*-butyl-3-(methylthio)-*as*-triazine-5-(4*H*)-one] has been researched for several years and found to be an affective herbicide for use on fallow ground in cereal grain producing areas. It is presently registered for use via Federal registration in Washington, Oregon, Utah, and Idaho; and by Special Local Need registration in Montana, Wyoming, Colorado, and Nebraska.

Large-scale field trials were initiated in 1978 to determine the use rates of metribuzin, timing of application, tank-mix combinations, and the plant-back interval to small grains. Test locations were established in Colorado, Wyoming, Kansas, and Nebraska, and in Washington, Oregon, and Montana.

Central Plains. Treatments were applied in the fall (after wheat harvest), as well as in the spring. Applications of metribuzin were made alone or as tank-mixes of paraquat (1,1'-dimethyl-4,4'-bipyridinium ion), glyphosate (*N*-(phosphonomethyl)glycine], atrazine [2-chloro-4-(ethylamino)-6-(isopropylamino)-*s*-triazine], or cyanozine {2-[4-chloro-6-(ethylamino)-*s*-triazin-2-yl]amino-2-methylpropionitrile} and compared with a standard herbicide treatment, as well as the farmer mechanical tillage practice. Data collected were: weed control, number of mechanical tillages performed, plant-back information on the subsequent winter wheat crop, and wheat yield.

Data indicate that metribuzin will control a wide spectrum of grasses and broadleaf weeds during the fallow period. For applications made in the fall, metribuzin rates of 0.5 to 0.75 lb a.i./A provided control of volunteer wheat, kochia [*Kochia scoparia* (L.) Schrad.], pigweed (*Amaranthus retroflexus* L.), lambsquarters (*Chenopodium album* L.), Russian thistle (*Salsola kali* L. var. *tenuifolia* Tausch), tansy mustard [*Descurainia pinnata* (Walt.) Britt.], and sunflower (*Helianthus annuus* L.). Spring applications of 0.38 to 0.5 lb a.i./A also provided control of these weed species. When weeds were present at the time of application, the use of a contact herbicide such as paraquat achievedthe best control of the existing vegetation and metribuzin was found to provide residual control of those weed species which germinated later.

Data also show that atrazine can be very effective for broad spectrum weed control; however, in coarse soils with high pH, phytotoxicity occurred to winter wheat planted 13 months later when atrazine was applied at 0.75 lb a.i./A. Metribuzin treatments in the same trial did not exhibit phytotoxicity or stand loss to the winter wheat crop.

In the trials where metribuzin was used for weed control, the need for mechanical tillage was reduced significantly. At Roscoe, Nebraska, (under high rainfall conditions) the farmer practice required 8 tillage operations, compared to 3 tillage operations for chemical fallow plots receiving metribuzin. Similar data were also collected at other locations.

Yield data collected during 1980 and 1981 show that wheat yields with metribuzin treatments were equal to and usually greater than the tillage check. In some instances heavier than normal rainfall was able to replenish the moisture lost earlier and compensated for earlier losses by weed competition and tillage.

Other promising treatments included a fall application of metribuzin at 0.5 plus a spring application of 0.38 lb a.i./A. This sequential application provided weed control in the fall, and provided additional weed control for the spring germinating weeds when compared to a single 0.75 lb a.i./A application as a fall application.

Atazine at 0.5 lb a.i./A plus metribuzin at 0.38 to 0.5 lb a.i./A provided better control of Russian thistle, Kochia, volunteer whear, and wild lettuce than atrazine alone and provided weed control for 5 additional weeks. Atrazine rates of 0.75 lb a.i./A plus metribuzin did not improve weed control, but resulted in atrazine carryover to the subsequent winter wheat crop.

Pacific Northwest. Chemical fallow trials initiated in the Pacific Northwest showed that the most effective treatments were fall metribuzin applications of 0.5 to 0.62 lb a.i./A. Spring applications at 0.38 to 0.5 lb a.i./A were found to be less effective for the control of downy brome (*Bromus tectorum* L.) and volunteer wheat.

Metribuzin treatments were applied in the fall during October and November. This appeared to be optimum time for application during the seasons of 1978-79, 1979-80, and 1980-81. At this time applications were made to standing, noncultivated wheat stubble. Winter annual weeds germinating in the fall were easiest to control with metribuzin. Fall applications received moisture for herbicide activation.

Tank-mixes of metribuzin were applied with 0.25 lb a.i./A paraquat, 0.5 lb a.i./A glyphosate, or 2.0 to 3.0 lb a.i./A propham (isopropyl carbanilate). In trials where vegetation was present, such as volunteer grains or downy brome, the use of paraquat or glyphosate offered control of these weeds. The tank-mix of propham plus metribuzin was found to offer control of volunteer wheat plus broadleaf weed species of tarweed (*Hemizonia congesta* DC.), henbit (*Lamium amplexicaule* L.), tumble mustard (*Sisymbrium altissimum* L.), blue mustard (*Chorispora tenella* DC.), and Russian thistle. When these treatments were applied during October or November, excellent control was obtained into the spring months when the initial tillage was not performed until May. Under higher than normal rainfall conditions of 1980-81, 2 to 3 mechanical tillage operations were performed with chemically followed treatments of metribuzin compared with 5 or 6 operations of the farmer tillage practices.

Metribuzin tank-mixes offered 95-100% control of the broadleaf weeds and volunteer wheat until late spring when tillage operations were performed. Fall applications offered the greatest benefit in the Pacific Northwest fpr chemical fallow treatments. No phytotoxicity occurred to the subsequent planting of the winter wheat crop.

The results of chemical fallow in the Northwest and in the Central Plains show that metribuzin and metribuzin tank-mixes are effective for weed control during the fallow period of cereal grain production. Results in the Central Plains of Colorado, Wyoming, and Nebraska show that the length of weed control of metribuzin was less than that of atrazine, however, was longer that that of cyanazine treatments. Winter wheat could be seeded to metribuzin treatments 10 months after fall applications, or 4 months following spring applications without phytotoxicity to the crop. Sequential applications of metribuzin applied in the fall followed with a spring application resulted in additional weed control compared with a single fall application of metribuzin. Tank-mixes of metribuzin plus atrazine were found to be beneficial; however, atrazine carryover occurred to the winter wheat crop when rates of 0.75 lb a.i./A were used.

Metribuzin applications in the Pacific Northwest were found to perform in a similar manner as in the Central Plains. The preferred timing of application was seen to be in the months of October or November, rather than August or September as in the Central Plains area. The fall applications offered better overall weed control with greater moisture conservation. In the Pacific Northwest, tank-mixes of metribuzin plus propham were particularly effective for the control of volunteer grain.

A SUMMARY OF LEAFY SPURGE (*EUPHORBIA ESULA* L.) CONTROL IN NORTH DAKOTA

Rodney G. Lym and Calvin G. Messersmith[1]

Abstract. Leafy spurge control by 2,4-D [(2,4-dichlorophenoxy)acetic acid], dicamba (3,6-dichloro-*o*-anisic acid), picloram (4-amino-3,5,6-trichloro-picolinic acid) and glyphosate [*N*-(phosphonomethyl)glycine] in North Dakota was summarized for 60 experimental and 68 demonstrational sites established between 1963 and 1981. Data were summarized across years by herbicide formulations, rates, and season of application. Leafy spurge control by 2,4-D averaged less that 30% after 1 year at rates up to 4.0 lb/A. Control was not affected by 2.4-D formulation or time of year when applied. 2,4-D at 1.0 lb/A applied spring and fall annually provided 65% control after 27 months. Dicamba at 6.0 lb/A or more provided over 90% control the first year, but control decreased rapidly during the second year regardless of formulation used or time of year applied. Dicamba at 1.0 lb/A applied both spring and fall gave 79% leafy spurge control after four years but control declined rapidly after treatments were stopped. Dicamba at 0.75 lb/A plus 2,4-D at 4.0 lb/A applied twice per year gave 97% control after 3 years. Picloram at 2.0 lb/A gave over 90% leafy spurge control for two growing seasons. Control was similar when using liquid or granular picloram regardless of spring or fall application. Picloram at 0.25 lb/A applied both spring and fall annually provided 98% control after 3 years. The combination of picloram at 0.5 lb/A plus 2,4-D at 1.0 lb/A controlled leafy spurge similar to picloram at 2.0 lb/A alone. Fall applied glyphosate at 0.75 lb/A gave 87% control after 9 months, but a follow-up herbicide treatment was necessary for leafy spurge seedling control. Leafy spurge control was not improved by increasing the ghyphosate rate.

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THE USE OF PP009 FOR CONTROL OF RHIZOME JOHNSONGRASS IN SAN JOAQUIN VALLEY COTTON

L. L. Willitts[1]

Abstract. PP009 [(±)-butyl 2-(4-{[5-(trifluoromethyl)-2-pyridinyl]oxy} phenyl)propanoate] is a new postemergence herbicide that selectively controls a broad range of perennial and annual grasses in dicot crops. The proposed common name is fluazifop. It has been field tested in the San Joaquin Valley of California since 1978, with rhizome johnsongrass [*Sorghum halepense* (L.) Pers.] in cotton one of its primary targets. Two half-rate applications of PP009 have proven to be more effective that the same total dose applied as a single treatment. Results from several trials have shown that the initial treatment should be applied when the johnsongrass is approximately 30 cetimeters tall, with the second treatment following 1 to 3 weeks later. Johnsongrass that is moisture-stressed or larger than 60 cm tall will not be as well-controlled.

In a 1980 trial conducted on a field severely infested with rhizome johnsongrass, split applications of PP009 at 0.56 + 0.56 kg ai/ha provided

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outstanding season-long johnsongrass control ranging from 93% when the two treatments were applied 7 days apart to 99% when they were applied 21 days apart. Again, in a 1981 trial, split applications provided better johnsongrass control than single applications, with 0.56 + 0.56 kg ai/ha and 0.56 + 0.28 kg ai/ha through 5 weeks after treatment, but the 0.56 + 0.28 kg ai/ha treatment showed greater johnsongrass regrowth by 8 weeks after treatment. In a field with less intense johnsongrass pressure (i.e. a light to moderate infestation), the 0.56 + 0.28 kg ai/ha treatment would probably have been adequate. Treatments of 0.42 + 0.42 kg ai/ha and 0.28 + 0.56 kg ai/ha were inferior to the previously-mentioned treatments, indicating that an initial treatment of 0.56 kg ai/ha is necessary to control the first flush of johnsongrass (and free the cotton from early competition).

PP009 appears to be equally active at spray volumes of 5 to 30 gpa, and the addition of a crop oil concentrate appears to increase it activity under some conditions. Symptoms of activity in treated grasses are not evident until a week or more after application, but growth ceases almost immediately. Leaves begin to show chlorosis and a characteristic red coloration followed by necrosis.

EFFECT OF CHLORSULFURON ON WINTER WHEAT YIELD AND BIOMASS PRODUCTION OF ROTATIONAL CROPS

T. C. Sampson, D. C. Thill and R. H. Callihan[1]

Abstract. Experiments were conducted at two locations in northern Idaho to evaluate the effect of chlorsulfuron {2-chloro-*N*-[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)aminocarbonyl]benzenesulfonamide} on weed control efficacy, winter wheat (*Triticum aestivum* L.) yield, and to determine the subsequent influence of chlorsulfuron soil persistence on rotational crops one year after application to winter wheat. Chlorsulfuron was applied at location I near Potlatch on April 16, May 17, May 3, and May 17 and at location II near Moscow on April 18, May 3, and May 17, 1980 at 0.0175, 0.035, and 0.07 kg/ha. An area 1.4 by 7.8 m was harvested from the center of each plot at both locations using a small plot combine and grain yield determined. Plots were left in stubble until planting time in the spring of 1981. The plots were tilled and four rows each of peas (*Pisum sativum* L. 'Alaska'), lentils (*Lens esculenta* 'Chilean'), barley (*Hordeum vulgare* 'Kimberly'), safflower (*Carthamus tinctorius* 'S-208'), and sunflower (*Helianthus annus* L. 'D0704-XL') were planted across the width of each plot. Vigor was visually evaluated at both locations and a 1.5m sample was harvested from the center of the two most vigorous rows of each crop for biomass determination. Peas and lentils were harvested when pods were beginning to fill, barley was harvested when headed, and safflower and sunflower were harvested in full bloom. All plants were cut at ground level and oven-dried before weighing. A preliminary soil leaching study was conducted using thick layer chromatography and eight different soil types ranging in organic matter from 1.1 to 45.2%.

Chlorsulfuron treatments in 1980 caused no significant effect on winter wheat yield at either location. Inadequate weed control was obtained for ivyleaf speedwell (*Veronica hederaefolia* L.) and erect knotweed (*Polygonum erectum* L.). The early date of application was

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generally most effective for control of broadleaf weeds at both locations and all application dates.

Chlorsulfuron soil persistence resulted in more rotational crop injury at location II than at location I. At location I, only the biomass production of lentils was reduced compared to the untreated check at the 0.07 kg/ha rate of chlorsulfuron applied in May. At location II, lentil biomass was significantly reduced at all rates and dates of application. Biomass production of peas was significantly reduced at the 0.035 and the 0.07 kg/ha rate at all dates of application. Sunflower biomass production was significantly reduced at the 0.70 kg/ha rate at all application dates. Biomass production of barley and safflower was not reduced when compared to the untreated check. Differential chorsulfuron soil persistence between the two locations appeared to be related to the differential soil organic matter content. The organic matter was 2.97 and 4.18% in the top 15.2 cm at locations I and II, respectively. Preliminary soil leaching experiments indicated that chlorsulfuron was very mobile in all soil types tested. Greatest mobility was evident in soils of relatively low organic matter and high sand content.

POSTEMERGENCE CONTROL OF ANNUAL GRASSES IN SUGARBEETS FROM HERBICIDE MIXTURES

E. E. Schweizer and L. D. Schild[1]

Abstract. The annual grasses barnyardgrass [*Echinochloa crus-galli* (L.) Beauv.], green foxtail [*Setaria viridis* (L.) Beauv.], yellow foxtail [*Setaria lutescens* (Weigel) Hubb], and wild oat (*Avena fatua* L.) are often not controlled in sugarbeet (*Beta vulgaris* L.) with postemergence herbicide mixtures because the broadleaf components in the mixtures may react antagonistically against these grasses and reduce herbicidal activity. Researchers have shown recently that BAS 9052 OH {2-[1-(ethoxyimino)butyl]-5-[2-(ethylthio)propyl]-3-hydroxy-2-cyclohexen-1-one}, diclofop {2-[4-(2,4-dichlorophenoxy)phenoxy]propanoic acid}, and RO 13-8895 {acetone-D-[α,α,α-trifluroro-*p*-tolyl)oxy]phenoxy]propionyl]oxime} will control annual grasses selectively in sugarbeets. Therefore, we conducted greenhouse studies to evaluate the effectiveness of these grass herbicides to control barnyardgrass, yellow foxtail, green foxtail, and wild oat when applied as mixtures with desmedipham [ethyl *m*-hydroxycarbanilate carbanilate (ester)], ethofumesate [(±)-2-ethoxy-2,3-dihydro-3,3-dimethyl-5-benzofuranyl methanesulfonate], and phenmedipham (methyl *m*-hydroxycarbanilate *m*-methylcarbanilate). The herbicide mixtures were applied to grasses at the four leaf stage of growth. Plants were harvested for dry weights 21 days after treatment. Barnyardgrass was the most susceptible and wild oat the least susceptible grass to all herbicide mixtures. Antagonism was observed when RO 13-8895 mixtures were applied to yellow foxtail, green foxtail, and wild oat. No antagonistic response was observed when either BAS 9052 or or diclofop was mixed with the broadleaf herbicides.

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EFFECT OF FOUR POST-EMERGENCE HERBICIDES ON FOUR SPRING BARLEY VARIETIES

S. A. Clay and D. C. Thill[1]

Abstract. The influence of several small grain herbicides, applied at recommended rates, on the components of yield, total grain yield, and grain quality of 'Steptoe,' 'Morex,' 'Klages,' and 'Karla' spring barley (*Hordeum vulgare* L.) varieties was investigated in the field under weed free conditions. The study was conducted at Kimberly, Idaho, under furrow irrigated, conventional tillage conditions; Moscow, Idaho, under dryland conventional tillage conditions; and Pullman, Washington, under dryland no-tillage conditions. Diclofop {2-[4-(2,4-dichlorophenoxy) phenoxy]propanoate} was applied at the three leaf stage of crop development at a rate of 1.12 kg/ha. Difenzoquat (1,2-dimethyl-3,5-diphenyl-1*H*-pyrazolium), chlorsulfuron {2-chloro-*N*-[[(4-methoxy-6-methyl-1,3,5-triazin-2yl)amino]carbonyl]benzenesulfonamide}, and metribuzin [4-amino-6-*tert*-butyl-3-(methylthio)-*as*-triazin-5(4*H*)-one] were applied at the five leaf stage of crop development at 1.12, 0.07, and 0.42 kg/ha, respectively. Crop stand and vigor reduction were evaluated at the two dryland locations one week after the final herbicide application. The only observable stand reduction occurred at Moscow in the metribuzin treated 'Morex' plots. Metribuzin also caused significant vigor reduction of spring barley treated with difenzoquat at both dryland locations. The lower leaves of all varieties of spring barley treated with difenzoquat at the Pullman location appeared chlorotic and some stunting was evident. Diclofop significantly reduced the vigor of 'Klages' at both locations. The influence of the various herbicide treatments on components of yield of each variety was investigated at the Pullman location. Stand counts and height were taken 2 weeks after herbicide application. Flag leaves were harvested 4 weeks after herbicide application and percent protein determined. Biomass samples from 1 m of row were harvested 6 weeks after herbicide application. Number of fertile tillers per meter row and number of seeds per head were determined at crop maturity. No significant differences were found. Application of metribuzin under irrigated conditions at the Kimberly location caused a significant yield reduction in any of the barley varieties when compared to the weed free, untreated check.

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THE INFLUENCE OF FOUR HERBICIDES ON FOUR SPRING WHEAT VARIETIES UNDER WEED FREE CONDITIONS IN IDAHO

J. M. Lish, W. J. Schumacher, D. C. Thill, and R. E. Ohms[1]

Abstract. Spring wheat varieties may vary in tolerance to herbicides. The influence of four herbicides on four spring wheat (*Triticum aestivum* L.) varieties was determined under dryland and irrigated weed free field conditions in Idaho. The spring wheat varieties 'Borah,' 'McKay,' 'Owens,' and 'Fieldwin' were treated with difenzoquat (1,2-dimethyl-3,5-

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diphenyl-1*H*-pyrazolium) at 1.12 kg/ha, diclofop {2-[4-(2,4-dichlorophenoxy) phenoxy]propanoic acid} at 1.14 kg/ha, chlorsulfuron {2-chloro-*N*-[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]carbonyl]benzenesulfonamide} at 0.07 kg/ha, and metribuzin [4-amino-6-*tert*-butyl-3-(methylthio)-*as*-triazin-5(4*H*)-one] at 0.28 kg/ha. 'Borah' and 'McKay' spring wheat yield was lower than 'Owens' which was lower than 'Fieldwin' when averaged across herbicide treatments. Difenzoquat treated spring wheat had a lower yield than diclofop, chlorsulfuron, metribuzin, and the untreated check when averaged across varieties. There was no significant variety by herbicide treatment interaction for yield. 'Borah' and 'McKay' treated with difenzoquat and 'McKay' and 'Owens' treated with chlorsulfuron had greater stand and vigor reductions than other herbicide treatment by variety combinations.

DICAMBA AND DICAMBA TANKMIXES FOR FIELD BINDWEED CONTROL APPLIED BETWEEN CROPPING SYSTEMS

Bart A. Brinkman[1]

Introduction

Field bindweed (*Convolvulus arvensis* L.) is a perennial weed commonly found in many dryland farming areas of the western states. It has an extensive root system which makes it extremely competitive with the growth of small grains or other crops grown in the Pacific Northwest.

Application of dicamba (3,6-dichloro-*o*-anisic acid) and dicamba tank-mixes with glyphosate [*N*-(phosphonomethyl)glycine] or 2,4-D [(2,4-dichloro-phenoxy)acetic acid] were evaluated for control of field bindweed and safety to rotational crops of winter wheat, spring barley, and potatoes.

Materials and Methods

Locations of field bindweed infestations for testing were near Pendleton, Oregon; Holden, Utah; and Genesee, Idaho. Locations were established in August and September of 1979 when field bindweed was in full to late bloom stage of growth. Plot design was a randomized complete block with three replications. Plots were 15 feet wide and 20 feet long. Applications were made by a CO_2 back pack sprayer with a water volume of 30 gallons per acre. Visual evaluations were made 9 to 12 months after application to determine weed control and rotational crop tolerance.

Winter wheat, spring barley, and potatoes were planted in soil treated with various rates of dicamba and dicamba tankmixes to determine the effect of herbicide soil residue. Plant-back sites were established near Pendleton, Oregon; Moscow, Idaho; Genesee, Idaho; and Boardman, Oregon. These sites were not infested with perennial weeds, with the exception of the spring barley plot in Genesee, Idaho. Dicamba was applied with hand held sprayers using 20 to 30 gallons per acre. Plot size ranged from 9 to 15 feet wide and 18 to 20 feet long.

Dicamba was applied Seotember 14, 1978 to fallow at various rates prior to planting winter wheat on October 15, 1979 at Pendleton, Oregon. At Moscow, Idaho, dicamba was applied September 1, 1978 and plots were

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planted to Steptoe spring barley and Red Pontiac potatoes on May 22, 1979. Dicamba was applied on September 5, 1979 at Genesee, Idaho and planted to Steptoe spring barley on April 19, 1980. The site at Boardman, Oregon was treated with dicamba on September 20, 1979 and planted to Russet Burbank potatoes on April 2, 1980.

Results and Discussion

Field bindweed. Dicamba and dicamba tankmixes with glyphosate or 2,4-D controlled field bindweed in excess of 95% when evaluated 9 months after application. Results showed little difference in weed control between herbicides applied alone or when tankmixed (Table 1). However, in another trial when dicamba and dicamba tankmixes were evaluated 12 months after application, control was less than 90% for all herbicides. Dicamba at 2.0 and 4.0 lb/A resulted in 81 and 82% control, respectively, and dicamba tankmixed with glyphosate or 2,4-D all resulted in less than 65% field bindweed control (Table 2). These results possible suggest that evaluations made early, soon after field bindweed emerges in the spring, show field bindweed control from the initial population sprayed. Later evaluations in the summer may reflect the initial population sprayed and seedlings that emerged in the spring and developed into perennials by the time of evaluation. This may indicate that higher rates of dicamba will persist in the soil, thus, affecting the germination of field bindweed seedlings.

Table 1. Response of field bindweed to dicamba and dicamba tankmixes applied in late August and evaluated 9 months after application.

Herbicide treatment	Rate (lb/A)	Field Bindweed control (%)
Dicamba	1.0	95 (2)[a]
Dicamba	2.0	99 (2)
Dicamba	4.0	100 (2)
Dicamba + Glyphosate	0.5 + 2.0	99 (2)
Dicamba + Glyphosate	1.0 + 1.0	99 (2)
Dicamba + 2,4-D amine	1.0 + 3.0	96 (2)

[a]Numbers in parenthesis indicate number of locations, date was averaged.

Table 2. Response of field bindweed to dicamba and dicamba tankmixes applied in early September and evaluated 12 months after application.

Herbicide treatment	Rate (lb/A)	Field Bindweed control (%)
Dicamba	1.0	58
Dicamba	2.0	81
Dicamba	4.0	82
Dicamba + Glyphosate	0.5 + 2.0	41
Dicamba + Glyphosate	1.0 + 1.0	55
Dicamba + 2,4-D amine	1.0 + 3.0	63

USE OF TRIALLATE TO CONTROL WILD OAT IN CONSERVATION TILLAGE SYSTEMS

S. J. Carlson and L. A. Morrow[1]

Abstract. Wild oat (*Avena fatua* L.) is a serious weed in small grain production. It germinates primarily in the spring and effectively competes with crop plants, particularly spring wheat (*Triticum aestivum* L.), for moisture and nutrients. Triallate [*S*-(2,3,3-trichloroallyl)diisopropylthiocarbamate] has been used extensively as an incorporated, preemergence wild oat control measure in conventional tillage systems. In conservation tillage systems, incorporation of soil-applied herbicides is minimal, so a preemergence wild oat control practice that does not require incorporation will improve wild oat control.

Triallate granules applied to Thatuna silt loam soil in a 56-cm precipitation zone, preplant or postplant preemergence at 2.8 kg/ha a.i. with a light harrowing after planting resulted in about 80 and 85% control of wild oat, respectively, where spring wheat was planted into standing stubble. Yield was approximately 1840 and 1980 kg/ha for the same treatments. At 1.4 kg/ha a.i. postplant preemergence, wild oat control was about 72% and yield was approximately 1290 kg/ha. This compares with about 54% control of wild oat and a yield of approximately 2100 kg/ha when 1.4 kg/ha a.i. triallate was applied as an emulsifiable concentrate in a comventional manner. Effective preemergence weed control may be difficult to achieve when the herbicide cannot be mechanically incorporated but granular formulations of herbicides such as triallate may be effective at increased rates in reduced tillage crop production systems.

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CONTROL OF BULBOUS BLUEGRASS IN WINTER WHEAT

L. A. Morrow and F. L. Young[1]

Abstract. Bulbous bluegrass (*Poa bulbosa* L.) is a perennial grass species that is becoming a problem in the wheat-producing areas of the Pacific Northwest. The weed grows from 15 to 60 cm tall and produces flowers that are modified into small pruplish bulblets without stamens or pistils. Experiments were conducted in the greenhouse and field to evaluate several herbicides for the control of bulbous bluegrass in winter wheat (*Triticum aestivum* L.). The field experiment was conducted on a shallow loess soil with an organic matter of 1.6%. Average annual precipitation is 33 cm.

In the field, spring postemergence applications of diuron [3-(3,4-dichlorophenyl)-1,1dimethylurea], paraquat (1,1'-dimethyl-4,4'bipyridinium ion), metribuzin [4-amino-6-*tert*-butyl-3-(methylthio)-*as*-triazin-5(4*H*)-one], terbutryn [2-(*tert*-butylamino)-4-(ethylamino)-6-(methylthio)-*s*-triazine], diclofop {2-[4-(2,4-dichlorophenoxy)phenoxy] propanoic acid}, or diclofop plus bromoxynil (3,5-dibromo-4-hydroxybenzonitrile) were applied to winter wheat in the tillering stage of growth. Bulbous bluegrass was 2.5 cm tall

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at the time of herbicide application. Bulbous bluegrass was effectively controlled with metribuzin at 0.56 and 1.12 kg/ha (94 and 99% control, respectively); however, the high rate severly injured the wheat. No control of bulbous bluegrass was obtained by any other herbicide with the exception of paraquat (53% control). Highest grain yield and whole plant dry weight (above ground) was obtained from wheat treated with metribuzin at 0.56 kg/ha, indicating excellent weed control and no wheat injury. Grain yield from wheat treated with paraquat or 1.12 kg/ha of metribuzin was not significantly different from the yield from the weed check. These treatments injured the wheat or reduced its population. Whole plant dry weight of wheat treated with paraquat or the high rate of metribuzin was lower that the wheat dry weight in the weedy check.

THE VALUE OF EPA's PROPOSED CROP GROUPING EFFORTS TO MINOR USES OF PESTICIDES

Mary P. Ferguson[1]

The Environmental Protection Agency (EPA) has recently drafted regulations which would streamline tolerance setting procedures. The regulations would allow for the more extensive use of group tolerances for related crops; crops groups are defined and procedures for the establishment of group tolerances are described. If implemented, the burden of establishing tolerances for pesticide residues in minor crops will be minimized.

In 1978, the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) was amended, giving special attention to minor use registration. Minor use pesticide registration data requirements were to be "commensurate with the anticipated extent of use, pattern of use, and the level and degree of potential exposure of man and the environment to the pesticide." In response to this minor use amendment, EPA published in March 1979 a policy statement for minor uses. Tolerance grouping was suggested as a way to increase the flexibility EPA had on tolerance setting. In September 1980, this minor use policy was expanded in an in-house memo from the Deputy Assistant Administrator, Ed Johnson. In it, Johnson stated EPA's policy on crop grouping, "EPA will accept extrapolations and reduced data to support establishment of group tolerances." This amendment to the Code of Federal Regulations would give EPA the tool to implement that policy.

The following is a summary of the procedures which are described in the most recent draft of the amendment:

(1) Each of the proposed groups list raw agricultural commodities that are considered to be related for the purpose of the new regulations. When there is an established or proposed tolerance for all representative commodities, a tolerance may be established for all commodities in the group.

(2) The group tolerance would reflect the maximum residues likely to occur on all individual crops within a group, so the use patterns for all the crops must be similar before a group tolerance is established.

(3) The group tolerance would reflect the maximum residues likely to

[1]IR-4 Program, University of California, Davis CA

occur on all individual crops within a group, so the use patterns for all the crops must be similar before a group tolerance is established.

(4) When the crop grouping contains commodities or by-products that are utilized for animal feed, a tolerance or exemption for the pesticide in meat, milk, poultry, and/or eggs must be established before a group tolerance is granted. Processing data from the representative crops which are processed will be required. Food additive tolerances will not be granted on a group basis.

(5) If the range of maximum residues found within a group varies by more than a factor of 5, a group tolerance will not be established. By keeping the range of residues small, the EPA intends not to alter the environment or health benefits of the present program.

(6) A commodity with a residue level significantly higher or lower than the other commodities in the group may be excluded from the group tolerance and given an individual tolerance. Group tolerances for systemic pesticides may require residue data from additional crops.

(7) Commodities not listed are not included in the group for purposes of the new regulation. The lists can be updated.

(8) Establishment of a tolerance does not substitute for the additional need to register the pesticide.

The proposed crop groups are as follows. The representative commodities are in brackets.

Root and Tuber Vegetables. [carrot, potato, radish, sugar beet]

Beet	Chervil, Turnip rooted	Goa Bean	Radish	Turnip
Burdock	Chicory	Horseradish	Rutabaga	Yam
Carrot	Dasheen (Taro)	Japanese Artichoke	Black Salsify	Yam Bean
Cassava	Ginger	Jerusalem Artichoke	Spanish Salsify	
Celeriac	Ginseng	Parsnip	Sugar Beet	
Chayote		Potato	Sweet Potato	

Leaves of Root and Tuber Vegetables. [turnip, sugar beet]

Beet	Chicory	Sugar Beet
Burdock	Dasheen (Taro)	Turnip
Carrot	Parsnip	
Celeriac	Radish	
Chervil, Turnip rooted	Rutabaga	
	Black Salsify	

Bulb Vegetables. [onion (green & bulb) and one other commodity]

Garlik	Onion
Leak	Shallot

Leafy Vegetables (except Brassica). [lettuce (heaf & leaf), celery, spinach]

Amaranthus	Chrysanthemum, Garland	Lettuce (head & leaf)	Spinach
Celery	Corn Salad	New Zealand Spinach	Chinese Spinach
Celtuce	Dandelion	Parsley	Malabar Spinach
Chervil	Endive	Rhubarb	Swiss Chard
Chrysanthemum, Edible-leaved	Garden Cress	Sorrel	Upland Cress

Brassica Leafy Vegetables. [broccoli, cabbage, mustard green]

Broccoli
Broccoli, Chinese
Broccoli Raab
Brussel Sprout
Cabbage
Chinese Cabbage
Savoy Cabbage
Cauliflower
Collard
Kale
Kohlrabi
Mustard Greens
Rape Greens

Legume Vegetables (succulent or dried). [beans, one succulent and one dried variety; lima beans; peas, one succulent and one dried variety; soybeans]

Beans - Adzuki, Field, French, Kidney, Lima, Moth, Mung, Navy, Pinto, Rice, Runner, Snap, Urd, Wax
Chickpeas
Chinese Longbean
Fava Bean
Lentils
Peas - Black-eyed, Cowpeas, Catjang, Field, Sugar, Garden
Southern Peas
Soybean

Foliage of Legume Vegetables (used an Animal Feed). [any variety of beans, field peas, soybeans]

Bean
Chickpeas
Chinese Longbean
Fava Bean
Lentils
Pea, including field pea
Southern Peas
Soybean

Fruiting Vegetables (except Cucurbits). [tomatoes, peppers]

Eggplant
Ground Cherry
Pepinos
Pepper - Chili, Sweet, Bell, Pimentos
Tomatillo
Tomatoes

Fruiting Vegetables (Cucurbits). [cucumber, cantaloupe or muskmelon, summer squash]

Bitter Melon
Chinese Wax gourd
Citron Melon
Cucumber
Edible Gourd
Cherkin
Melons - Cantaloupe, Casaba Crenshaw, Honeydew, Honey-balls, Mango Melon, Muskmelon, Persian
Pumpkin
Summer Squash
Winter Squash
Watermelon

Citrus Fruits. [sweet orange, lemon, grapefruit]

Calamondin
Citrus Citron
Citrus Hybrids
Grapefruit
Kumquats
Lemon
Limes
Mandarin
Sweet Orange
Sour Orange
Pummelo
Satsuma Mandarin

Pome Fruits. (apple, crabapple, pear]

Apple
Crabapple
Loquat
Pear
Oriental Pear
Quince

Stone Fruits. [apricot, sour cherry, peach, plum, fresh prunes]

Apricot	Nectarine	Plum, Damson	Japanese Plum
Sour Cherry	Peach	Prune	
Sweet Cherry	Plum	Chickasaw Plum	

Small Fruits and Berries. [blackberry, blueberry, cranberry, strawberry, grape]

Blackberry	Currant	Loganberry
Blueberry	Dewberry	Mulberry
Boysenberry	Elderberry	Raspberry
Cranberry	Gooseberry	Strawberry
Highbush Cranberry	Grape	Youngberry
	Huckleberry	

Cereal Grains. [barley, corn (fresh sweet and dried field), rice, sorghum, wheat]

Barley	Millet	Rice	Triticale
Buckwheat	Oats	Rye	Wheat
Corn - Fresh sweet	Pearl Millet	Sorghum	Wild Rice
Dried field	Popcorn	Teosinte	

Cereal Grains (Forage, Fodder and Straw). [barley, corn, sorghum, wheat]

Barley	Millet	Rice	Triticale
Buckwheat	Oats	Rye	Wheat
Corn - Fresh sweet	Pearl Millet	Sorghum	Wild Rice
Dried field	Popcorn	Teosinte	

Grass (Forage, Fodder & Hay). [bermudagrass, bluegrass, bromebrass or fescue]

Bermudagrass	Bromegrass	Pasture and Range Grasses
Bluegrass	Fescue	Grasses grown for hay or silage

Any other grass, Gramineae family, (either green or cured) except those included in the group cereal grains that will be fed to, or grazed by livestock.

Non-Grass Animal Feeds. [alfalfa, clover]

Alfalfa	Lupine	Vetch
Clover	Sainfoin	Crown Vetch
Lespedeza	Trefoil	Milk Vetch

Herbs and Spices. [basil, chives, dill, marjoram, sage]

Anise	Chives	Fenugreek	Nasturtium	Tansy
Balm	Clary	Horehound	Pennyroyal	Tarragon
Basil	Coriander	Hyssop	Rosemary	Thyme
Borage	Costmary	Lavender	Rue	Wintergreen
Burnet	Curry	Marigold	Sage	Woodruff
Camomile	Dill	Sweet Marjoram	Savoy	Woodworm
Catnip	Fennel	Wild Marjoram	Sweet Bay	

Individual Tolerance Crops

Asparagus	Hops	Okra	Persimmon
Avocado	Kiwifruit	Papaya	Pineapple
Figs	Mango	Pawpaw	Water Cress
Globe Artichoke	Mushrooms	Peanuts	Water Chestnut

Discussion

The benefits of the crop grouping scheme are obvious. Group tolerances could be granted for those pesticides for which EPA has data for the representative crops and limited resources could be directed to the development of residue data for those representative crops. Field data, particularly phytotoxicity data, would then be obtained for individual crops; although pesticide residues remaining on the crop may be similar for the entire group, certain crops could exhibit sensitivities to a particular chemical.

Several problems could develop from the establishment of a group tolerance. (1) Once a group tolerance is established, States could possibly issue third party special local need 24(c) registrations without confirmation of the registrant. If this registration is not based on sufficient crop safety data, liabilities could be incurred. (2) The Acceptable Daily Intake (ADI) for a pesticide could be met or exceeded if all the crops in the group are included in the Theoretical Maximum Intake Calculation. This would mean crops for which the pesticide is not registered would automatically be included in this calculation of theoretical exposure of humans to the pesticide.

Inspite of these possible problems, these proposed regulations are welcomed by our agricultural industry. The concept of grouping botanically similar crops for the purposes of predicting what residues will be found at harvest makes sense. For example, if similar cultural practices are used, the residues at harvest found on quince should be very similar to those for apples and pears. And the residues found on collards should be similar to those found of broccoli, cabbage, and mustard greens. This rationale of similar residues for similar crops using similar cultural practices should be in accordance with EPA's responsibility of protecting the public and the environment while extending the use of important pest control materials to the minor crop industries of this country.

This proposed amendment is still is draft form. EPA has been accepting comments for several months. The crops discussed are included in the second draft, dated January 13, 1982.

WEED CONTROL IN DRY BEANS IN CALIFORNIA

Larry W. Mitich and Steven A. Fennimore[1]

Approximately 170,000 acres of dry beans are grown annyally in California. The number one kind is blackeye beans with 43,000 acres. Light red kidney beans and large lima beans are the next most polular kinds with about 30,000 acres each. Approximately 11,000 acres each of garbanzos, pinks, dark red kidney, and small white beans are grown.

Technically, all the beans grown in California are called dry beans.

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Strictly speaking though, common or dry beans include only pinto, kidney, pink, black, small red, and small white. Other classes are lima (large and baby limas), blackeye, and garbanzo (chickpea). Tolerance to herbicides varies among the different classes.

Yellow nutsedge (*Cyperus esculentus* L.) and the nightshade complex (*Solanum* and *Physalis* spp.) create the greatest weed problems in dry bean production. These weeds abound in the blackeye bean production area in the Jan Joaquin Valley and none of the registered herbicides provide consistent good control of them without causing some crop injury.

Other major weed species include barnyardgrass [*Echinochloa crus-galli* (L.) Beauv.]. redroot (*Amaranthus retroflexus* L.), field bindweed (*Convolvulus arvensis* L.), common lambsquarters (*Chenopodium album* L.), jimsonweed (*Datura stramonium* L.), and common purslane (*Portulaca oleracea* L.).

Subsurface layering of herbicides is being used successfully for the control of yellow nutsedge in dry beans. EPTC (*S*-ethyl dipropylthiocarbamate) and alachlor [2-chloro-2',6'-diethyl-*N*-(methoxymethyl)acetanilide] appear to be the best preplant herbicides available for nutsedge control. EPTC cannot be used on blackeye or lima beans because of substantial crop injury. Alachlor is safe on limas but fails to provide dependable yellow nutsedge control under the field conditions typically encountered in dry bean production. Improper soil incorporation or inadequate soil moisture are usually responsibile for poor nutsedge control with preplant alachlor treatments. Applying alachlor with a spray blade places it into moist soil without the soil dilution encountered with conventional incorporation.

Bean response to subsurface treatments has been good. Only blackeye beans show sensitivity to the alachlor treatment. All other dry bean classes appear tolerant to the herbicide.

A study was conducted in 1981 to provide additional data concerning weed control in various classes of dry beans. Trials were conducted in Butte, Colusa, Santa Barbara, San Joaquin, Stanislaus, Sutter, and Tulare counties and at the University of California Experimental Farm at Davis. Objectives were to compare the effectiveness of several standard use herbicides with several new experimental herbicides and herbicide combinations in several locations in the state, and with several classes of beans. A major objective was to evaluate the effectiveness of new herbicides and herbicide combinations in controlling yellow nutsedge and the nightshade complex (black nightshade, hairy nightshade, and groundcherry) with present standard use herbicides which do not control such weeds. Additional objectives were to compare the effectiveness of the new herbicides in controlling other weeds such as redroot pigweed, jimsonweed, common purslane, and barnyardgrass, and to evaluate the crop tolerance to these compounds compared to standard use herbicides.

The herbicides were applied either as preplant incorporated treatments, the chemicals being incorporated into the soil to a depth of 2 inches immediately following application, or as postemergence treatments which were made 2 to 6 weeks following crop emergence when the weeds were approximately 1 inch in height. All herbicides were applied with a CO_2 backpack sprayer.

The preplant incorporated herbicides in dark red kidney bean trials at the University of California Experimental Farm at Davis lacked a good stand of weeds. Only redroot pigweed was present in sufficient numbers to warrant evaluation. All treatments gave good to excellent pigweed control except PPG-844 at 0.5 lb/A, but yield was not affected (Table 1). Phytotoxicity to the beans was never greater than 23% and the beans recovered within 2 to 3 weeks.

Table 1. Weed control with preplant incorporated herbicides in dark red kidney beans at the U.C. Davis Experimental Farm. The treatments were made and the beans planted June 25, 1981. Ratings for weed control and phytotoxicity were taken July 20, 1981 and the harvest was October 31, 1981.

Herbicide	Rate lb/A	Mean of 4 plots: Phyto-toxicity	Mean of 4 plots: Percent pigweed control[1/]	Mean of 4 plots: Yield per plot[2/]
Alachlor	3.0	1.3	100	7.6
MON-097	1.0	1.0	100	6.4
MON-097	2.0	2.3	100	7.1
Alachlor + trifluralin	3.0 + 0.5	2.0	100	7.4
Alachlor + ethalfluralin	3.0 + 1.5	1.0	100	6.6
PPG-844	0.5	1.0	75	7.3
PPG-844	1.0	2.0	100	6.9
Naptalam	2.0	2.0	100	7.1
Naptalam	4.0	1.8	100	6.9
Vernolate	3.0	1.5	80	7.9
Vernolate	4.0	1.3	100	7.7
EPTC	3.0	1.8	100	7.6
Trifluralin	0.75	1.5	100	7.3
Trifluralin + EPTC	0.5 + 1.5	2.3	100	7.0
Metolachlor	2.5	0.8	100	7.0
Pendimethalin	0.75	1.5	93	6.1
Ethalfluralin	1.5	1.0	100	7.8
NC-20484	1.0	2.0	80	7.2
NC-20484	3.0	1.5	100	7.9
Control (weeded)	-	0.8	94	7.5
Control (unweeded)	-	1.0	0	6.6

1/ Percent weed control per 100 cm^2 plot.

2/ Yield in pounds.

Table 2 shows the results of the postemergence herbicides on dark red kidney beans at Davis. Redroot pigweed control was poor with all herbicides except PPG-844 at 0.2 lb/A plus surfactant and RH-0265 at 0.125 lb/A which gave good control. Within 3 weeks after treatment, all signs of phytotoxicity had disappeared. A similar situation occurred in the post-emergence trial in large lima beans at Davis (Table 3).

Large lima beans exhibited considerably more phytotoxicity to pre-plant incorporated herbicides than kidney beans (Table 4). EPTC, EPTC + trifluralin (α,α,α-trifluoro-2,6-dinitro-*N*,*N*-dipropyl-*p*-toluidine), and naptalam (*N*-1-naphthylphthalamic acid) at 4 lb/A caused considerable injury. NC-20484 (2,3-dihydro-3,3-dimethyl-5-benzo=furanyl ethanesulphonate) at 1 and 3 lb/A failed to give satisfactory redroot pigweed control.

Control of the nightshade species varied from very poor (30%) with trifluralin at 0.75 lb/A to very good (90% of better) with alachlor at 3 lb/A and metolachlor [2-chloro-*N*-(2-ethyl-6-methylphenyl)-*N*-(2-methoxy-1-methylethyl)acetamide] at 2.5 lb/A in a light red kidney bean trial in San Joaquin County (Table 5). Pendimethalin [*N*-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine] + metolachlor (0.75 + 2.5 lb/A) and MON-097 [2-chloro-*N*-(ethoxymethyl)-6-ethyl-*o*-acetotoluide] at 3 lb/A also gave good nightshade control. The best control (95%) of common purslane was

Table 2. Weed control with postemergence herbicides in dark red kidney beans at the U.C. Davis Experimental Farm. The beans were planted June 24, 1981, treatments applied July 24, 1981, ratings taken August 3, 1981; harvest was October 31, 1981.

			Mean of 4 plots		
Herbicide	Rate lb/A	Surfactant	Phyto-toxicity	Percent pigweed control1/	Yield per plot2/
PPG-844	0.1	0.5% X-77	1.8	68	6.5
PPG-844	0.2	0.5% X-77	1.8	93	6.8
Bentazon	0.75	-	1.0	46	6.9
Bentazon	0.75	0.5% Agridex	2.0	50	6.7
Sethoxydin + bentazon	0.5 + 0.75	-	1.8	29	7.7
Ro 13-8895 + bentazon	0.375 + 0.75	-	1.8	36	7.5
RH-0265	0.125	0.5% X-77	1.5	43	6.7
RH-0265	0.125	-	1.5	86	6.4
RH-0265	0.25	0.5% X-77	1.8	29	6.3
RH-0265	0.25	-	1.5	14	7.1
Control	-	-	0	0	6.9

1/ Percent weed control per 100 cm^2 of plot.

2/ Yield in pounds.

Table 3. Weed control with postemergence herbicides in large lima beans at the U.C. Davis Experimental Farm. The beans were planted June 24, 1981, and treatments applied July 24, 1981 and ratings were taken August 3, 1981.

Herbicide	Rate lb/A	Mean of 4 plots: Surfactant	Phytotoxicity	Percent pigweed control[1/]
PPG-844	0.1	0.5% X-77	2.3	77
PPG-844	0.2	0.5% X-77	2.3	93
Bentazon	0.75	-	1.0	55
Bentazon	0.75	0.5% Agridex	2.0	63
Sethoxydin + bentazon	0.5 + 0.75	-	1.5	15
Ro 13-8895 + bentazon	0.375 + 0.75	-	2.3	39
RH-0265	0.125	0.5% X-77	1.8	46
RH-0265	0.125	-	1.8	8
RH-0265	0.25	0.5% X-77	2.0	77
RH-0265	0.25	-	1.5	39
Control	-	-	0	0

1/ Percent weed control per 100 cm^2 of plot.

obtained with 3 lb/A of MON-097 and 1.5 lb/A of ethalfluralin [*N*-ethyl-*N*-(2-methyl-2-propenyl)-2,6-dinitro-4-(trifluoromethyl)benzeneamine] (97% control). Naptalam, NC-20484 at 1 lb/A, EPTC and metolachlor gave unsatisfactory control. Control of barnyardgrass and volunteer grain (mostly barley) was evaluated with postemergence herbicides in light red kidney beans in San Joaquin County (Table 6). None of the treatments gave satisfactory control of the volunteer grain and only Ro 13-8894 and sethoxydin {2-[1-(ethoxyimino)butyl]-5-[2-(ethylthio)hydroxy-2-cyclohexene]--1-one}, both at 0.5 lb/A, gave better than 80% control of barnyardgrass.

Some conclusions on preplant incorporated herbicides and crop phytotoxicity drawn from the various trials follows.

Alachlor at 3 lb/A caused more injury to lima and blackeye beans than kidney beans but they generally outgrew the initial injury. Alachlor gave 80 to 95% control of redroot pigweed, barnyardgrass, the nightshades, and jimsonweed, 73% control of common purslane, and 47 to 68% control of yellow nutsedge.

EPTC at 3 lb/A produced severe phytotoxic symptoms in large lima beans but only slight injury in red kidney beans which outgrew the symptoms. EPTC gave 80 to 93% control of redroot pigweed and barnyardgrass but gave mixed results with the nightshades--76% control in one trial but no control

Table 4. Weed control with preplant incorporated herbicides in large lima beans at the U.C. Davis Experimental farm. The treatments were made and the beans planted June 25, 1981. Ratings for weed control and phytotoxicity were taken July 20, 1981.

Herbicide	Rate lb/A	Mean of 4 plots: Phytotoxicity	Mean of 4 plots: Percent pigweed control 1/
Alachlor	3.0	2.5	85
MON-097	1.0	2.0	94
MON-097	2.0	3.0	100
Alachlor + trifluralin	3.0 + 0.5	2.0	94
Alachlor + ethalfluralin	3.0 + 1.5	1.8	94
PPG-844	0.5	2.3	94
PPG-844	1.0	2.5	94
Naptalam	2.0	1.8	100
Naptalam	4.0	2.8	100
Vernolate	3.0	2.8	85
Vernolate	4.0	3.5	100
EPTC	3.0	4.8	94
Trifluralin	0.75	2.0	100
Trifluralin + EPTC	0.5 + 1.5	4.0	100
Metolachlor	2.5	1.8	94
Pendimethalin	0.75	2.8	85
Ethalfluralin	1.5	2.0	100
NC-20484	1.0	3.0	23
NC-20484	3.0	3.0	69
Control (weeded)	-	0.8	100
Control (unweeded)	-	0.5	0

1/ Percent weed control per 100 cm^2 of plot.

Table 5. Weed control in light red kidney beans with preplant incorporated herbicides in San Joaquin County, California. The treatments were made and the beans planted June 29, 1981.

Herbicide	Rate lb/A	Mean of 4 plots: Percent nightshade control	Percent purslane control
Alachlor	3.0	90	73
Metolachlor	2.5	91	66
EPTC	3.0	76	28
Ethalfluralin	1.5	65	97
Pendimethalin	0.75	48	60
Trifluralin	0.75	30	91
Trifluralin + EPTC	0.5 + 1.5	64	90
Pendimethalin + metolachlor	0.75 + 2.5	86	79
NC-20484	1.0	35	50
NC-20484	2.0	60	85
Naptalam	1.5	55	33
Naptalam	3.0	60	53
MON-097	3.0	89	95
Control	-	5	5

in another. Control of yellow nutsedge and common purslane was poor (39%).

Ethalfluralin at 1.5 lb/A caused 20% injury in large lima and blackeye beans while giving less than 10% injury in red kidney beans; all beans outgrew the initial injury. Ethalfluralin gave over 88% control of redroot pigweed, common purslane, barnyardgrass, and volunteer grain, and 65 to 80% control of the nightshades. Control of yellow nutsedge ranged from fair to none.

MON-097 resulted in 30 to 40% injury in large lima and blackeye beans at 2 and 3 lb/A, and 7 to 22% injury in kidney beans at 1, 2, and 3 lb/A. Control of redroot pigweed, common purslane, and jimsonweed at 2 and 3 lb/A was 92% or better. Nightshade control was variable (40 to 89%) and nutsedge control was poor (43%).

Observations on the performance of some postemergence applied herbicides.

Sethoxydin at 0.5 lb/A caused slight (5 to 12%) injury in kidney and lima beans and gave good (85%) control of barnyardgrass. Sethoxydin + bentazon at 0.5 + 0.75 lb/A resulted in 8 to 17% injury in all bean varieties, but gave greater than 79% control of barnyardgrass, nightshade,

Table 6. Weed control with postemergence herbicides in light red kidney beans in San Joaquin County, California. The beans were planted June 25, 1981 and the treatments were made July 13, 1981.

Herbicide	Rate lb/A	Mean of 4 plots: Percent barnyardgrass control 1/	Percent volunteer grain control 1/
Ro 13-8895	0.5	80 a	55 a
Sethoxydin	0.5	85 a	35 b
Sethexydin + bentazon	0.5 + 0.75	79 a	35 b
Bentazon	0.75	0 d	0 c
PPG-844 + bentazon	0.2 + 0.75	20 c	23 b
Ro 13-8395 + bentazon	0.375 + 0.75	38 b	43 ab
PPG-844	0.2	13 c	35 b
RH-0043	0.25 + 0.25% X-77 surfactant	28 bc	33 b
MC-10978	0.5	13 c	20 b
Control	-	0 d	0 c

1/ Treatments with the same letter(s) following are approximately equal.

and common purslane.

Bentazon at 0.75 lb/A caused only minor (7 to 12%) crop injury while giving 100% control of nightshade and 96% control of purslane.

MC-10978 at 0.5 lb/A caused considerable injury (40%) to light red kidney beans but gave 98 to 100% control of the nightshades and common purslane, and 80% control of redroot pigweed.

REDUCE OVERALL YEILD WITH WEED CONTROL IN ALFALFA, BUT...

R. L. Chase[1]

Weeds are a serious problem to alfalfa producers. If not controlled, they increase in population and seriously reduce the amount of good quality hay that can be produced. Quality is becoming a more important

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factor in the marketing of Utah hay, and weeds seriously reduce that quality. Since weeds are harvested with the hay, a weed control program seldom produces an increase in total yield. However, weeds are usually less palatable and lower in protein and energy than hay. Therefore, controlling weeds in hay improves forage quality.

In order to determine effective control measures and find out how much quality is lost when weeds are not controlled, 15 weed control experiments were conducted throughout Utah in November and December of 1980. Six of the most common alfalfa herbicides were tested on different weeds and varying degrees of weed infestations. One herbicide, metribuzin [4-amino-6-*tert*-butyl-3-(methylthio)-*as*-triazin-5(4*H*)-one], was sprayed in March to determine its effectiveness applied in the spring. Table 1 shows the average weed control effectiveness on different weed species.

Table 1. Effects of herbicides on weed control in established alfalfa

		Weed control (%)[b]						
Herbicide[a]	Rate (lb ai/A)	TM(5)[c]	SP(2)	BM(2)	DL(4)	QG(2)	DB(2)	KB(2)
Simazine	1.2	92	100	95	11	10	92	3
Diuron	1.5	78	98	99	4	7	39	0
Metribuzin	0.5	81	100	100	4	13	86	22
Metribuzin	1.0	96	100	100	46	10	99	90
Pronamide	1.0	22	34	13	0	51	89	90
Pronamide	2.0	39	40	8	2	88	97	98
Terbacil	0.75	97	100	23	23	50	97	28
Terbacil	1.2	100	100	48	52	39	100	25
Hexazinone	1.0	100	100	100	60	5	100	97
Metribuzin (spring applied)	0.5	77	100	100	39	21	100	89

[a]Herbicides applied during November and December, 1980. Metribuzin also applied in March, 1981.

[b]Visual estimates April or May 1981. Weed abbreviations: TM = tansy-mustard; SP = shepherdspurse; BM = blue mustard; DL = dandelion; QG = quackgrass; DB = downy brome; KB = Kentucky blyegrass

[c]Number in parenthesis indicates number of trials evaluated and averaged for that species. There were four replications.

Two of the 15 trials were harvested to determine what effect weeds had on alfalfa yield. The two trial areas were somewhat weedy with the following species: tansy mustard [*Descurainia pinnata* (Walt.) Britt.], shepherdspurse [*Capsella bursa-pastoris* (L.) Medic], purple mustard (*Chlorispora tenella* DC.), and prickly lettuce (*Lactuca serriolo* L.). The total forage was weighed and then the alfalfa was separated from the weeds and weighed.

The weeds in the untreated check plot caused that plot to yield the most forage (Table 2), but only 56% of the weight was due to alfalfa.

Table 2. Effect of herbicides on forage makeup of first cutting alfalfa

Treatment	Rate (lb ai/A)	Alfalfa + weeds[a]	Alfalfa[a]	% Alfalfa
simazine	1.2	10.28	10.00	97
diuron	1.5	10.76	10.56	98
metribuzin	0.5	10.42	10.10	97
metribuzin	1.0	10.19	10.17	100
pronamide	1.0	12.83	8.43	66
pronamide	2.0	13.31	8.95	67
terbacil	0.75	12.40	10.04	81
terbacil	1.2	11.08	9.43	85
hexazinone	1.0	10.56	10.56	100
Spring metribuzin	0.5	9.92	9.80	99
untreated	-	13.40	7.55	56

[a]Fresh weight (lbs.) from 30 ft^2, average of two trials.

and the rest (44%) was due to weeds. Pronamide [3,5-dichloro(*N*-1,1-dimethyl-2-propynyl)benzamide], being a grass herbicide, only gave partial control of the mustards, so again, total yield was high, but alfalfa accounted for only 67% of the total weight. The rest of the herbicides in the trials generally gave good control of the weeds so that the percent of alfalfa in the harvested plots was close to 100%. The amount of alfalfa in these plots was 30% more than the alfalfa in the untreated check plot, although that plot yielded the most total forage.

Researchers have found an inverse relationship between weeds and alfalfa protein content. That is, as the weed population increases, protein content decreases. We ran analyses to determine the nutritional value of the alfalfa and the weeds. The alfalfa averaged 25.77% protein while the weeds averaged 17.16%. Acid detergent fiber (ADF) was 31.53% for alfalfa and 39.68% for weeds. Net energy in Meg Cal/lb was .656 for alfalfa and .521 for the weeds. The high ADF for the weeds shows that they are not as digestible as the alfalfa, nor as palatable.

There is some nutritional value in weeds, but cows, especially dairy cows, will root out many weeds, especially mustards. They are simply not as palatable as good quality hay.

If a grower is selling hay with only 56% alfalfa and the rest weeds, instead of #1 dairy hay, he would probably have to settle for #3 feeder hay. This could mean a difference of $20-25/ton.

Another important factor needs to be considered. If weeds are not controlled and allowed to produce seeds, weeds will grow in numbers and cause a greater and greater decrease in forage quality.

The message is clear--if one wants a high yield, irregardless of quality, let the weeds grow. If quality is the desired product, weed control definitely pays.

YELLOW NUTSEDGE CONTROL IN FIELD CORN

Stott W. Howard and J. O. Evans[1]

Abstract. Yellow nutsedge (*Cyperus esculentus* L.) is rapidly becoming a major problem in corn, potatoes, and other row crops in Utah. On a silage corn field in Hooper, Utah, field trials were established using a completely randomized block design with three replications in 1980 and again with four replications in 1981. The seedbed was prepared with a moldboard plow followed by a "S" shank harrow with a sandpacker attached. Herbicides were applied with a bicycle sprayer and immediately incorporated with a tandem disk set to cut five inches. Normal farm practices ensued including cultivation with a twelve inch furrowing shovel and furrow irrigation.

Metolachlor [2-chloro-*N*-(2-ethyl-6-methylphenyl)-*N*-(2-methoxy-1-methylethyl)benzenamine] showed good control both years at 3.92 - 4.48 kg/ha. This herbicide also maintained activity through harvest time. Of note were the excapes in the furrow bottoms in all treatments, which may be due to treated soil displacement during furrow operations and/or herbicide leaching.

Introduction

Yellow nutsedge is rapidly becoming a major problem in corn, potatoes, and other row crops in Utah. According to the 1980 Utah Exotic Noxious Weed Survey, yellow nutsedge is established in five counties: Kane, Grand and Washington, where it occurs in abundance, and Weber and Davis where it occurs in limited areas.

The objective of this study was to determine the efficacy of a number of herbicides for control of yellow nutsedge in field corn.

Materials and Methods

The plots were located on a silage corn field in Hooper, Weber County, Utah. This farm has been in corn for several years. The seedbed was prepared with a moldboard plow followed by a "S" shank harrow with a sandpacker attached. The finished seedbed was smooth and free from litter.

The field trials were set up using a complete randomized block design with three replications in 1980 and again with four replications in 1981.

The herbicides were applied with a bicycle sprayer equipped with 8002 nozzles applying 20 GPA at 30 psi. The herbicides that were included in both trials were:

Herbicide	1980 rate (kg/ha)	1981 rate (kg/ha)
EPTC/R25788	4.48	4.48
EPTC/R25788	6.72	6.72
Vernolate/R25788	4.48	4.48
Vernolate/R25788	6.72	6.72
Metolachlor	2.24	2.8
Metolachlor	4.48	3.92

These herbicides were selected based on their success in controlling yellow nutsedge in peanuts, soybeans, and other row crops in the South (1, 2, 3). They were immediately incorporated into a warm, moist, well drained sandy loam with an offset disk set at a five inch cutting depth.

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Two passes were made with the disk to insure incorporation of 2 - 3 inches. The field was planted the next day with Ferry Morse (113 day) silage corn.

Results

The 1980 field trial had a planting date of June 6, and was harvested on September 26. The soil had a pH of 7.7 and an organic matter content of 1.57 percent. There was 0.82 inches of rainfall the month following application. The following table shows the results of the three readings.

Treatment	Rate (kg/ha)	Yellow nutsedge control (%)		
		July 8	August 6	Sept. 24
EPTC/R25788	4.42	82a	85a	72a
ETPC/R25788	6.72	88a	85a	87a
Vernolate/R25788	4.42	82a	77a	75a
Vernolate/R25788	6.72	87a	92a	88a
Metolachlor	2.24	83a	88a	83a
Metolachlor	4.48	85a	92a	92a
Control	--	50b	0b	6b

Treatments with the same letter in the individual columns are not significantly different at the 5 percent level, LSD.

The first reading shows no significant differences between any of the treatments nor any treatment showing acceptable control of 90 percent.

The second reading shows metolachlor at 4.48 kg/ha and vernolate/R25788 (*S*-propyl dipropylthiocarbamate) at 6.72 kg/ha giving acceptable control at 92 percent. The final reading taken two days before harvest shows only metolachlor at 4.42 giving acceptable control at 92 percent.

The 1981 trial had a planting date of May 5, and a harvest date of September 18. The soil had a pH of 7.7 and an organic matter content of 1.43 percent. There was 3.26 inches of rainfall the month following application which is 2.4 inches more than the previous year's trial. The following talbe shows the results of the three readings.

Treatment	Rate (kg/ha)	Yellow nutsedge control (%)		
		June 9	July 23	Sept. 22
EPTC/R25788	4.42	78 b	41 bc	10 de
EPTC/R25788	6.72	83ab	69a	30 cd
Vernolate/R25788	4.42	86ab	84a	71a
Vernolate/R25788	6.72	88ab	64ab	45 bc
Metolachlor	2.8	98a	78a	68ab
Metolachlor	3.92	98a	89a	93a
Control	--	0 c	0 c	0 e

Treatments with the same letter in the individual columns are not significantly different at the 5 percent level, LSD.

The first reading shows metolachlor at 2.8 kg/ha and 3.92 kg/ha giving acceptable control. The only treatment which retains acceptable control on the final evaluation, which was post harvest, is metolachlor at 3.92 kg/ha. Looking across the rows shows the activity vs. time for the individual treatment. It is interesting to compare the readings of EPTC (*S*-ethyl dipropylthiocarbamate) at 6.72 kg/ha to metolachlor at 3.92 kg/ha. The EPTC has noticeable decrease in activity during the season while metolachlor retains its activity. The significant lack of control by EPTC/R25788 at both rates in the final evaluation may be due to the unusual amount of rainfall during the month following application.

Of note in the 1981 trial were the escapes in the furrow bottoms in later readings. This may be due to soil displacement during furrow operations and/or herbicide leaching. Another important factor was that the safener, R25788, worked extremely well both years as there was no signs of phytotoxicity in any of the treatments in which it was involved.

Conclusions

Metolachlor gave acceptable control of yellow nutsedge in field corn at 4.42 kg/ha in 1980 and at 3.92 kg/ha in 1981.

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PP009: A NEW SELECTIVE HERBICIDE FOR CONTROL OF ANNUAL AND PERENNIAL GRASSES

R. R. Robinson, S. R. Colby, and A. A. Akhavein[1]

Abstract. PP009 {(±)-butyl 2-[4-[[5-(trifluoromethyl)-2-pyridinyl]oxy]-phenoxy]propanoate} is a highly active, selective herbicide being developed by the control of grass weeds in broadleaf crops. The proposed common name of PP009 is fluazifop.

PP009 has been field tested in small plots in the United States since 1978. Postemergence applications of 0.28 to 1.12 kg/ha have consistently provided effective control of a broad range of perennial and annual grasses. All broadleaf crops tested to date (over 40) have been found tolerant to rates of PP009 needed to control grasses.

On rhizome johnsongrass [*Sorghum halepense* (L.) Pers.], sequential postemergence applications of PP009 at rates of 0.42 + 0.42 kg/ha have provided initial knockdown and control of regrowth from rhizomes under arid western conditions. In humid regions of the Midsouth and Southeast, effective control has been obtained at 0.28 + 0.28 kg/ha. A substantial reduction in the population of viable rhizomes has been observed in the

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year following PP009 application. Effective control of bermudagrass [*Cynodon dactylon* (L.) Pers.] and quackgrass [*Agropyron repens* (L.) Beauv.] has been obtained at rates similar to those needed for control of johnsongrass.

Fragmentation of the rhizomes or stolons of perennial grasses is necessary to obtain control at the above indicated rates. Higher rates are necessary for control of undisturbed perennial grasses. Against perennial grasses, sequential applications are frequently more effective for full season control than a single application of the same total amount.

PP009 is effective against a broad range of annual grasses at rates of 0.14 to 0.56 kg/ha. Species controlled in this rate range include:

Volunteer corn
Volunteer cereals
Shattercane [*Sorghum bicolor* (L.) Moench]
Goosegrass [*Eleusine indica* (L.) Gaertn.]
Broadleaf signalgrass [*Brachiaria platyphylla* (Griseb.) Nash]
Johnsongrass seedlings
Barnyardgrass [*Echinochloa crus-galli* (L.) Beauv.]
Junglerice [*Echinochloa colonum* (L.) Link]
Canarygrass (*Phalaris* spp.)
Foxtails (*Setaria* spp.)
Crabgrasses (*Digitaria* spp.)
Wild oat (*Avena fatua* L.)
Panicum spp.

This is only a partial list; many other species are controlled.

Useful soil residual activity against annual grasses by PP009 may be obtained following postemergence application at rates of 0.56 kg/ha or higher. Preplant soil incorporation and preemergence control is possible with PP009 at rates of 0.56 kg/ha or higher.

PP009 (technical material) is of relatively low oral and dermal toxicity and of low irritant potential to skin and eyes. The acute oral LD_{50} for male and female rats is 3328 mg/kg. PP009 has relatively low toxicity to mallard ducks, bees, and earthworms. PP009 is moderately toxic to fish; the LC_{50} at 96 hours for rainbow trout is 1.6 ppm.

PP009 is available as an emulsifiable concentrate formulation containing 4 lbs active material per US gallon. ICI Americas Inc. has submitted to the Environmental Protention Agency a data package requesting registration of PP009 on soybeans and cotton. Registration for additional crop uses is planned.

CONTROL OF RHIZOME JOHNSONGRASS WITH FLUAZIFOP IN WESTERN IRRIGATED COTTON

M. R. Hargrave, M. W. Grubbs and S. D. Watkins[1]

Abstract. Fluazifop {(±)-butyl 2-[4-[[5-(trifluoromethyl)-2-pyridinyl]-oxy]phenoxy]propanoate} is a selective, systemic graminicide being developed by ICI Americas Inc. for use in a wide range of broadleaf crops. Fluazifop has been field-tested in Arizona and California cotton (*Gossypium hirsutum* L.) since 1979. Sequential over-the-top application at 0.42 +

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0.42, 0.56 + 0.56, and 0.84 + 0.84 kg/ha, separated by two to four weeks, have provided excellent knockdown and seasonal control of rhizomatous johnsongrass [*Sorghum halepense* (L.) Pers.], without significant injury to cotton. Repeated half-dose treatments at 0.42 kg/ha or greater were generally superior to single applications of the same total dose. Results indicate that effective control is achieved when initial treatments are applied early in the growing season to johnsongrass approximately 30 cm tall. Fluazifop is not highly effective when treatments are applied to johnsongrass drought-stressed or to plant heights greater than 60 cm. The addition of a crop oil concentrate at 2.34 L/ha or a nonionic surfactant at 0.1% (v/v) has been shown to enhance postemergence control. Effective weed control has been achieved with spray volumes ranging from 95 to 376 L/ha. Fluazifop treatments that afforded the most complete weed control also provided the highest cotton yields.

Introduction

Johnsongrass is a perennial weed species that grows vigorously, spreads rapidly, and produces an extensive rhizome system (6). It is well-adapted to cotton production areas of Arizona and California and has become difficult to control due to its aggressive growth habit (4), and because rhizome segments, from which new plants can arise, are easily dispersed throughout fields by cultivation equipment. In California, growers of the San Joaquin Valley ranked johnsongrass as the most troublesome weed infesting cotton (2). Johnsongrass is also considered the most important perennial weed in many irrigated desert areas (1). Cotton competes poorly with johnsongrass, which necessitates the need for early control measures to prevent weed establishment and avoid yield reductions (3, 4).

Fluazifop is a new, highly selective systemic herbicide that controls a broad range of annual and perennial grasses. Extensive worldwide testing has shown fluazifop to possess a wide margin of safety when applied postemergence to non-graminacous crops.

Since, 1979, field research has been conducted to determine the effectiveness of fluazifop in controlling rhizomatous johnsongrass in cotton when administered as a broadcast postemergence treatment. The objectives of these studies were to: 1) determine optimum rates and application timings, 2) evaluate the comparative effectiveness of single vesus sequential foliar applications, 3) assess the influence of adjuvants on herbicidal activity, and 4) determine the herbicidal tolerance of cotton and subsequent effects of yields following broadcast foliar applications.

Materials and Methods

Twenty-one field experiments were conducted between 1979 and 1981 with grower-cooperators near Phoenix and Yuma, Arizona, and in the central and southern portion of California's San Joaquin Valley. Soil textures ranged from sandy loam to clay loam (pH 6.7 to 8.6) and contained less than 2.0 percent organic matter.

All fields were subjected to preplant cultural practices that were considered normal for each respective area. Most field were disced at least twice, chiseled, listed, and preirrigated. Each field received preplant incorporated treatments of trifluralin (α,α,α-trifluoro-2,6-dinitro-*N*,*N*-dipropyl-*p*-toluidine), fluchloralin [*N*-(2-chloroethyl)-2,6-dinitro-*N*-propyl-4-(trifluoromethyl)aniline], or pendimethalin [*N*-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine] at 1.81 L/ha, or prometryn [2,4-bis(isopropylamino)-6-(methylthio)-*s*-triazine] at 1.12 kg/ha.

Following April plantings, trials were established in areas with moderate to heavy infestations of rhizome johnsongrass. Initial treatments were made in late April or early May, when cotton ranged in height from 8 to 15 cm (2 to 4 leaves) and johnsongrass 15 to 45 cm (3 to 6 leaves). In studies which included delayed applications, treatments were applied from late May to mid-June. During this period, cotton height ranged from 13 to 25 cm (5 to 8 leaves) and johnsongrass 15 to 75 cm (3 to 8 leaves). Sequential treatments were administered to designated plots 17 to 42 days following the first, with 25 days the average interim period.

All herbicide treatments were applied broadcast foliar at 95 to 376 L/ha with a tractor-mounted, compressed-air sprayer. Flat fan nozzles (Teejet 8001-8004) attached to a four-row boom were used in all experiments. Plot size was 4 m by 15 m and all treatments were replicated four times in a randomized block design. During 1979 and 1980, cultivated control plots were incorporated into the experimental design. In 1981, single or double cultivated rows situated adjacent and parallel to each treated plot served as the control. The cotton cultivars included in Arizona testing were 'Deltapine 61' and 'Stoneville 825', and in California, 'Acala SJ-2' and 'Acala SJ-5'. Johnsongrass was controlled between rows of all plots by rolling cultivator.

Fluazifop was applied as single over-the-top treatments at rates of 0.28 to 2.24 kg/ha at two stages of johnsongrass growth, or as split postemergence treatments at rates of 0.28 to 1.12 kg/ha. Certain studies investigated the comparative effectiveness of fluazifop applied alone, and when tank-mixed with nonionic surfactants at 0.1 to 0.5% (v/v), or with crop oil concentrates at 2.34 L/ha. The effects of varied spray volumes on efficacy were also examined. Seed cotton yields were collected from selected studies and were determined by harvesting the center two rows of each plot with a single row spindle picker.

Visual estimation of control and crop injury were generally conducted 2, 4, 6-9, and 16-26 weeks following the final treatment during all three years of testing. Ratings were based on a scale of 0 = no injury and 100 = complete kill. All data were subjected to analysis of variance. Duncan's multiple range test was used to determine significant differences among means at the 0.05 level of probability.

Results and Discussion

Effect of fluazifop on two stages of johnsongrass growth. During 1979 and 1980, the comparative effectiveness of fluazifop was examined when applied to johnsongrass approximately 30 and 60 cm in height. Rates of 0.56, 1.12, and 2.24 kg/ha were administered as broadcast treatments at three trial locations and 0.56, 0.84, and 1.12 kg/ha were used at a fourth location. A nonionic surfactant was included in all fluazifop treatments at a rate of 0.1% of the spray volume. Results indicate that fluazifop was less effective when applied late postemergence, particularly at 0.56 and 1.12 kg/ha (Tables 1 and 2). Early postemergence treatments at identical rates increased seasonal control by a mean 25 and 23%, respectively. Differences in herbicidal activity were not generally as striking between plots treated at 2.24 kg/ha, although applications to the earlier growth stage improved seasonal control by an average of 14%. Weed control assessments at harvest (Table 2) showed that early postemergence treatments provided control that was superior to identical rates applied later. Generally, however, differences were not statistically significant.

Plowman et al. (5) have reported fluazifop to be most effective when applied to johnsongrass in an active state of growth. Higher dosages may be required if the weed is drought-stressed, growing under conditions of low relative humidity, or if rhizomes are not well-fragmented during preplant cultural operations. A 1980 Madera, California study showed control increasing an average of 8 to 15% for fluazifop rates of 0.56, 0.84, and 1.12 kg/ha, following the season's initial furrow irrigation six weeks after treatment (data not shown). An increase in herbicidal response following irrigations (thus promoting vegetative growth) has been observed in several other studies. However, because little supportive data exists, the interaction between soil moisture and the systemic activity of fluazifop needs closer examination.

Table 1. Effect of growth stage and rate of fluazifop on weed response Tolleson, Arizona - 1979

Treatment	Rate[a] (kg/ha)	Growth[b] stage	Percent johnsongrass control[c] at indicated weeks after treatment	
			2	4
Fluazifop	0.56	I	52ab	68a
Fluazifop	0.84	I	55ab	63ab
Fluazifop	1.12	I	63a	82a
Fluazifop	0.56	II	23 c	30 c
Fluazifop	0.84	II	27 c	28 c
Fluazifop	1.12	II	45 b	42 bc
Untreated check			0 d	0 d

[a]A nonionic sufactant was added to all treatments at 0.1% (v/v).

[b]Growth state I = johnsongrass approximately 30 cm tall, stage II = 60 cm tall

[c]Means followed by the same letter are not significantly different at the 0.05 level of probability as determined by Duncan's multiple range test.

Injury symptoms on cotton plants were observed during 1980 testing in the San Joaquin Valley. Although not significant, symptoms manifested as reddish speckling of upper leaf surfaces and were most prevalent on cotton receiving single fluazifop treatments of 2.24 kg/ha, the maximum dosage tested. Injury did not appear on subsequent plant growth, and yields were not adversely affected. Crop phytotoxicity was not obserbed in the San Joaquin Valley during 1981, nor in any ICI studies conducted in Arizona over the three-year period.

Effect of single versus sequential applications of fluazifop. Since 1979, field studies have been conducted to determine the effect on weed control following single and repeated treatments of fluazifop at 0.28, 0.42, 0.56, 0.84, and 1.12 kg/ha. As in studies in which application timings were keyed to weed development, initial treatments were administered to johnsongrass approximately 30 cm in height. A nonionic surfactant was added at 0.1% (v/v) to each of the spray dilutions.

Results show that consistent season-long control was achieved with split applications at rates of 0.42 + 0.42 kg/ha or greater. With the

Table 2. Effect of growth stage and rate of fluazifop on weed response - 1980

Treatment	Rate[a] (kg/ha)	Growth[b] stage	Percent johnsongrass control[c] at weeks after treatment and locations shown									
			Rosedale, CA			Tipton, CA				Bard, CA		
			2	4	28	2	4	7-9	21	2	4	26
Fluazifop	0.56	I	20c	50bc	57c	30a	53c	67ab	65ab	69b	60c	48d
Fluazifop	1.12	I	57b	67b	77ab	33a	53c	68ab	62ab	73ab	65bc	70b
Fluazifop	2.24	I	77a	90a	90a	47a	83a	85a	87a	79a	70ab	81a
Fluazifop	0.56	II	20c	38c	33d	35a	67abc	53b	43b	56c	51d	34e
Fluazifop	1.12	II	23c	50bc	62bc	35a	65bc	45b	45b	59c	61c	58c
Fluazifop	2.24	II	30c	57bc	68bc	47a	80ab	90a	77ab	73ab	76a	81a
Untreated check			0d	0d	0e	0b	0d	0c	0c	0d	0e	0f

[a] A nonionic surfactant was added to all treatment at 0.1% (v/v)

[b] Growth stage I = johnsongrass approximately 30 cm tall
Growth stage II = 60 cm tall

[c] Means followed by the same letter are not significatly different at the 0.05 level of probablility as determined by Duncan's multiple range test.

exception of 0.28 kg/ha, the lowest rate tested, repeated half-dose treatments proved to be superior to single applications of the same total dose (Tables 3 and 4). Sequential treatments of fluazifop at 0.56 + 0.56 kg/ha, separated by two to four weeks, provided excellent knockdown and seasonal control of johnsongrass, and proved to be significantly more efficacious than a single dose at 1.12 kg/ha. Significant rate responses also occurred with split applications at 0.42 + 0.42, 0.84 + 0.84, and 1.12 + 1.12 kg/ha. Single treatments at 1.12 kg/ha or less have generally not provided satisfactory control in the majority of field trials.

Effect of adjuvants and diluent volumes. The addition of adjuvants to dilutions of fluazifop is currently recommended by ICI to enhance herbicidal activity. Studies were initiated in 1981 to determine if varied concentrations or types of adjuvants would influence weed control.

Results obtained from a Yuma, Arizona study suggest that adjuvants influence the efficacy of lower fluazifop rates to a greater extent than higher rates during the initial four weeks following application (Table 5). the addition of a nonionic surfactant at 0.1% (v/v), or crop oil concentrate at 2.34 L/ha to 0.28 kg/ha of fluazifop substantially enhanced weed control. A moderate increase in control occurred when adjuvants were added to fluazifop dilutions of 0.56 kg/ha, whereas additions to fluazifop at 0.84 kg/ha revealed no significant difference. The rate responses for fluazifop at dosages of 0.28 and 0.56 kg/ha were significant through four weeks posttreatment. These results correspond to those observed in a companion study conducted near Hanford, California in which significant increases in weed control occurred following the addition of a nonionic surfactant or crop oil concentrate adjuvant (data not shown).

Studies in central and southern California during 1980 and 1981 have shown fluazifop to provide excellent weed control regardless of spray volume. Significant differences in control have not been observed with diluent volumes ranging from 95 to 376 L/ha (Table 6). This flexibility in use should prove useful due to the diversity of application equipment now being utilized by cotton producers.

Effect of yields. During 1980, yields were collected from two studies which examined the effects of sequential treatments and varied application timings. Results presented show that yields followed the same general trend as weed control, with seed cotton production numerically highest in plots exhibiting superior johnsongrass control (Table 7).

Cotton receiving single, early postemergence treatments of flazifop were generally better yielding than cotton treated later with identical rates. All treatments resulted with yields numerically superior to the untreated control. Because the experimental error was high in each trial, significant differences in yields between rates and growth stages were not detected. However, split treatments of fluazifop at 0.56 + 0.56 and 1.12 + 1.12 kg/ha and early postemergence applications at 2.24 kg/ha resulted in yields statistically different from those collected from untreated plots.

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Table 3. Effect of single versus sequential applications of fluazifop on weed response - 1980

Treatment[a]	Rate[b] (kg/ha)	Percent jonsongrass control[c] at weeks after treatment and locations shown									
		Rosedale, CA			Tipton, CA				Bard, CA		
		2	4	28	2	4	7-9	21	2	4	26
Fluazifop	0.56	20c	50b	57b	30c	53b	67b	65a	69c	60d	48d
Fluazifop	1.12	57b	50b	77ab	33c	53b	68b	62a	73c	65cd	70c
Fluazifop	2.24	77a	90a	90a	47b	83a	85ab	87a	79b	70c	81b
Fluazifop	0.56 + 0.56	60b	93a	90a	88a	95a	93a	87a	78b	83b	93a
Fluazifop	1.12 + 1.12	53b	75ab	70ab	87a	95a	97a	88a	88a	93a	96a
Untreated check		0d	0c	0c	0d	0c	0c	0b	0d	0e	0e

[a]Initial treatments applied to johnsongrass approximately 30 cm in height.

[b]A nonionic surfactant was added to all treatments at 0.1% (v/v).

[c]Means followed by the same letter are not significantly different at the 0.05 level of probability as determined by Duncan's multiple range test.

Table 4. Effect of single versus sequential applications of fluazifop on weed response

Treatment[a]	Rate[b] (kg/ha)	Percent johnsongrass control[c] at weeks after treatment and locations shown					
		Tolleson, AZ 1979		Hanford, CA 1981	Rosedale, CA 1981		
		2	4	4-5	4	9	14-16
Fluazifop	0.56	52a	68a	61b	58b	56d	54cd
Fluazifop	0.84	55a	63a	70b	60b	69cd	61bc
Fluazifop	1.12	63a	82a	66b	68b	76bc	70b
Fluazifop	0.28 + 0.28	63a	65a	55b	59b	56d	48d
Fluazifop	0.42 + 0.42	-	-	93a	91a	88ab	86a
Fluazifop	0.56 + 0.56	-	-	93a	95a	94a	91a
Fluazifop	0.84 + 0.84	-	-	96a	98a	95a	93a
Untreated check		0b	0b	0c	0c	0e	0e

[a] Initial treatments applied to johnsongrass approximately 30 cm in height.

[b] A nonionic surfactant was added to all treatments at 0.1% (v/v).

[c] Means followed by the same letter are not significantly different at the 0.05 level of probability as determined by Duncan's multiple range test.

Table 5. Effect of spray tank additives on weed control. Yuma, Ariaona, 1981

Treatment[a]	Rate	Percent johnsongrass control[b] at indicated weeks after treatment		
		2	4	26
Nonionic surfactant	0.1% v/v	0 e	0 e	0 d
Crop oil concentrate	2.34 L/ha	0 e	0 e	0 d
Fluazifop	0.28 kg/ha	58 d	68 d	78 c
Fluazifop + NS	0.28 kg/ha + 0.1% v/v	70 c	88ab	80 bc
Fluazifop + COC	0.28 kg/ha + 2.34 L/ha	75 bc	83 b	91ab
Fluazifop	0.56 kg/ha	71 c	76 c	93ab
Fluazifop + NS	0.56 kg/ha +	78ab	85ab	98a
Fluazifop + COC	0.56 kg/ha + 2.34 L/ha	79ab	86ab	86abc
Fluazifop	0.84 kg/ha	80ab	86ab	91ab
Fluazifop + NS	0.84 kg/ha +	79ab	86ab	98a
Fluazifop + COC	0.84 kg/ha +	83a	91a	98a
Untreated check		0 e	0 e	0 d

[a]Treatments applied to johnsongrass approximately 30 cm tall at 294 L/ha on April 30, 1981. NS = nonionic surfactant, COC = crop oil concentrate.

[b]Means followed by the same letter are not significantly different at the 0.05 level of probability as determined by Duncan's multiple range test.

Table 6. Effect of spray volume on johnsongrass control. Hanford, CA 1981

Treatment[a]	Rate[b] (kg/ha)	Volume (L/ha)	Percent johnsongrass control[c] at indicated weeks after treatment	
			5	7
Fluazifop	0.56	95	65 bc	69 cde
Fluazifop	0.56	188	64 c	66 de
Fluazifop	0.56	376	73abc	65 e
Fluazifop	0.84	95	80a	88a
Fluazifop	0.84	188	69abc	69 cde
Fluazifop	0.84	376	70abc	73 bcde
Fluazifop	1.12	95	73abc	81abc
Fluazifop	1.12	188	80a	86ab
Fluazifop	1.12	376	77ab	80abcd
Untreated check			0 d	0 f

[a]Treatments applied to johnsongrass approximately 30 cm tall on April 15, 1981.

[b]A nonionic surfactant was added to all treatments at 0.1% (v/v).

[c]Means followed by the same letter are not significantly different at the 0.05 level of probability as determined by Duncan's multiple range test.

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Table 7. Effect of single versus sequential applications of fluazifop on weed control and seed cotton yields - 1980

Treatment	Rate[a] (kg/ha)	Growth[b] stage	Rosedale, CA[c]		Tipton, CA[c]	
			Johnsongrass percent control at harvest	Yields (kg/ha)	Johnsongrass percent control at harvest	Yields (kg/ha)
Fluazifop	0.56	I	57 bc	1187 bcd	65ab	2175a
Fluazifop	1.12	I	77ab	1319abc	62ab	2043a
Fluazifop	2.24	I	90a	1912a	87a	2372a
Fluazifop	0.56	II	33 c	923 cd	43 b	1318ab
Fluazifop	1.12	II	62ab	1319abc	45 b	1319ab
Fluazifop	2.24	II	68ab	1187 bcd	77ab	1319ab
Fluazifop	0.56 + 0.56	I + II	90a	1318abc	87a	1714a
Fluazifop	1.12 + 1.12	I + II	70ab	1714ab	88a	1648a
Untreated check			0 d	527 d	0 c	461 b

[a]A nonionic surfactant was added to all treatments at 0.1% (v/v).

[b]Growth stage I = johnsongrass approximately 30 cm tall
Growth stage II = 60 cm tall

[c]Means followed by the same letter are not significantly different at the 0.05 level of probability as determined by Duncan's multiple range test.

SHANK INJECTION OF THIOCARBAMATE HERBICIDES FOR WEED CONTROL IN SUNFLOWER

J. L. Handly, R. H. Callihan, and G. A. Lee[1]

Abstract. The feasibility of shanking thiocarbamate herbicides parallel to the seed furrow was tested for weed control in sunflower (*Helianthus annuus* var. 894). This represents a summary of four years of field and greenhouse studies.

EPTC (*S*-ethyl dipropylthiocarbamate), vernolate (*S*-propyl dipropylthiocarbamate), butylate (*S*-ethyl diisobutylthiocarbamate), and cycloate (*S*-ethyl *N*-ethylthiocyclohexanecarbamate) were applied at 3.4, 4.9, 6.7, and 11.2 kg a.i./ha. Herbicides were shanked 2.5, 5, 7, and 10 cm below the soil surface. For calculation of band width tame oat (*Avena sativa*) was seeded 2.5 cm deep perpendicular to the seed furrow as an indicator plant.

Field and greenhouse studies show that the band of weed control produced from each treatment is a function of depth and herbicide vapor pressure. Bands of weed control ranged from 22.7 cm for vernolate at 11.2 kg a.i./ha to 9 cm for butylate at 3.4 kg a.i./ha. Both were applied 2.5 cm below the soil surface.

Although injury symptoms were observed in early growth stages, yield data from field trials in 1981 showed no significant yield reductions indicating tolerance to a shanking herbicide application on both sides of the seed furrow.

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METRIBUZIN FOR FALLOW-SEASON WEED CONTROL IN WINTER WHEAT

N. E. Humburg[1]

Abstract. Metribuzin [4-amino-6-*tert*-butyl-3-(methylthio)-*as*-triazin-5(4*H*)-one], alone and in combination with other herbicides, has been evaluated annually in Wyoming for nearly a decade. Effective combinations included metribuzin with short- and long-residual triazines, paraquat (1,1'-dimethyl-4,4'-bipyridinium ion), and glyphosate [*N*-(phosphonomethyl)glycine]. Spring treatments with metribuzin at 0.38 or 0.5 lb/A, alone or in combinations, controlled weeds prior to seedbed preparation. Post-harvest application of metribuzin at 0.5 or 0.75 lb/A provided weed control comparable to spring applications of 0.38 or 0.5 lb/A. Metribuzin has demonstrated a high degree of control of weeds commonly found in wheat fields, such as lambsquarters (*Chenopodium* spp.), Russian thistle, (*Salsola kali* L. var. *tenuifolia* Tausch), downy brome (*Bromus tectorum* L.) and other annuals, as well as volunteer wheat.

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GROWTH AND DEVELOPMENT IN BIOTYPES OF COMMON GROUNDSEL (*SENECIO VULGARIS*) RESISTANT OR SUSCEPTIBLE TO TRIAZINES

Jodie S. Holt and Steven R. Radosevich[1]

Abstract. Comparative growth, development, and resource allocation by triazine susceptible and resistant biotypes of common groundsel (*Senecio vulgaris* L.) grown in two light intensities were studied over a seven week period. This study was conducted to determine the effects of previously demonstrated photosynthetic differences between biotypes on growth and development, and to determine whether the two biotypes are equally affected by reduced light intensity.

Dry matter production, height, number of leaves, and leaf area of the susceptible biotype were greater than those of the resistant biotype at all harvests at both light intensities. Root/shoot ratios were lower in the resistant biotype at all times in high light. Lower values for these parameters in resistant plants are due to lowered photosynthetic capacity, which limits growth and retards root production relative to shoot production.

Net assimilation rate (NAR) was lower in resistant plants than susceptible ones when grown in high light, and similar in low light. Leaf area ratio (LAR) in resistant plants was higher than in susceptible ones in both light regimes, implying greater relative production of photosynthesizing tissue in resistant plants to compensate for reduced photosynthetic efficiency. As a result, relative growth rate (RGR) was very similar between biotypes. A lower plastochron index (PI) of resistant plants younger than five weeks from sowing, relative to susceptible plants of the same age, suggests that resistant plants are at least two days behind susceptible plants developmentally, when grown in high light.

Shade lowered dry weight production, height, number of leaves, leaf area, NAR, RGR, PI, and root/shoot ratios in both biotypes. Values for these growth parameters in susceptible plants were equal to or larger than in resistant plants at all harvests. Allocation patterns and LAR shifted towards increased shoot and leaf production in response to shade in both biotypes. In proportion to their greater maximum photosynthetic capacity, susceptible plants in some cases were relatively more affected than resistant ones by shade, which limited photosynthate production, and therefore, growth.

These results demonstrate decreased fitness from soon after germination onward of resistant plants to grow and reproduce, when compared to susceptible plants.

[1]University of California, Riverside, and University of California, Davis, CA

AERIAL APPLICATION OF IPA GLYPHOSATE

Mark E. Winkle[1]

The commercial formulation of the isopropylamine (IPA) salt of glyphosate [*N*-(phosphonomethyl)glycine] teceived a federal registration 1/81 for aerial applications at a 0.43 kg ae/ha rate in reduced tillage

[1]Product Development Representative, Monsanto Company, Spokane WA

systems. Since that time aerial applications of IPA glyphosate have become an integral part in many reduced tillage programs involving cereal grain production in the Pacific Northwest. There have been indications that IPA glyphosate rates less than 0.43 kg ae/ha provide annual grass weed control. Consequently, four aerial locations were established in 1981 at rates ranging from 0.11 - 0.43 kg ae/ha to evaluate annual weed control. In addition, a tank mix of IPA glyphosate plus dicamba (3,6-dichloro-*o*-anisic acid) at a rate of 0.21 kg ae/ha + 0.28 kg ai/ha, respectively, was also aerially applied at all locations. All treatment rates were applied with a fixed wing aircraft at a pressure of 1.3 - 1.8 kg/cm^2 and carrier volume of 46.77 L/ha. Weed species initially present were downy brome (*Bromus tectorum* L.) and volunteer wheat (*Triticum aestivum* L.).

Weed control results evaluated 30 days after treatment (DAT) at IPA glyphosate rates of 0.43 and 0.32 kg ae/ha were greater than 90% for both volunteer wheat and downy brome. At an 0.21 kg ae/ah IPA glyphosate rate, weed control was 80% for downy brome and 78% for volunteer wheat, whereas at 0.11 kg ae/ha weed control results were 44 and 43% for these weeds, respectively. The tank mix combination of IPA glyphosate plus dicamba provided 75 - 78% control of both weed species. However, the residual effects of dicamba provided 85-90% tansy mustard [*Descurainia pinnata* (Walt) Britt.] control 45 DAT. As a result of these studies and other research efforts, a new label IPA glyphosate rate of 0.32 kg ae/ha was approved 12/81 for volunteer wheat, downy brome, and other selected annual weeds in reduced tillage systems.

Herbicide drift was visually monitored at all locations. In general, IPA glyphosate movement was observed between 15.2 and 22.9 m from the spray pattern. However, leaf spotting was observed 38 m from the treatment area at one location. It should be pointed out that a crosswind of 8.1 to 12.9 km/hr was present at this location. Consequently, it is important for the pilot to consider wind speed and direction and leave an appropriate buffer area when making a herbicide application near adjacent desirable vegetation.

In summary, IPA glyphosate rates of 0.43 and 0.32 kg ae/ha provided good volunteer wheat and downy brome control. Treatment rates below 0.32 kg ae/ha provided control less than 80%. Future research will continue to investiage IPA glyphosate rates less than 0.32 kg ae/ha using a water carrier volume less than 46.77 L/ha. As in any application, an appropriate buffer zone must be maintained between a treatment area and adjacent susceptible vegetation.

WEED CONTROL IN ESTABLISHED ALFALFA WITH METRIBUZIN AND PARAQUAT

H. L. Ramsey, R. L. Pocock, and J. M. Schell[1]

The residual property of metribuzin [4-amino-6-*tert*-butyl-3-(methylthio)-*as*-triazin-5-(4*H*)-one] plus the contact activity of paraquat (1,1'-dimethyl-4,4'-bipyridinium ion) offers additional weed control and extends the period of application of metribuzin to alfalfa after spring growth begins in the Pacific Northwest.

[1]Mobay Chemical Corporation, Kansas City, MO

Metribuzin is registered for weed control in dormant·established alfalfa. Mebribuzin use rates range from 0.25 to 1.0 lb active ingredient per acre depending upon soil type and weed species to be controlled. Metribuzin should be applied prior to green-up while the alfalfa is still dormant. (The alfalfa must be in a dormant period and application made prior to green-up.) The lower use rates are recommended for use on sandy soils which are also low in organic matter. Weed species such as common lambsquarters (*Chenopodium album* L.), henbit (*Lamium amplexicaule* L.), common chickweed (*Stellaria media* L.), and shepherdspurse (*Capsella bursa-pastoris* L.), are effectively controlled. Weed species in the Pacific Northwest such as downy brome (*Bromus tectorum* L.) and tansy mustard [*Descurainia pinnata* (Walt.) Britt.] are often difficult to control with lower use rates of metribuzin used alone. Mild winter weather enhances winter annual weed growth leading to "sodded in" downy brome, and conditions where mustards bolt from the rosette stage of growth. Under these conditions a tank-mix of metribuzin plus paraquat significantly aids in the control of these weeds versus either herbicide used alone.

Research trials were conducted during the winters of 1978-79, 1979-80, and 1980-81 to determine the herbicide rates, and the crop tolerance of alfalfa after dormancy had broken and growth had begun. Data were evaluated and summarized for the performance of metribuzin alone, or as a tank-mix with paraquat for the control of downy brome and tansy mustard. Applications were made when the alfalfa plants had 2 inches or less new growth. Data collected over the past 3 years include weather conditions of: 1978-79, cold winter with snow cover; 1979-80, relatively mild winter with minimal snow cover; and 1980-81, extremely mild winter without snow cover.

The tank-mix of metribuzin plus paraquat applied to alfalfa with 2 inches or less of new growth was effective in controlling downy brome and tansy mustard. Treatments of metribuzin at 0.25 to 0.50 lb plus paraquat at 0.25 to 0.38 lb active ingredient per acre gave 95 to 100% control, depending upon herbicide rates used.

Metribuzin alone gave control of common lambsquarters, common chickweed, shepherdspurse, and henbit, while the tank-mix of metribuzin plus paraquat provided effective control of downy brome and tansy mustard.

The tank-mix of metribuzin plus paraquat has enhanced weed control in alfalfa, especially under conditions when winter annual weed growth commonly occurs during mild winter conditions in the Pacific Northwest. Maximum contact activity, obtained by complete spray coverage of the weeds, was an important factor in obtaining optimum control.

GRASS CARP: THE COLORADO DIVISION OF WILDLIFE'S VIEWPOINT

Robin F. Knox[1]

Introduction

Grass carp were first introduced into the United States in 1963 by the U.S. Fish and Wildlife Service and held at the Fish Farming Experiment Station, Stuttgart, Arkansas. Known introductions since that time have occurred in 35 states, although the actual number of states is probably

[1]Colorado Division of Wildlife, 6060 Broadway, Denver, CO 80216

higher due to the unknown interstate distribution of fish from commercial producers. Grass carp have been collected from natural waters in 13 states. Where it has been intensively investigated, as in Missouri, the distribution of grass carp is closely associated with large rivers such as the Missouri and Mississippi, probably because of the origins of this species in large rivers of eastern Asia, from the Amur River Basin to the West River. The limited number of fish reported from small streams in Missouri had all been captured within several kilometers of the Missouri River.

Prior to the mid-1970's there was little interest in the grass carp within the state of Colorado. But as interest and public knowledge in the apparent weed-munching capabilities of this critter became more widespread, Division biologists, being the cautious reactionary bunch that they are, decided to take action.

Regulatory History in Colorado

Grass carp were first listed as being a "prohibited species" in the Division of Wildlife's 1975 fishing regulations. This action was similar to that taken by other states. Since that time, the grass carp and grass carp hybrids have been widely introduced throughout the nation. Many states have rescinded their importation bans on grass carp and grass carp hybrids.

Bending to public demand and an increasing "se la ve" attitude on the part of some Division fishery biologists, the Colorado Wildlife Commission, in November, 1980, amended the regulation to allow the Division to authorize in writing, the possession of prohibited species.

Since that change has become effective, there has been increased public interest in using the grass carp for aquatic weed control. In order to treat public requests for the possession of grass carp uniformly, the following guidelines for possession were formulated as part of the Commission Policy Document:

SUBJECT: GRASS CARP

The Commission recognizes that the use of grass carp or grass carp hybrids as a biological tool for aquatic weed control has some benefit to the citizens of Colorado. There is an increasing public demand for the use of this fish to control aquatic weeds in situations where chemical or mechanical control is not possible. It is, therefore, the intent of the Commission to allow the use of grass carp or grass carp hybrids as a method for aquatic weed control within the following guidelines.

1. Possession, importation, or use of grass carp or grass carp hybrids east of the Continental Divide may be authorized in writing by the Director of the Division of Wildlife.
2. Possession, importation or use of grass carp or grass carp hybrids west of the Continental Divide is prohibited.
3. No person may ship or transport into the state any grass carp or grass carp hybrids unless they comply with Division regulations on the Importation of Live Fish and Viable Fish Eggs. (Reference: Regulations Chapter 7 #703, Section a., pages 7-10).
4. Persons may apply in writing to the Division for a grass carp or grass carp hybrid use permit. Each use permit application needs to be accompanied by a description of the body of water to be stocked; a site location map; and the source of grass carp.

Present Status

Following the passage of the Commission Policy on grass carp, there developed considerable internal Division dissension on whether or not the use of grass carp or grass carp hybrids should in fact, be allowed in Colorado. However, this was almost a mute point since 6 bodies of water were already known to have grass carp or hybrids.

Feelings among Division biologists are apparently divided into three camps: First, those who are in strong favor of introducing grass carp to control aquatic vegetation; Second, those who say "stock grass carp over my dead body" or "the only good grass carp is one used to fertilize my garden;" and Third, those biologists who don't care one way or another.

To help the reader understand the basis of this internal discussion, I would like excerpt several items from Division Statutes and Commission Policies. First the Division's Legislative declaration:

> 33-101. Legislative declaration. (1) It is the policy of the state of Colorado that the wildlife and their environment, and the natural, scenic, scientific, and outdoor recreation areas of this state are to be protected, preserved, enhanced, and managed for the use, benefit, and enjoyment of the people of this state and visitors to this state. It is further declared to be the policy of this state that there shall be provided a comprehensive program of outdoor recreation in order to offer the greatest possible variety of outdoor recreation opportunity to the people of this state and its visitors and that to carry out such program planning, acquisition, and development of outdoor recreation lands, waters, and facilities.

Second, a portion of the Commission Policy on Fish Stocking (policy D-1) in Colorado:

> Native fish species will be propagated and planted in the water of the state where a justifiable need exists. Justification will be based on creating a fishery where none would exist without stocking or the desire to enhance a fishery where wild fish populations are not capable of supporting adequate fishing recreation. Non-native (exotic) fish species will be introduced only when sufficient investigations are conducted to insure that the species will not have an adverse effect on the habitat occupied by native fish species; when it is ecologically suitable for the environment; when they will be contained within the boundaries of the state; and when there exists a justifiable biological or social need for the species.

Additionally, the following quote was typical of the "against" arguments used to conteract the position of those who felt the grass carp was a useful tool to control aquatic vegetation in Colorado:

> "Specifically, how can we *insure* that such an introduction will not have an adverse impact upon native fish habitat when we have *no* study in Colorado that addresses this point? Also, how can we insure that someone will not take grass carp from a dead-end situation and put them in a river?
>
> "My concern still stands. In fact, apparently we do not even have a *scientific* study designed to evaluate the impacts of grass carp introductions upon native species and their habitats! Having a Denver staff person "monitoring" the permits certainly does not qualify as a scientific study.
>
> "With all due respect for your opinion that the grass carp policy statement was appropriate, I would like to point out that for every exotic species introduction program that went astray, there was some-

one who thought it was appropriate. You should know that I also reviewed "considerable information" on grass carp and am not convinced a Colorado introduction program is appropriate. I am concerned that 35 states prohibit grass carp introductions, including at least one the previously studied this topic. Also, I would like to offer the following three quotes from separate publications dealing with the grass carp situation in Florida: (1) until definitive studies demonstrate a benign effect on fisheries and wildlife, it is recommended that grass carp not be used in water bodies where the primary concern is fisheries or wildlife habitat, (2) a decline in numbers of some waterfowl species was attributed to changes in hydrilla abundance as a result of the combined effects of grass carp, water levels, and other factors, and (3) there can be little doubt that if grass carp occur in densities similar to those found in those research ponds, waterfowl habitat degradation will likely occur.

"The above quate should illustrate why I think the grass carp issue goes beyond fish management."

The problems and unanswered questions that have been raised are valid. The need for protection of native species and habitats must be balanced with the Division's other responsibilities in the aquatic resource realm.

These internal discussions did have a positive impact. Over the next five years or so the Division will use a cautious, controlled approach to the use of grass carp, with an eye toward developing useful management guidelines.

Summary

To briefly review, the main concerns of using herbivorous fish in Colorado are:

1) The probability of escapement to West Slope waters.
2) The possible adverse impacts on native fish fauna.
3) The possible adverse impacts on sportfish and sport waterfowl.
4) The possible introduction of new diseases and parasites.

In order to address these concerns and still allow the use of grass carp in Colorado, a permit system is being developed. This permit system hopefully will allow for an oderly, controlled introduction of grass carp into eastern Colorado waters. The main points of this system include:

1) Grass carp will only be allowed east of the Continental Divide in closed bodies of water.
2) All fish will need to meet the Division's regulations on certifying that the fish are disease-free and from a reputable dealer.
3) The Division will try to realize some research and management benefits from these initial introductions.
4) Applications for use will be refused when they are considered to be inappropriate.

The Division, in this manner, can hopefully mesh the needs of its citizens for aquatic plant control and its statutory mandate of protecting and managing the aquatic resource of the state of Colorado.

MINUTES OF THE WESTERN SOCIETY OF WEED SCIENCE BUSINESS MEETING MARCH 11, 1982, DENVER, COLORADO

President Alex Ogg called the meeting to order and requested approval of the 1981 business meeting minutes as published in the 1981 Proceedings. It was moved, seconded, and carried that the minutes be approved as published.

Reports were presented as follows:

1. *Necrology:* Ralph Whitesides reported the death of Dick Beeler, Editor of *Agrichemical Age* and an Honorary Member of WSWS. President Ogg called the society to observe his passing with a moment of silence.

2. *Nominations:* The WSWS Nominations Committee for 1981-82 was composed of Ralph E. Whitesides, Chairman, Garry D. Massey, and Larry Morrow. Ralph Whitesides reported that the following persons were elected to office:

President Elect: Garry Massey (won by coin toss following tie vote with Phil Olson).
Secretary: Bart Brinkman
Chairman-Elect, Research Section: Charles Stanger
Chairman-Elect, Education & Regulatory Section: Gus Foster
WSSA Representative: Clyde Elmore

Approximately 36% of the Society Membership voted in the 1982 election. Larry Morrow will serve as Chairman of the Nominations Committee for the 1982-83 year. Committee members will be Delbert R. Harper and Ralph E. Whitesides.

3. *Site Selection:* No formal report was submitted by the Site Selection Committee. President Ogg announced that the 1983 meeting will be held at the MGM Grand Hotel in Las Vegas, Nevada, the 1984 meeting will be held at the Spokane Sheraton, and the 1985 meeting will be in Phoenix, Arizona.

4. *Placement:* Donn Thill announced that the WSSA file was available in the placement room, and was being actively used by both employers and prospective employees.

5. *Editorial Committee:* LaMar Anderson reported that abstracts for oral papers to be presented at the annual meeting frequently lacked substance and did not provide much information when published in the Proceedings. Members contributing abstracts or full length papers should follow WSSA guidelines. He encourage full length manuscripts and asked that all Proceedings contributions be submitted by April 1.

6. *Education-Regulatory Section:* Stan Heathman reported that the section meeting was an integral part of the general session during this meeting; and no separate session was held.

7. *Research Section:* Peter Fay announced that agronomic and horticulture papers comprised two-thirds of the 1982 progress report. He also reminded the membership that some reports were not submitted on acceptable quality paper for photocopy and had to be retyped in the requested camera-ready format.

The reports from individual project sections are as follows:

Project 1. Perennial Herbaceous Weeds, Gus Foster, Chairman. Rodney Lym was elected Chairman-Elect for 1984; Tom Schwartz will be chairman for 1983. Three subjects were discussed during the project meeting.

Subject 1--Facts of 2,4-D SULV. Peter Fay introduced the subject. Dr. Fay's initial exposure to the project came through calls from growers.

Dealers in Montana were suggesting deep root control of perennials with SULV. Dr. Fay was unable to find data to support this claim, either from surrounding Universities or from Thompson-Hayward. Dr. Fay's question to the group was, "Is it possible for 2,4-D amine to control deep rooted perennials?"

Dr. Allan Shadbolt, Thompson-Hayward, National Director of Field Research and Development, Kansas City, Kansas gave the following background. The letters "SULV" stand for "Special Ultra Low Volume". The product was developed in 1976 using a solvent process that was essentially non-soluble. It was designed to be applied by aircraft to reduce volatility and evaporation. Thompson-Hayward's primary emphasis with this product was less drift, therefore, keeping more material on the target area. Evaluations conducted by Thompson-Hayward indicate that this does not drift more than the standard water released materials. Dr. Shadbolt stated that 2,4-D SULV had been tested in grower and demonstration trials. Dr. Shadbolt said that Thompson-Hayward would continue to develop this product for uses on more weeds and crops. Thompson-Hayward is seeking a federal label for 2,4-D SULV.

In summary, no replicated field plot data is available to document the claims that SULV is translocated into the root system of perennial weeds. Field studies have been established in Wyoming and Montana to address this claim.

Subject 2--Is there a need for herbicide rotation in perennial weed control? Dr. Harold Allen, University of Wyoming, Laramie, Wyoming introduced the subject.

Dr. Alley stated that Dr. Jesse Hodgson, Montana State University, selected 11 ecotypes of Canada thistle. He studied these selections in a weed nursery. His work demonstrated that 2,4-D could provide from 0 - 90% control of Canada thistle. He identified his selections into 4 individual ecotypes based of 2,4-D activity/control. Dr. Alley stated there is a potential for resistance. He stated to the session the need to identify resistant populations of each perennial weed.

Comments within the session verified that resistant ecotypes of perennial weeds do exist. In summary, resistant populations to a herbicide have been identified.

Subject 3--Is there an advantage to herbicide combination for perennial weed control? Dr. Robert Zimdahl, Colorado State University introduced the subject.

Dr. Zimdahl stated that the advantages to combinations of herbicides to control perennial weeds were 1) better control, 2) less persistence, and 3) less expense. The disadvantages were stated as being 1) less persistance, 2) more expensive, and 3) inapproriate timing. He raised the question if anyone had found evidence that combination of herbicides were effective for perennial weed control.

It was suggested that when mixed populations of species were present, combinations have shown to be more effective. Dr. Alley state that evidence had shown a synergism between dalapon and amino-triazole.

In summary, field research did not provide the data that herbicide combinations were effective for perennial weed control. On a species, a combination will be no more effective than the highest rate of an application of the individual herbicide.

Projects 2 and 3: The projects 2 and 3, Herbaceous weeds of range and forest, and Undesirable woody plants, combined to consider the topic: Public and Agency Land Improvement Policies as They Relate to Weed Control. James M. Krall moderated the panel. Panel speakers were George Hittle, Wyoming State Department of Agriculture; Bob Newlin, U.S. Department of Agriculture Forest Service; Buck Walter, U.S. Department of Interior BLM; and Michael Newton, Professor of Forestry at Oregon State University.

Specific topics addressed were:

1. Public Land Agency Improvement Policies: What are they?
2. Public Land Agency Herbicides Use Policies
3. Public Land Use Control Programs: Funding and Implementation

The following points were established: (1) Public Agencies are operating under an uncoordinated set of laws; (2) The herbicide list for BLM and Forest Service is now the same; (3) Adequate funding for weed control is lacking for public lands use. The Forest Service estimates that they are only treating half of the land known to be infested. Money is lacking for even adequate assessment of weed problems. (4) Public Agencies must be willing to stand behind creditable scientific data in making decisions on weed control practices; and (5) At public input sessions, public agencies should not accept public opinion as equal to sound scientific study.

Tom Whittson, University of Wyoming, was elected Chairman-Elect of Project 2; 40 were in attendance.

Project 4: Weeds in Horticultural Crops. Bill Cobb, Elanco Products, was Chairman and introduced the following two subjects:

1. IR-4, State 24-C, and Emergency Section 18 Registrations for Horticultural crops. A total of 42 people were in attendance at this meeting, about 25% of those in attendance had some sort of direct regulatory involvement in pesticide minor crop registrations. Approximately 50% of the participants were industry affiliates and 50% had University, USDA, and/or Extension affiliation. The following major points were discussed:
   a. The need for standardization of IR-4 protocols
   b. Industry registrants need to be more timely in responding to IR-4 participation inquiries.
   c. EPA does no longer require efficacy data.
   d. EPA proposed crop groupings for IR-4 registrations
   e. "EE" section of FIFRA regulations
2. Orchard and Vineyard Weed Control. Major points of discussion included:
   a. Problems in no-till citrus management, including soil compaction
   b. Concerns of herbicide buildup
   c. Sod strip grass variety research
   d. Orchard herbicide tank mixes
      1) Registration/legality
      2) Physical and chemical compatibility
      3) Herbicide antagonism

Ray William, Oregon State University, will be the Chairman for the 1983 meeting. Linda Willits, ICI America, was elected Chairman-Elect for 1983.

Project 5: Weeds in Agronomic Crops. Pat Rardon, Montana State University was Chairman. Larry G. Thompson, Eli Lilly and Company, will be the 1982-83 Chairman, and Russell P. Schneider, Monsanto Company, Was elected Chairman-Elect. Two questions were discussed from the floor: (1) Are we developing the necessary technology for no-till farming? (2) How will agronomic cropping systems change if inexpensive glyphosate becomes available in the future?

Subject 1: The technology in weed science is being developed for no-till farming; however, inputs from other disciplines such as soil scientists, entomologists, plant pathologists, economists, plant breeders, etc., should be coordinated so that all the available information could be gathered and disseminated to growers. A suggestion was made that a task force or no-till group be organized for this purpose. The economic advantages of no-till farming must be real and thoroughly understood by growers before this practice will be widely accepted.

Subject 2: The question of "How agronomic cropping systems will change if inexpensive glyphosate or other effective compounds become available in the future" was not answered. General consensus was that there will be no inexpensive herbicide compounds available in the future. Even when a proprietary product comes off patent and becomes generic, the cost to the consumer has generally remained the same. A grower's cropping system will not change unless he can see a good return on his investment. The basic problem of all U.S. farmers is that they are being underpaid for their commodities.

Project 6: Aquatic, Ditch, and Non-crop Weeds. Project Chairman Floyd Colbert opened the session with a call for a nomination of Chairman-Elect. Two nominations were made with the election of Randall Stocker, Imperial Irrigation District, El Centro, California. Leslie Sonders will serve as Chairman for 1983.

Dr. Cross, acting as program moderator, introduced Tom Jackson of the U.S. Fish and Wildlife Service. Dr. Jackson gave a very informational presentation on the pros and cons of using White Amur for the use of aquatic weed control. Dr. Jackson is a very strong supporter for the introduction and use of White Amur for planned management programs utilizing White Amur for aquatic weed control.

Dr. Comes introduced Robin Knox of the Colorado Division of Wildlife who followed with a brief review of Colorado Division of Wildlife views on the pros and cons of the introduction of White Amur and for hybrids into Colorado for aquatic weed control east of the Continental Divide.

Project 7: Chemical & Physiological Studies. Lowell Jordan was Chairman of the session. Lloyd Haderlie was elected Chairman-Elect for 1983.

Clyde Elmore and Art Lange are writing a book on herbicide symptoms on horticultural crops. Pot tests to create herbicide symptoms in the greenhouse do not always create typical field symptoms.

Floyd Colbert discussed herbicide injury from an industry point of view. Bob Callihan cautioned against the diagnosis of a problem strictly from a point of symptom expression. Expression is a combination of complex interactions.

Lowell Jordan asked for symptoms of glyphosate injury and got more than 20 diverse answers. Lloyd Haderlie studied the symptoms of glyphosate injury and concluded that the effect of glyphosate in plants is extremely complex.

Steve Radosevich asked, "Are physiological studies of plants without herbicides of benefit to weed science?" Does physiology of plants guide plant succession? The conversation revolved around plant ecology. Jodie Hope emphasized the point that *why* something died is more important than the *fact* that it died. Radosevich feels that triazine resistance as a means of "fit" is an extreme case of niche occupation. The less competitive plant gains a niche over a more agressive, but herbicide-sensitive ecotype.

There was some debate over the quality of weed science research over the years.

Subject 2: Quick tests for herbicides. Ohmas Omad discussed quick tests for a biological activity. Standard tests take 3 weeks. Organized chemists can produce 2 to 3 compounds per day so the need for quick tests. CO_2 evolution was mentioned as a quick test. Leaf punch techniques were discussed.

8. *Financial Report:* Business Manager-Treasurer, LaMar Anderson presented the following financial statement for the 1981-1982 fiscal year:

<u>Income</u>	
Registration, San Diego Meeting (258+22)	$6,440.25
Dues, members not attending annual meeting (122)	610.00
Spouse luncheon tickets	270.00
1981 Research Progress Report sales	2,961.32
1981 Proceedings sales	3,210.02
Sale of back issues of publications	56.50
Advance order payments	68.40
Payment of outstanding invoices from previous year	13.50
Interest on checking account	121.71
Interest on savings certificate	665.95
Preregistration for Denver meeting	75.00
Total fiscal year receipts	$14,492.65
Assets, March 10, 1981	11,700.69
	$26,193.34
<u>Expenditures</u>	
1981 Annual Meeting incidental expenses	200.83
1982 Annual Meeting incidental expenses	188.89
Luncheon, 1981 Annual Meeting	2,885.85
Guest speaker expenses	1,040,46
Graduate Student room subsidy	270.00
Business Manager honorarium	500.00
CAST dues	492.00
1981 Research Progress Report publication costs	3,416.80
1981 Proceedings publication costs	2,894.20
Postage	824.25
Newsletter printing costs	163.43
Office supplies	96.95
Refunds	2.00
1982 Program printing costs	406.20
	$13,381.86
<u>Assets</u>	
Savings certificates	$12,500.00
Cheking	261.48
Cash on hand	50.00
	$12,811.48

Robert Parker, Chairman of the Finance Committee, reported that the finance committee had audited the treasurer's financial records. The committee found the records to be accurate and the Society to be in sound, acceptable financial condition. WSWS has $12,500, or about one year's operating requirements, invested in savings certificates.

9. *Resolutions:* In behalf of the Resolutions Committee Roger Willemsen submitted the following resolutions:

Resolution No. 1. Local Arrangements and Program

WHEREAS, the facilities and arrangements for the 1982 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 Dr. Harvey Tripple and members of the 1982 Local Arrangements Committee, to Chairman Dr. J. Wayne Whitworth, members of the program committee, and to the Stouffer's Denver Inn.

(Proposed recipients: Dr. Harvey Tripple, Dr. J. Wayne Whitworth, Member of the 1982 WSWS Local Arrangements Committee, Members of the 1982 WSWSProgram Committee, and Stouffer's Denver Inn)

It was moved, seconded, and carried to approve Resolution No. 1.

Resolution No. 2. Yearbook of Agriculture - Weeds

WHEREAS, the total losses due to weeds and their cost of control in the United States are estimated to be $18 billion annually; and

WHEREAS, there is a need by farmers, county agricultural agents, vocational agricultural teachers, university weed specialists, state departments of agriculture officials, chemical industry representatives, fish and wildlife specialists, department of interior and agriculture specialists, EPA specialists, and consumers for a book describing weeds and their control,

THEREFORE, BE IT RESOLVED that the Western Society of Weed Science urges the United States Department of Agriculture to publish a Yearbook of Agriculture dealing with weeds.

(Proposed recipients: Secretary of Agriculture, Secretary of Interior, Chairman, Senate Appropriations Committe; Chairman, Senate Agriculture and Forestry Committee; Chairman, House Agriculture Committee; Administrator, APHIS; Director, SEA; Deputy Director, SEA-AR; Deputy Director, SEA-CR; Deputy Director, SEA-E)

It was moved, seconded, and carried to approve Resolution No. 2.

Resolution No. 3. Federal Noxious Weed Act of 1974

WHEREAS, the losses due to weeds and their cost of control in the United States are estimated to be $18 billion annually; and

WHEREAS, there are many problem weeds in the world not known to be present in the United States, and surveys need to be conducted to determine if they have entered the United States and have become established; and

WHEREAS, some weeds on the Federal Noxious Weed List occur in limited areas in the United States and should be controlled or eradicated to prevent their spread and prevent the cost of weed control and losses due to weeds from escalating;

THEREFORE, BE IT RESOLVED that the Western Society of Weed Science urges the Office of Management and Budget; the Subcommittee on Agriculture, Rural Development, and Related Agencies; the United States Senate; the Subcommittee on Agriculture and Related Agencies; the House of Representatives; and the Secretary of Agriculture to make funds available to carry out the provisions of the Federal Noxious Weed Act of 1974.

(Proposed recipients: Secretary of Agriculture; Director, Office of

Management and Budget; Chairman, Subcommittee on Agriculture, Rural Development and Related Agencies; and Chairman, Subcommittee on Agriculture and Related Agencies)

Discussion of Resolution No. 3: It was suggested that this resolution be send to the directors of APHIS. It was moved, seconded, and carried to ammend the motion to read "WSWS representing 402 members in the 11 western states". It was moved, seconded, and carried to approve Resolution No. 3 as amended.

10. *Local Arrangements for 1983:* Jim Krall reiterated that the Local Arrangements Committee for 1983 has made arrangements for the Western Society of Weed Science to meet at the MGM Grand Hotel in Las Vegas, March 8-10, 1983.

11. *WSSA Report:* Harold Alley reported on the annual meeting and on the financial conditions of WSSA. Members will be receiving a revision of the constitution and operating procedures. A 5th edition of the Herbicide Handbook, with 11 new herbicides, will soon be available. The 1983 meeting of WSSA will be in St. Louis, Missouri on February 8-10 and the 1984 meetings will be in Miami at the Hyatt Regency on February 9-12.

12. *CAST Report:* Lowell Jordan announced that CAST dues for individuals are $15 per year and encourage individual member participation. He enumerated the 1982 published reports that are available on a fee and free basis. He stressed the importance to weed scientists of the reports on IPM and on Chemical Hazards in the Environment. The WSWS representative on the CAST Board of Directors serves on the CAST budget, finance, membership and liaxon committees. Dr. Phillip Upchurch is the new president of CAST. Jordan remarked that CAST has had greater political impact that has NAS.

13. *Honorary Members and Fellows:* Larry Burrill reported that Phillip Upchurch was elected an Honorary Member of WSWS and Lowell Jordan and Bert Bohmont were elected Fellow of the Society.

Robert Phillip Upchurch

R. Phillip Upchurch was born February 9, 1928, in rural Wake County, North Carolina and lived there during his early years. He received the BS and MS degrees in Agronomy at North Carolina State College in 1949. From 1949 to 1951 he served as a Research Instuctor at N.C. State College with responsibilities in forage crops. Graduate studies were conducted at the University of California-Davis and there he obtained the Ph.D. degree in Plant Physiology in 1953. While working on the doctorate he was awarded an NSF Fellowship.

From 1953 to 1965 Phil served successively as Assistant Professor, Associate Professor, and Professor of Crop Science at North Carolina State University where his responsibilities were in Weed Science. In 1963, he received the Sigma Xi Research Award at N.C. State for his research on the behavior of herbicides in soil. Also during this period he served two years in the U.S. Air Force (1955-57).

From 1965-1975 he served with the Monsanto Company in St. Louis, Missouri, successively as Senior Research Group Leader, Research Manager, and Manager of Research. He was associated with the development of butachlor and glyphosate herbicides.

His service to WSSA culminated in 1972 as President. In 1975 he was elected a Fellow in WSSA. In WSSA he was instumental in the development of *Weeds Today* and the *WSSA Newsletter*.

In 1972 Phil helped to form the Plant Growth Regulator Working Group and served at Chirman in 1973-74 and as Executive Officer from 1974-1977.

He has been an active participant in the Council for Agricultural Science and Technology (CAST) since its inception in 1972 and is currently serving as President.

From 1975 to 1981 Phil served as Head of the Department of Plant Sciences at the University of Arizona where he is currently Associate Director of the Arizona Agricultural Experiment Station and Director of Development for the College of Agriculture.

Over the years Phil has published numerous articles in the area of Weed Science.

Bert L. Bohmont

Bert L. Bohmont was born and raised on a farm and ranch combination near Wheatland, Wyoming. He attended high school in Wheatland and college at the University of Wyoming where he received a bachelor's degree in 1955 and a master's degree in 1956.

Bert was the State Agronomist for the Wyoming Department of Agriculture from 1956 until January of 1965. He served two years in the United States Army while on leave from the Department from 1957 to 1959.

Bohmont has been employed at Colorado State University since January 1965. He has risen through the ranks from assistant to full professor and is presently the Agricultural Chemicals Coordinator attached to the Dean's Office in the College of Agricultural Sciences. He took time out to complete the requirements for the Ph.D. degree in 1970 at the University of Wyoming.

During the past seventeen years, Bert has been heavily involved in activities concerning pesticides, including pesticide applicator training, IR-4 Minor Use Pesticide Registration, Pesticide Impact Assessment Programs, and has served on many boards and committees concerned with pesticide use and safety. In 1975 Bert developed the "Project Impact" slide/tape cassettes that were used nationally for pesticide applicator training and certification.

Bohmont has published a newsletter *Pesticide Pipeline* for over fifteen years and also has 76 articles and publications to his credit. In 1981 he wrote a book *The New Pesticide User's Guide*.

Bert was named "Spokesman of the Year" in 1973 in a joint recognition by *Farm Chemicals* magazine and Chevron Chemical Company. In 1977 he was honored with the Colorado State University "Distinguished Service Award."

Bohmont has been a member of the Western Society of Weed Science for approximately 20 years and has served as Chairman of the Education and Regulatory Section as well as Chairman of the Public Relations Committee for a number of years.

Lowell S. Jordan

Professor Lowell S. Jordan is a native of Oregon who grew up on a ranch. He received a B.S. from Oregon State University and a Ph.D. from the University of Minnesota. After graduation, he spend some time at Southern Illimois University as an Assistant Professor before moving to the University of California at Riverside. Present teaching responsibilities include Weed Science and Herbicide Physiology and Biochemistry. As Program Advisor for Plant Physiology and Pest Management Programs, he has worked with a large number of graduate students. About 30 Ph.D. and 40 M.S. students have received individual guidance from Dr. Jordan. He is presently major advisor for 7 graduate students. In addition, he has published over 200 technical and semitechnical articles concerning research in many aspects of weed science.

Dr. Jordan has served on numerous WSSA committees included Manpower and Placement, Policy and Site, Honors and Awards, Editorial, Long Range Policy and Planning, Local Arrangements, Monographs, Publication Coordination, Program, and Board of Directors. He is presently an Associate Editor. He was chosen to be a WSSA Fellow in 1980.

His Western Society of Weed Science service has included President, Program Chairman, Finance, Local Arrangements, Research, Executive, Fellows and Honorary Members Committees, and Representative to CAST. As a member of the CAST Board of Directors, he serves on the Membership, Budget and Finance, and Liaison Committees.

15. *New Business:*

a. President Ogg reported on a proposal from the Western Aquatic Plant Management Society that they affilliate with WSWS. Ogg appointed Neil Humburg and Dick Comes to work with him on developing recommendations to pass through the WSWS and WAPMS boards of directors.

b. The question of the suitability of summer WSWS meetings was raised by Harold Kempen. A straw vote indicated heavy preference for *not* shifting the meeting time to summer.

c. President Ogg relinquished the presidency to the new WSWS President, Wayne Whitworth, who expressed appreciation for the assistance he received as 1982 Program Chairman. President Whitworth adjourned the meeting at 9 a.m.

Written reports from WSWS Committees were filed with the secretary.

Respectfully submitted

Robert H. Callihan
WSWS Secretary

HONORARY MEMBERS OF WSWS

*Dick Beeler, 1976
Dale H. Bohmont, 1978
R. Phillip Upchurch, 1982

FELLOWS OF WSWS

Robert B. Balcom, 1968
Alden S. Crafts, 1968
D. C. Tingey, 1968
*Jesse M. Hodgsen, 1969
Bruce Thornton, 1970
W. A. Harvey, 1971
Boysie, E. Day, 1972
K. C. Hamilton, 1973
*Oliver A. Leonard, 1974
Clarence I. Seeley, 1975
J. LaMar Anderson, 1977
David E. Bayer, 1978
Louis A. Jensen, 1979
W. A. Anliker, 1980
J. Wayne Whitworth, 1981
Lowell S. Jordan, 1982

*Walter S. Ball, 1968
F. L. Timmons, 1968
Lambert C. Erickson, 1969
Lee M. Burge, 1970
Virgil M. Freed, 1971
*H. Fred Arle, 1972
Harold P. Alley, 1973
William R. Furtick, 1974
Richard A. Fosse, 1975
Arnold P. Appleby, 1976
Arthur H. Lange, 1977
Kenneth W. Dunster, 1978
Gary A. Lee, 1979
P. Eugene Heikes, 1981
Bert L. Bohmont, 1982

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*deceased

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