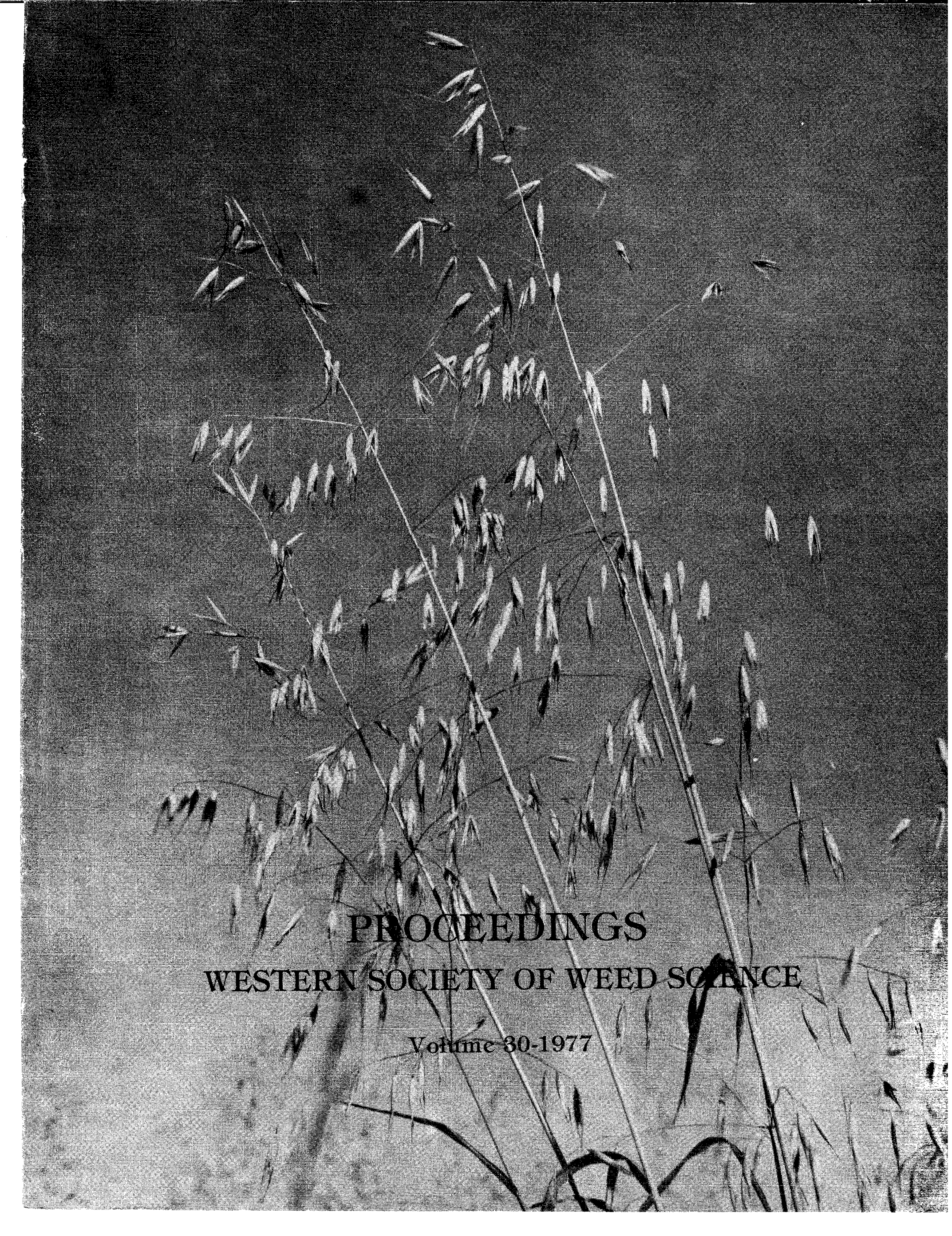

PROCEEDINGS

WESTERN SOCIETY OF WEED SCIENCE

Volume 30-1977

WESTERN SOCIETY OF WEED SCIENCE

1976 - 1977

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1977

PROCEEDINGS

OF

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PAPERS PRESENTED AT THE ANNUAL MEETING

MARCH 15, 16, 17, 1977

SENATOR HOTEL
SACRAMENTO, CALIFORNIA

PROGRAM AND TABLE OF CONTENTS

PRESIDENTIAL ADDRESS

CHALLENGES IN THE WESTERN SOCIETY OF WEED SCIENCE

Clyde L. Elmore[1]

It is a pleasure to be able to open this 30th meeting of the Western Society of Weed Science. This Society is unique among weed science societies.

The Western Society is the oldest (1938) weed society, older even than WSSA, it contains the largest area, has the fewest members, and covers an area of more diversity in crops, weather, topography, etc.than the other regional societies. It is also different from other weed science societies in that the program is project (workshop or discussion) oriented. This means also that we must work harder.

Since our theme is "Where do we go from here" I would like tp propose some challenges. Some of these challenges are for each of us as individuals and others are for the Society as a whole.

Individuals in the Western Society of Weed Science have a certain expertise that should be utilized in regulatory decisions and as sources for information. In the West most of our crops are "minor crops" or we have only small acreages of major crops, thus we should contribute heavily in minor crop research and registrations.

Individuals should participate in achieving more special local needs (24C) registrations. University personnel and industry should have informational input before registration is approved; also, before registration suspension. By cooperating in this area, needed safe registrations should be granted.

Individuals should participate in IR-4 registration (interstate when possible). We should also answer the question, "Is weed science being adequately serviced by IR-4, or is insecticide registration reaping the benefit, and if so what are we going to do about it?"

Individuals should become involved in crop protection economics! Determine the cost-risk questions on herbicides. Don't wait until a metropolitan senator suggests that every herbicide be banned before we pull together the information that hand weeding will quadruple the cost of lettuce on the consumer's table.

Individuals should promote an easing of registration requirements for non-food uses of herbicides. Once the toxicology of an herbicide is evaluated, must industry prove, and reprove, that when forest trees or ornamental plants are treated with an herbicide the application is safe. The concern is borne by the user, it's their plants that might be harmed.

How can the Society become more influential? One area is in development of the field of crop protection by calling them crop protection chemicals instead of "Pest Management", "Weed Control", or "Herbicides".

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[1]Department of Botany, University of California, Davis, CA 95616

A "pest" as defined by Webster is: a fatal epidemic disease; plague; anything very mischievous, annoying, or injurious. The entomologists seem to feel that pests = insects thus "Pest Management" is an integrated insect - insecticide or insect - biocontrol program.

Weed scientists should be in the forefront of crop protection. Push for crop protection programs, and push for funding of these programs. Most Pest Management Programs (funded by federal sources) are insect programs. At the University of California we have "Pest and Disease Control Guides". One would think you would find information on insects, pathogens, rodents, weeds, etc. pertaining to a crop. "Nothing on weed control". We have a separate publication, "Weed Control in Direct-seeded or Transplanted Tomatoes", for example. These should be Crop Production Guides: Weed Control.

Another area I feel the Western Society has a real challenge is in developing publications unique to western conditions. Expertise in these areas are in the west. Areas such as:

- Poisonous plants - the ecology and control in range areas
- Brush or weed tree management in conifer forests
- Management of brush in recreational areas
- Crop protection programs for vegetable crops
- Crop protection programs for tree crop and vines
- Crop protection programs in certain agronomic crops

These are but a few of the challenges before us.

As individuals we must take the responsibility to get involved in these areas. As a Society, we have the power that often individuals do not possess to make improvements, to provide information, so badly needed in plant protection in the west's agriculture.

PESTICIDE INDUSTRY'S RELATIONSHIPS WITH UNIVERSITIES IN THE FUTURE

Glenn C. Klingman[1]

In the area of Weed Science there is good reason to be evaluating the relationships between the university and industry. There have been more advancements in this area of science in the last 35 years than in all previous time. For the farmer and to the advantage of the consumer, the relationship has been a healthy, productive one. But, can it be improved? If so, how?

Looking at future responsibilities and potential contributions, I do not foresee many dramatic changes. I do see a need for better understanding of research conducted by each group and the objective or need for such research. For industry, the objective is a packaged product that fills a need. For the university, it could be a publication, it could be a public service including service to agriculture or it could be leadership training through students.

If properly developed in the future, Weed Science will help reduce energy requirements for food production, will help to increase food supplies - especially in underprivileged or developing nations and it will help to keep the grocery bill from unacceptable increases. It has implications of health,

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[1]Eli Lilly and Company, Greenfield, IN 46140

economics, environmental benefits and an adequate food supply not only for agriculture - but for mankind.

Weed Science includes the following methods of weed control:

1. Mechanical - tillage and mowing.
2. Crop competition with weeds for light, moisture, soil nutrients and carbon dioxide.
3. Crop rotation directly associated with chemical rotation.
4. Fire.
5. Biological - such as insects, diseases, parasitic plants.
6. Chemical.

Industry has concentrated on the chemical approaches. It is conceivable that industry may become more involved in biological weed control, especially where the method involves the production and distribution of insects or disease organisms. A "biological control insecticide" (*Bacillus thuringiensis)* has been marketed by industry in recent years.

Since industry is primarily concerned with chemical weed control, this paper will deal principally with the research, development and marketing of herbicides. The topic "Pesticide Industry's Relationships with Universities" implies a certain division of responsibility between industry and the university.

Before proceeding, I would like to recognize others that have kind enough to give me their thoughts on the subject - representing industry's point of view. These are: Dr. Will Carpenter of Monsanto Agricultural Products Company, Dr. D. L. Watson of Velsicol Chemical Corporation, Dr. Gid Hill of E. I. du Pont de Nemours and Company, Dr. Fate Thompson formerly of Ciba-Geigy Corporation, now North Carolina State University. And from Eli Lilly/Elanco: Jim Barrentine, Jon Hooks, Earl Jackson, Charles Moore, Stan Parka, Wally Rogers, George Shoop, Paul Thayer and Bill Wright.

First, I would like to cover the research done to get a pesticide cleared and a label approved by EPA and/or state regulatory agencies while at the same time satisfying company objectives of safety and efficacy. Most of this research is done by industry with some of the work done by universities. The discussion will be divided into four distinct areas as follows:

1. Chemistry of pesticide development.
2. Biological research done for pesticide development.
3. Environmental Studies.
4. Toxicology.

CHEMISTRY OF PESTICIDE DEVELOPMENT

In today's world no one can afford the 6 to 10 million dollars and 7 to 10 years development time without strong patent protection. Seldom can a university provide the chemical analog and chemical structure activity support needed for legal protection of a major product used worldwide. For example, in today's world and with today's costs, 2,4-D would not be developed - without patent protection. It would remain an academic curiosity. The world would miss the extra food produced as a result of 2,4-D use. Also, mankind would have missed the lift of the burden of hand weeding from his shoulders. Mankind's loss would be great, if such a chemical had not been developed. Patents are a must for such research and development programs to continue.

It is my opinion, and shared by those that responded on this subject, that industry is best qualified to do the chemical synthesis, analog synthesis and chemical structure activity studies necessary for patent preparation, submission to the patent offices and eventually patent protection.

Analytical procedures for plant, soil and animal tissues plus technical and formulated compound must be developed and submitted to EPA. For example, we must determine the presence or absence of the chemical and/or metabolites in crops, soils, water and in animal tissue if the crop is used for animal feeds. Analytical data are so important to other areas of research that industry must move promptly to develop these techniques. We cannot wait for data from a graduate student thesis. Thus, analytical procedures are nearly always first developed by industry. Several of those that responded commented that university workers have been especially helpful in collecting soil and plant residue samples.

Biochemistry research is also an important area. Pesticide degradation in soils with identification of degradation metabolites and decline curves must be developed. Plant uptake and metabolism in the crop must be reported. Soil adsorption, soil desorption, hydrolysis, volatility and partition coefficients must be determined. These data are required by EPA. In industry there is an urgency and high priority attached to getting this work done promptly to meet EPA requirements. Some companies depend upon university research to meet EPA requirements and regulatory agencies regularly support such research. It is important that some confirmation studies be conducted by either industry or governmental labs, but there should be an awareness that such studies are being conducted by industry.

Industry is normally responsible for formulation development and manufacturing processes. From the development of manufacturing processes and formulation development comes cost of manufacturing data. Quality control is important to the user and thus is of importance to the manufacturer. These areas have been left largely to industry development.

Often the university can work with regulatory agencies, such as EPA, to verify industry data and to further assess environmental hazards. At this time there is considerable duplication of effort in this area between industry and the university. There is good reason for at least limited confirmation studies.

BIOLOGICAL - PESTICIDE DEVELOPMENT

Biological studies are basic to the entire research program. Such studies build the foundation for future usefulness of the chemical. It starts with screening programs that indicate general biological efficacy. It was the opinion of several industry representatives that responded that some companies expect universities to screen their compounds; they felt that this is not generally fair to the university or to the use of public funds.

The first indication as to whether there is activity from foliar application, soil surface application or from soil incorporation is developed at this time - usually by industry. Crop tolerance and specific weed species controlled are important criteria in determining the future value of the chemical. The first tests may be conducted in the greenhouse.

Initial field trials are also usually conducted by industry. However, university researchers may effectively conduct various types of field trial experiments. It is at this point that major cost expenditures begin to develop. In the field trial experiments, research will further determine the spectrum of weed control and crop tolerance. University data could be more useful in getting labels approved by EPA if scientists are careful in recording soil types and more specific regarding data on weed species, rates of application and methods of application that are to appear on the label. Also, if EPA guidelines are specific about techniques and methodology, every effort should be made to use the prescribed methods. Following determination of weed control efficacy and crop safety, compatibility with other pesticides normally used on the tolerant crops will be researched.

Half-life studies and monitoring soil persistence are important to determine the duration of biological activity as well as environmental impact. Runoff studies and leaching studies are important in following the movement of the pesticide, in determining safe uses and often as an explanation of different plant responses on different soil textures and soil types. Laboratory studies may be conducted to simulate field conditions. Industry research will, of necessity, remain dominant in these areas - at least in providing enough data to get experimental permits from EPA and for EPA label approval. Long-term detailed or local situation studies in the above areas may be appropriately done by university researchers.

Crop rotation studies are extremely important to the farmer. If there are crop rotation problems, the farmer needs to be appropriately instructed so that he can plan accordingly. These studies are required by EPA prior to granting an approved label. University researchers can make significant contributions in conducting these experiments.

The experimental permit program is now largely conducted by industry. It is my opinion that university extension workers and the industry should cooperate in conducting experimental permit programs.

Technical information for use by marketing usually comes directly from industry plant science representatives. Frequently, university researchers, including Extension workers, also provide technical guidance and information to industry marketing programs and to market research programs.

ENVIRONMENTAL STUDIES

Environmental studies usually involve several research disciplines. To determine dissipation in the soil will likely involve an analytical chemist, perhaps a biochemist and a plant science field researcher.

The mechanism of degradation will probably involve a biochemist, analytical chemist, plant physiologist and perhaps a physical chemist. Radioactive studies may be needed. A microbiologist will likely determine the effects of the chemical on microorganisms and also the effect of the microorganisms in decomposing the chemical. All of the above may be involved in determining the chemical degradation in soil, air or water and the duration of biological activity.

Additional leaching and runoff studies may be needed to satisfy environmental concerns. These may involve radioactive materials. Soil bound materials that may be absorbed by plants will also be studied.

Special studies to determine the toxicity of the pesticide to fish, wildlife and birds must be conducted. Such studies must indicate the presence (amount) of such residues in the various organs and muscle tissues. Also, bioaccumulation in the food chain must be studied.

The above studies may be done by industry, by special contract research laboratories that have developed to do this type of research and by university researchers.

TOXICOLOGY

Toxicology requires both short-term and long-term studies. The studies are highly specializ3d and require specially trained toxicologists and pathologists to analyze and interpret data and slides made from various animal tissues and organs following termination of the experiment. Neither plant scientists nor agricultural university personnel are directly involved in these studies - either in industry or in the university. Therefore, I'll not discuss these tests further.

The university is singularly charged with the challenge of education, including both on-campus resident instruction as well as off-campus adult education. On-campus training includes both undergraduate and graduate training. Professional workers must be trained for university, regulatory and other governmental industry programs. Also, the university is best qualified, through its extension programs to educate the public in the safe and proper use of pesticides. The university is being further challenged at this time by the training programs mandated by EPA - as a part of the restricted pesticide application program. For Weed Science the "on-campus" area of resident instruction represents an area of weakness as I see it from industry. There are no standard curriculums for the training of weed scientists. We nearly always need to put new employees through a training period.

What do we in industry need as training for weed scientists? Usually we want a man with strong training in crop science or in horticultural science. Normally this includes courses in botany, plant physiology, crop science, horticultural science, soils and soil fertility, organic chemistry, statistics, plant pathology, entomology, weed science and taxonomy. A course in public speaking is suggested. Also, experience in the management of field plot research is helpful. To go into sales or marketing courses in sales, marketing and advertising are suggested. A farm background with crop production experience is a strong plus.

As a professor at North Carolina State University, for graduate programs I favored field research programs for the Masters Degree thesis. For the Ph.D. program I favored laboratory or greenhouse programs for the thesis. The end result was a student that had practical field experience plus strong laboratory and greenhouse experience.

The university also has one other major opportunity. Weed control programs are seldom dependent on one approach alone. The university researcher is best qualified to develop complete "season-long" or "integrated" programs for farmer use. He may want to use only one or he may want to use all six methods of weed control in his total program. This can also be called "systems research" in which the weed control program is fit into a more efficient crop production scheme. The university researcher is best qualified to fit this jigsaw together.

The farmer needs the unbiased comparison of available herbicides in a total weed control system. Costs, efficacy of weed control, crop safety, crop yields, etc., all need to be determined. He needs chemical control compared with cultural, biological, rotation, fire and crop competition. From such comparisons, strong recommendations to farmers become possible. From such research the farmer gets state recommendations for efficient weed control systems. Also, if a system should fail,the combined effort of industry and the university can jointly identify the problem and make appropriate recommendations.

Further, it is my belief, and also the belief of several that volunteered information without question from me, that certain aspects of weed science field research should be done by the Agricultural Experiment Station or the USDA - as done 10 to 15 years ago in many areas. These programs were between the university laboratory program and the farmer demonstration program. Such programs may be combination laboratory, greenhouse and field plot studies. Programs growing from this research are appropriate for farmer demonstration purposes. This work must be impartial or non-biased. Thus, support from special interest groups, including industry, should be kept to a minimum. In states where such programs have developed, farmer support is usually very strong. Farmers do not hesitate to talk to their state legislators in support of such programs.

One last observation made by a number of respondents. It is believed that the public would benefit and that the university and industry would benefit from forming weed science departments, comparable to those organized for entomology and plant pathology. The reasons for the existence of entomology departments and plant pathology departments apply equally to weed science.

Together - the university, the USDA, EPA and industry have a joint responsibility to develop weed control programs that allow production of an adequate and healthful food supply at a price the consumer can afford to pay. Cooperation between the university, the USDA and industry forms the backbone of efficient weed control in agriculture. Although there has been and will continue to be duplication, some necessary and for good reason, the total discipline of Weed Science is to be complimented for a job well done.

FEDERAL GOVERNMENT PARTICIPATION IN WESTERN STATES' NOXIOUS WEED CONTROL PROGRAMS

Dennis L. Isaacson[1]

ABSTRACT: Federally-administered lands represent a large proportion of the total area of the western United States. The occurrence of noxious weeds on these lands can cause serious problems for users of federal land and for adjacent landowners. Federal participation is widely recognized as an integral part of control programs organized on

[1]Oregon Department of Agriculture, Noxious Weed Control, Salem, Oregon 97310

a statewide basis, and several public laws are directly or indirectly concerned with control of noxious weeds on federal land. Until recently, however, the lack of appropriations for these laws has limited control efforts.

Special appropriations have recently been allocated to some federal agencies for noxious weed control. Both Oregon and Wyoming have entered into contracts with the Bureau of Land Management providing support for control efforts. Funds have been allocated to the U. S. Forest Service for weed control in the current fiscal year, and appropriations to both these agencies have been understood to be sustaining. One important factor in obtaining this support has been state participation in educating others about noxious weed problems and the need for all landowners to be involved in control programs. There is a continuing need for states to be involved in this educational process.

Future involvement of federal agencies in area-wide control efforts implies a need for close coordination with state and local weed control districts. To better coordinate these efforts and to promote interstate cooperation in matters related to noxious weed control on federal land, a regular forum is proposed for communication between western states regarding interaction with federal agencies.

WYOMING'S SUCCESS WITH FEDERAL WEED CONTROL PROGRAMS

George F. Hittle[1]

Wyoming's success with Federal weed control programs has not been an easy task. The Federal weed control program in Wyoming is being pursued under the Carlson-Foley Act.

INTERPRETATION of P.L. 90-853: You need statewide weed control programs to be eligible to participate under the Carlson-Foley Act (P.L. 90-853) 90th Congress S. 2671-10-17-68. States with effective weed laws and an active noxious weed control program with the coordination responsibility centered in the State Department of Agriculture would be eligible to participate. This appears to be the key provision of the act. State control of noxious plants occuring on Federal lands is very unlikely without assurance of reimbursement.

RECOMMENDATIONS: Cooperative aspects of action programs involving Federal agency; bureau and state field units should be coordinated and implemented through maximum use of local agreements under existing authorities.

PROBLEMS ENCOUNTERED: Appropriations received to date have been appropriated through other means and implemented through the Carlson-Foley Act. Approoriated funds for weed control have not been available for the past 15 years.

[1]Weed and pest coordinator, Wyoming Department of Agriculture

In order to formulate a successful program on Federal land we needed to organize our own state program. First step was passage of statewide weed (Wyoming Weed & Pest Control Act of 1973) Act creating Weed and Pest Control Districts in all counties (mandatory requirement). All land within the state of Wyoming is included in the Weed and Pest Control Districts including Federal, State and private and municipally owned land.

Success did not come easy. (Hard work by many individuals). Wyoming has some hard nosed weed fighters (this came about after 20 years of hard work by Dr. Alley), who we feel is one of the most outstanding weed specialists in the U.S.

Wyoming's programs are developed on theory to start at the top of watersheds and drainages and work downward without neglecting other programs already in effect. We only develop realistic programs. Wyoming has two types of weed control programs: 1. Cropland 2. Rangeland. The rangeland program will be the only one discussed here today because of Federal involvement.

The Federal government administers 51% of the land in Wyoming and controls the head waters where our programs begin.

As Wyoming's programs began to develop on private and state land, farmers and ranchers began to criticize the program because it lacked cooperation from Federal agencies. Serious noxious weed problems were beginning to develop on Federal lands in Wyoming. We were to the point that our own programs were going to collapse if we didn't get Federal participation in weed programs.

Several attempts were made to schedule meetings with various Federal agencies to discuss the existing problems and try to establish new guidelines and procedures. The government agencies response in most cases was encouraging, but due to various reasons and conflicts of schedules most attempts failed.

A decision was made in 1975 to send a delegation to Washington to discuss the issues with the appropriate groups.

First let me warn you before you decide to pursue a similar program. Do your homework, research existing laws, etc.; look for loop holes, find out where the money is available. At least five national laws direct that the Federal agencies develop renewable resources and control noxious weeds. Specific acts are: Bankhead-Jones Farm Tenant Act, Granger-Thye Act, Multiple Use-Sustained Yield Act, Carlson-Foley Noxious Plant Control Act and the recent Federal Land Policy and Management Act. No weed control on Federal lands is in violation of state and national law. Establish committees of both professional and non-professional (farmers and ranchers actively involved in weed control programs).

Letters were sent requesting our Congressional Delegation to schedule a Congressional meeting. In October of 1975, three cowboys, one farmer, one weed supervisor and a hard nosed professor of weed science headed for Washington, not really knowing what to expect. We arrived completely unknown, but by the time we left, I guarantee you they knew who we were and what our intentions were.

The problems were clearly put on the line and assistance clearly outlined, slides were shown depicting the problems in Wyoming. Discussion of economic and its relationship to the agriculture productivity of state was stressed.

A proposed amendment to P.L. 90-853; which states the "Federal Government shall implement and pursue an effective program for the control of designated noxious plants on land under their control or jurisdiction" was presented to Congress.

Through Wyoming's efforts we know who to contact from each Federal agency when weed problems develop.

Weed control programs should be budgeted as a line item entry with high priority established.

Each Federal agency is allowed to maintain their own restricted use pesticide list.

Agencies insisted that the program would have to be submitted by Wyoming before their group could offer the assistance necessary to develop and conduct the program.

We agreed to develop such a program providing Federal agencies finance their share. Providing funding becomes available for weed control programs.

The meeting resulted in everyone gaining a better understanding of the overall weed situation in Western U.S.; especially from the standpoint of the many different interests represented.

The meeting was a beginning for us and considerable follow-up and program planning was needed for implementation. Letters of encouragement from Federal agencies were received.

In December of 1975 we received word that B.L.M. was allocating $128,000 for Wyoming weed programs. This set the planning stages.

Knowing the money was allocated and putting it to work is two different things. Many problems developed. Plans had to be developed, budgets prepared; priorities established before a contract could be signed.

The contract called for: The state to develop, administer and coordinate a program to control noxious weeds upon national resource lands; including an inventory of noxious weeds and submit progress reports.

Priorities were established in cooperation with BLM, WDA and the Wyoming Weed and Pest Council.

Priority No. 1: Initiated control programs that were already backlog on BLM record.

Priority No. 2: Carryout weed inventory program on priority areas.

Plans called for a coordinated weed control program to include but not limited to following outline.

1. Updated weed inventory.
   - A. By all land ownership and weed species.
2. Identify agency for lead responsibility.
3. Develop a systematic plan for annual treatment.
   - A. Develop a 5-year plan to be updated annually.
   - B. Determine how many acres should be treated each year.
   - C. Coordinate with all landowners.
   - D. Determine specific areas where treatment will begin this year and acreage to be treated next year, etc.
   - E. Use herbicides that will accomplish the job.
4. Environmental considerations.
   - A. Joint preparation of Federal Environmental Analysis Report assess the weed program effect on the environment.
   - B. Prepare a pesticide proposal to include specific designated noxious weeds to be treated, chemical to be used for treatment, rate and method of application.

5. Follow-up program.
   A. This is the key to success; the issue was put on the line. The agencies were told without follow-up programs it would meet failure and the initial economic gains would be wasted.
   B. Practices considering techniques to prevent or reduce reinfestation following chemical treatment.

WYOMING'S WEED CONTROL PROGRAM 1976:

A. Weed control Programs:
   Wyoming Department of Agriculture entered into cooperative agreement with the Weed and Pest Control Districts to treat 1,273 acres of designated noxious weeds on BLM land at a projected cost of $70,088.00: equivalent to $55.00 per acre.

   Problems Encounted
   1. Obtaining approval on herbicides which would provide most effective weed control.
   2. Terrain, difficulty of treating weeds in nearly unaccessible areas.

B. Weed Inventory Surveys:
   1. Establish priority area to be surveyed for noxious weeds.
   2. Survey the program areas. Approximately 1,778,322 acres were surveyed at the cost of $71,132.00. Breakdown of cost was shared by BLM, State Land Office and Weed and Pest Control Districts.
   3. Compiling the survey information.
   4. Complete the information for approval of recommended herbicides.
   5. Project summary develop 5 year realistic plan (which includes):
      A. Problem Definition
      B. Project Methodology
      C. Project Outputs
      D. Project Impacts Upon Region
      E. Budget: Project for each of five years and updated annually.
   6. Environmental Analysis Report
   7. Weed control programs will be initiated this year on areas surveyed last summer.

Additional information from the 1975 Washington meeting:

In the summer of 1976 we received word that Congress had appropriated over $800,000.00 for noxious weed control on land administered by U.S.F.S. This is quite a contrast compared to $50,000.00 they received previously. Wyoming, received $150,000.00 of this money. Plans are being finalized at the present time to incorporate F.S. lands into program areas.

All of the appropriations so far are a direct result of the Wyoming Delegation going to Washington in 1975

I received many inquires from other states during 1976 wanting information on how we obtained the money.

After much consideration we selected three states out of eleven western states to attend a meeting in Cheyenne to discuss feasibility of expanding the weed program on Federal lands into Western U.S.

In September, 1976, a delegation from Wyoming and Nebraska headed for Washington. When we arrived this time they knew who we were and what we represented.

Forty-six persons attended the meeting, Congressional Delegation was present from Wyoming, Nebraska, Oregon and North Dakota. Nine Federal agencies were represented. Again the seriousness of the weed problems in Wyoming and why cooperation was needed from Federal agencies was outlined. We outlined what can be done to correct this problem using various types of control measures.

A. Biological Control
B. Chemical Control Methods
C. A combination of Herbicides plus mechanical practices.

The importance of the effective Range Improvement Program was also discussed.

We not only met with Congressional Delegation but expanded it and held eight individual meetings with various Federal agencies.

We demanded Weed Control Programs be initiated on Federal lands in Western U.S.

Keep in mind, we not only identified problems but offered some excellent solutions plus encouraged follow-up meetings.

Feedback from the meetings are starting to come in. We have already received comments on an additional $128,000.00 from BLM.

Wyoming's 1977 programs consists of two categories:

1. Survey Programs
2. Control Programs: a. Cropland b. Rangeland

Survey Programs: An approximately 1,000,000 acres at project cost of $35,262.00.

Control Program: Initiate Designated Noxious Weed Control Programs on approximately two million acres at a cost of $92,738 (on Federal lands only).

Wyoming 1977 Designated Noxious Weed Control Budget

Following is a break down of money allocated for designated weed control by various agencies. The amount shown is for actual control work and administrative costs.

Money allocated for 1977 fiscal year, for control programs.

State Agencies	Amount
Department of Agriculture	$35,000
Land Commission	25,000
Highway Department	40,000
Game & Fish Commission	10,000
Recreation Commission	10,560
TOTAL	$120,560

Administrative cost is projected at approximately 30 percent. This includes but is not limited to salaries, clerical, etc. $36,168.

Overall Total $156,728

Federal Agencies	Amount
B.L.M.	$120,000 & 123,000
U.S.F.S.	150.000
Bureau of Reclamation	15,000
A.S.C.S.	100,000
B.I.A.	15,000
TOTAL	$523,000

A. Valuation losses in taxes caused by designated and declared weeds to state of Wyoming is estimated at $1,701,317.00 per year (private land only).

B. Gross agriculture income is approximately $410,200,000.00 of which is being produced on 26,578,355 acres (private land per year, losses caused by designated and declared weeds are equal to $8,801,876 lost income per year to farmers and ranchers in 1976.

C. Economic losses caused by designated and declared weed to state of Wyoming is estimated at approximately $20,510,000.00 per year.

Other On Going Federal Programs:

A. B.I.A.
B. National Park Service
C. Bureau of Reclamation
D. One new Federal program we are pursuing is with A.S.C.S.

After two years of working with A.S.C.S., the A.S.C.S. is going to participate in designated noxious weed control under practice SB-12 and S-1 of AC Program.

We feel the A.S.C.S. Weed Control Program is one of the most beneficial programs available to the American Agriculture Industry.

The agriculture outlook is not very promising for 1977 and Wyoming is going to do all it can to encourage farmers and ranchers to pursue effective weed control programs.

In summary, Wyoming will use all its tools to help Western U.S. pursue effective weed control programs on Federal land, but a word of warning, don't get caught riding our shirt-tails.

GROWTH PROMOTING EFFECTS OF AN OXIDATION PRODUCT OF INDOLEACETIC ACID

V. McMahon[1]

ABSTRACT: Our hypothesis that 3-methylene oxindole (MeOx) acts as a natural plant growth regulator was tested in the coleoptile tissue of wheat (*Triticum aestivun*) seedlings. Coleoptiles were selected which had attained a height of 3-5 cm after 72 hours of growth, their terminal meristem was removed by excising the top 3 mm of tissue and discarded, the remaining coleoptile tissue was aged for 4 hours, and the next 5 mm segment was excised for the bioassay of auxin. Segments were floated in varying concentrations of indole-3-acetic acid (IAA) and MeOx. Our data show that optimum concentrations for growth are 1×10^{-5} and 1×10^{-8} for IAA and MeOx, respectively. These data are consistent with our mung bean (*Phaseolus vulgaris*) studies which show the same response.

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CONTROL OF WEEDS IN ALMONDS AND PISTACHIOS

A.H. Lange, H.J. Schlesselman, L. Nygren, B. Fischer, H. Kempen, G. Stevenson and R. Vargas[1]

ABSTRACT: Almonds and pistachios require good weed control. In order to bring young orchards into bearing in minimum time, weeds must be kept under control. Young trees do not compete well with weeds and weed growth interfers with harvesting, as they come into bearing. Most of the almonds are furrow or flat flood irrigated, but an increasing acreage is being sprinkler irrigated, particularly on new hill plantings. Most pistachio orchards are either sprinkler irrigated or utilize drip irrigation. Likewise, most new pistachio plantings in recent years have been planted on rolling land suitable only to sprinkler or drip irrigation. Preemergence weed control is effective either as a strip down the tree row or more recently as a broadcast application in some soils.

Herbicides such as napropamide, oryzalin, prodiamine, oxadiazon, oxyfluorfen, and norflurazon show considerable advantage over simazine selectively where widely different soil and irrigation variables exist as in most of California.

The most important perennial weeds are controlled by the incorporation of trifluralin coordinated with postemergence spot treatment with herbicides such as MSMA, 2,4-D, and glyphosate. These herbicides can be used effectively in trees, providing the herbicides are not allowed to drift and are kept off the foliage.

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EFFECTS OF DAYLENGTH ON THE FLOWERING OF REDROOT PIGWEED

J. L. Anderson and F. B. Salisbury[1]

A photoperiod response among native broad-leaved annual plants is the rule rather than the expection (Vince-Prue, 1975). We would almost expect such a summer annual to respond to short daylength. In the course of gathering data for a growth and development model of redroot pigweed (*Amaranthus retroflexus* L.), we investigated its response to daylength. Preliminary studies indicated that seedlings grown under 8-hr daylength for 7 consecutive days developed inflorescences at the terminal node within 14 days and continued flowering at each successive node. Seedlings grown under 16-hr daylength did not develop inflorescences until 6 weeks later when the plants were 40 to 50 cm in height.

This study was designed to determine the minimum daylength that would induce flowering, the response to an increasing number of consecutive short days, and the developmental stage at which redroot pigweed becomes receptive to a photoperiod stimulus.

MATERIALS AND METHODS

Redroot pigweed seeds were sown onto 10 cm pots of moistened potting medium containing equal parts of peat moss, firbark, perlite, and vermiculite in a 20 C greenhouse with supplemental lighting to provide 18-hr daylength. Following germination, seedlings were thinned to four per pot.

To determine the minimum daylength that will induce flowering, plants were grown under 8, 10, 12, 14, or 16-hr daylengths for 15 consecutive days and then returned to the standard 18-hr daylength conditions. To determine how many consecutive short days are required to initiate flowering, test plants were subjected to 1 to 15 consecutive 8-hr days and then returned to standard long-day conditions. Plants were observed for inflorescence development for 50 days following treatment.

To determine what effect plant age might have on the photoperiod response in redroot pigweed, seedlings in the cotyledonous stage, having one true leaf or having 2 to 3 true leaves, were grown for five consecutive days of 8-hr hadlength, then returned to the 18-hr daylength greenhouse. All experiments were replicated eight times.

RESULTS AND DISCUSSION

Minimum Daylength

A dramatic effect of daylength upon flowering in redroot pigweed was observed. Inflorescence development in plants receiving 12-hr or shorter daylength was visible 11 days after the beginning of the induction period. The results after 28 days (15 days treatment plus 13 long days) are shown in Figure 1. It is interesting that 100% of the seedlings exposed to 12-hr daylengths bloomed within a month, whereas only 6% (two seedlings) flowered under 16-hr daylengths. It would appear that the critical day-

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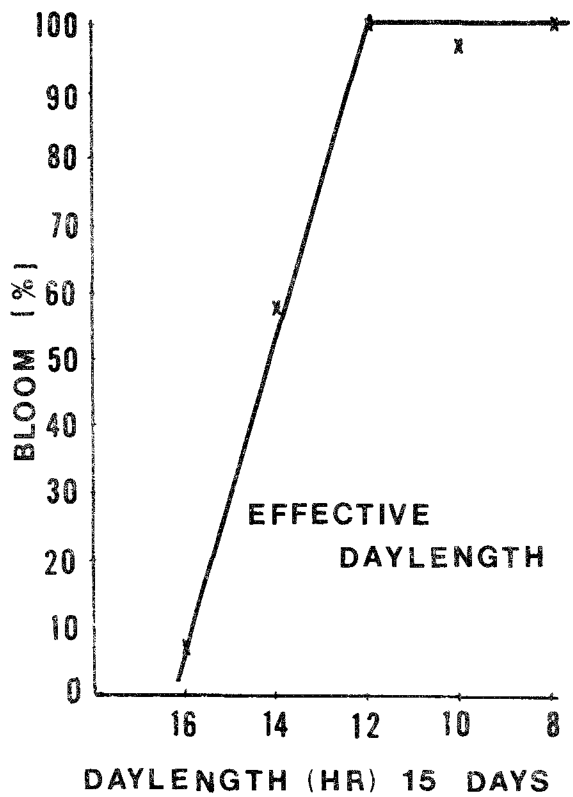

Figure 1. The effect of 15-day daylength treatments upon subsequent flowering of redroot pigweed seedlings.

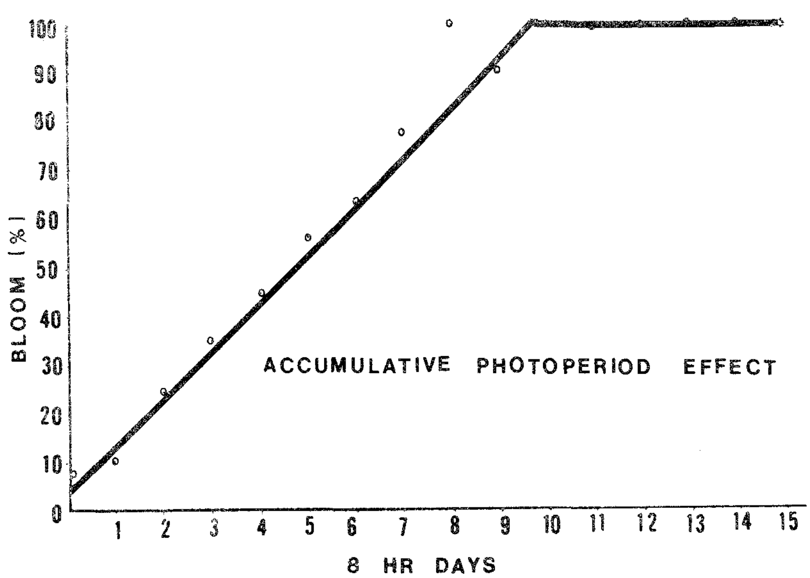

Figure 2. The accumulative effect of short daylengths upon subsequent flowering of redroot pigweed seedlings.

length for flower initiation is about 14 hrs. Some range of response is expected in a seedling population.

Length of Inductive Period

The cumulative effect of the number of 8-hr daylengths on flowering is shown in Fig. 2. On an individual plant basis, flowering was either an all or nothing response. Once a plant responded to the photoperiod stimulus, it flowered at every node. On a seedling population basis, the percentage of plants responding to daylength was directly proportional to the number of sonsecutive days of short daylength exposure. Evidently, some seedlings were just at the threshold of their response when a given treatment terminated, since the response of these seedlings was delayed. Twenty days later the percentage of seedlings in bloom had increased in all treatments (Table 1).

Table 1. Effect of consecutive short days on flower formation in redroot pigweed.

Length (days of	% Seedlings in Blossom	
8 hr daylength	After 28 days	After 48 days
0	6	44
1	11	32
2	24	52
3	35	57
4	45	76
5	57	79
6	64	93
7	77	100
8	100	100
9	90	100
10-15	100	100

Effect of Seedling Age on Photoperiod Response

Redroot pigweed seedlings subjected to five 8-hr days while in the cotyledonous or first-leaf stages of development did not flower within a 50-day period after treatment, whereas 80% of the seedlings in the 2 to 3 leaf stage had developed an inflorescence during that period. Based on these studies, it would appear that some minimum age or leaf surface is required before redroot pigweeds are receptive to photoperiod. However, we have seen seedlings in the field and greenhouse in bloom during late autumn that were only about 1 cm in height. Perhaps temperature or some other factor might also influence flower initiation of redroot pigweed.

Redroot pigweed shows the photoperiod response of a typical quantitative short-day plant (Vince-Prue, 1975). Flowering was strongly promoted by short days, but all plants bloomed when they reached a height of 45 to 60 cm, whether they had been exposed to a short daylength or not.

LITERATURE CITED

Vince-Prue, Daphne. 1975. Photoperiodism in Plants. McGraw-Hill Book Company, London. 444 p.

EFFECTS OF PICLORAM ON LEAFLET ULTRASTRUCTURE OF VELVET MESQUITE AND CATCLAW ACACIA

C. A. Bleckmann, H. M. Hull, and H. L. Morton[1]

ABSTRACT: Previous field and laboratory studies have indicated that picloram (4-amino-3,5,6-trichloropicolinic acid) is more effective in controlling *Acacia* species than *Prosopis* species. In the present study, greenhouse-grown seedlings of velvet mesquite [*Prosopis juliflora* var. *velutine* (Woot.) Sarg.] and catclaw acacia (*Acacia greggii* A. Gray) were used. Within 1 hr of application of the herbicide to upper leaflet surfaces, ultrastructural changes were evident. In both species, initial effects were noted in chloroplast structure, where unusual finger-like projections extended into the cytoplasm. These structures, which contained no grana, were present 1 and 3 hr after treatment but had disappeared after 8 hr. The presence of these structures was also related to the application of the surfactant X-77. They were more highly developed in treated *Prosopis* than treated *Acacia*. An extensive, loosely organized membrane system was occasionally observed within the vacuole of *Acacia*. Also, a dense structure, apparently consisting of concentric membranes, seemed to develop from the membrane system. Similar, but less symmetrical, structures were occasionally observed in untreated plants of both species. A temporary proliferation of endoplasmic reticulum was noted in *Acacia* 27 hr after treatment with no comparable development in *Prosopis*. By 72 hr the cell contents of *Prosopis* were showing signs of damage, but the symptoms (shrunken cytoplasm, disrupted chloroplasts) were much more severe in *Acacia*. This preliminary study indicates that the ultrastructural effects of picloram, as its morphological effects, are more pronounced in *Acacia* than *Prosopis*. The actual mode of action is not yet completely known.

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SOME EFFECTS OF GLYPHOSATE ON THE FOLIAR ULTRASTRUCTURE OF VELVET MESQUITE SEEDLINGS

H. M. Hull, C. A. Bleckmann, and H. L. Morton[1]

ABSTRACT: In studies with greenhouse-grown seedlings of velvet mesquite [*Prosopis juliflora* var. *velutine* (Woot.) Sarg.], we applied either 1,000 or 10,000 ppmw ai of the isopropylamine salt of glyphosate to the upper surfaces of centrally located leaves. All treatment solutions contained 0.5% v/v of a nonionic surfactant, X-77. Within 1 hr after application, although no visible injury was evident on the treated leaves, transections of individual leaflets showed alight swelling of the chloroplasts and the emergence of numerous curious protuberances, enclosed within the chloroplast envelope. Some contained an inner core of cytoplasm, possibly resulting from an invagination in the protuberance. Although many of the protuberances

contained what was apparently stroma, none contained a framework of grana and connecting frets. Protuberances of this nature have been reported in recent Italian works on supposedly normal foliage of *Arisarum* and several other genera. We had not observed it before in the literature nor in the ultrastructural studies of normal leaves of *Prosopis*. By the 5th hr after treatment, the chloroplasts appeared round and turgid, with some of the thylakoid units swelling into myelin-shaped figures; grana were disintegrating in a few of the chloroplasts. By the 4th day, even in the leaf below the treated leaf, all chloroplasts had become largely disrupted, and increasing numbers of plastoglobuli began to appear. At this time mesophyll cells of the treated leaves were largely plasmolyzed, and the cytoplasm and organelles had severely shrunken and condensed in the ends of the cells. Starch grains had completely disappeared. Although leaves treated only with the X-77 did not show visible damage, a few chloroplast protuberances were present, even within 1 hr. Unlike leaves receiving glyphosate, however, the protuberances did not contain cytoplasm. Some chloroplast degeneration was evident with the X-77 alone after 4 hr, but only in the treated leaves. These observations suggest a multi-faceted herbicidal mechanism, including the possibility of photosynthetic inhibition and an accelerated rate of normal senescence.

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CHARACTERIZATION OF BLACK AND HAIRY NIGHTSHADE

A. G. Ogg, Jr.[1]

ABSTRACT: Nightshades are becoming increasingly prevalent weeds in the irrigated croplands of the western United States. There are several major species, and because of their differences in growth habit and possible differential tolerance to herbicides, it is important that they be correctly identified. A polling of weed researchers in the western United States indicates that frequently hairy nightshade (*Solanum sarachoides* Sendt.) has been identified as black nightshade (*Solanum nigrum* L.). Further confusion has arisen because several similar appearing "black" nightshades may be present also. A taxonomical key characterizing the major species of nightshades will be presented. Hairy nightshade can be readily separated from the various "black" nightshades by the presence of many fine hairs on the stems and leaves, the large calyx that clasps the berry, and the greenish berries at maturity. Separation of the various "black" nightshades (*Solanum nigrum* L., *S. nodiflorum* Jacq., and *S. americanum* Mill.) appears to be more difficult, and taxonomists often disagree on their characterization.

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DIFFERENTIAL TOLERANCE OF SMALL GRAINS TO METRIBUZIN

R. H. Callihan, S. W. Gawronski, and B. L. Potter[1]

ABSTRACT: Thirty-eight small grain cultivars of wheat, barley, and oats were treated with soil and foliar applications of metribuzin to define differences in herbicide tolerance among genotypes. Leaf discs cut from plants grown in untreated soil were placed separately in metribuzin solutions to test and develop a sinking leaf-disc method for determining tolerance differences among small grain cultivars. There was relatively good correlation between greenhouse and laboratory results. Oats were most susceptible to metribuzin and had the smallest range of response among cultivars tested. Wheat was less susceptible to metribuzin but had the widest range of response among cultivars. Barley was least susceptible to metribuzin and had a wider range of response among cultivars than oats, but a narrower range of response than wheat cultivars. Information on varietal tolerance may be important in situations where metribuzin is present as a soil carryover herbicide or where it is to be applied postemergence. Laboratory and growth chamber results suggest the sinking disc technique may be one method of discerning plant sensitivity and tolerance and of screening small grains for genetic resistance in parents and progeny.

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WILD OAT SYMPOSIUM

PREFACE

Gary A. Lee[1]

Wild oat (*Avena fatua L.*) has been a major weed problem throughout the world and is emerging as a serious problem in many crop systems in the western United States. Adaptations of farming practices to reduce labor and power requirements have enhanced the wild oat problem. This species is spreading into areas previously uninfested as well as intensifying in areas where little or no economic problem existed. In order to develop adequate and effective control measures for this weed species, research efforts must be focused on the biology of the plant, and herbicidal and cultural control measures.

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Producers must be aware of the potential problems associated with wild oat through extension and educational programs. It is apparent that wild oat problems are quite different in each geographic area of the western United States. As cropping systems change, the need for different control measures occurs. Research and extension efforts must define the particular problems within a given agronomic area. A broad approach to wild oat control must be utilized if infestations are to be effectively diminished.

Communication among the research and extension personnel is an important aspect in developing effective control programs. Thus, the Western Society of Weed Science has provided the membership an opportunity to share research results, action programs, and to stimulate interaction between weed scientists involved in the control of this serious weed problem.

WILD OATS: GLOBAL GLOOM

John D. Nalewaja[1]

Introduction

Wild oats originated in the Pamir, a plateau of central Asia where the Hindu Kush, Tien Shan, and Himalayan mountains converge (4). Neolithic man started the movement of wild oats from the center of origin and more recently with world trade, wild oats became distributed throughout the world as an economically important weed infesting small grains wherever grown.

The common name wild oats applies to several species and subspecies. Plants of the *Avena* genus which can survive in nature are referred to as wild oats. The major *Avena* species which infest cultivated crops are *A. fatua* L., *A. sterilis* ssp. *ludaviciana*, *A. sterilis* ssp. *macrocarpa*, *A. barbata*, and others as well as hybrids of the various species and subspecies.

All subspecies of *A. sterilis* are identified by the basifracture of the rachilla during separation of the second floret from the first. The abscission layer is evident as a suckermouth on only the first floret of the spikelet in this species. All seeds of *Avena fatua* have the suckermouth appearance since the abscission layer is formed at the base of all florets. *Avena barbata* is similar to *A. fatua* except that the seed is more slender with a lemma which ends in two points and is tetraploid rather than a hexaploid.

The distribution of the various species of wild oat has been described by Thurston and Phillipson (4), and Bachthaler (1). These reports along with personal communication with various people throughout the world are the basis for the following endeavor to catagorize wild oat infestation levels and crop losses from wild oats worldwide.

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[1]Professor of Agronomy, North Dakota State Univ., Fargo, ND.

Wild oats appear to be a problem wherever small grains constitute the major crops in a rotation. The great diversity within and among wild oat species provides a weedy type adaptable to various regions of the world where either fall or spring small grains are grown.

WILD OATS DISTRIBUTION AND LOSSES

An attempt was made to identify areas and densities of wild oat infestation throughout the world and to estimate crop yield losses caused by wild oat competition. Various individuals were contacted for information on locations of wild oats and levels of infestations. Based upon these responses and on information from the literature, production losses were estimated by the author. The percentage infestation levels used and the average yield losses are given in Table 1. The production loss was based upon crop area and yield per area using 1971 agricultural statistics. World wide production of wheat in 1976 was about 20% greater than in 1971. Consideration was given to the yield level and present use of wild oat control practices in determining percent infestation and yield loss. For countries where direct losses were available, these values were used.

Wheat and barley only were considered; and, yield losses for the two crops were combined in the production loss given. It is believed by the author that the estimates used to predict losses were conservative, based upon situations where losses were documented from competition experiments. Further, percentage yield losses were claculated on present yields with wild oat competition and not on the potential yield had wild oats not been present.

The preciseness of the yield losses may not be important relative to production losses. The importance is that one weed species, wild oats, causes tremendous reductions in the world food supply.

Losses presented do not take into account any indirect losses caused by wild oats, e.g., transportation costs, dockage, or control expenditures which are also very important in addition to yield losses when assessing the cost from an infestation of wild oats.

North America

The distribution and density of wild oats in North America are presented in Figure 1. Heavy infestations occur throughout the prairie provinces of Canada, the western half of the United States with the heaviest infestation in the north, and throughout the wheat growing areas of Mexico. Infestations are high in many areas of North America with 20 to 40% yield losses in some areas. Wild oat infestations in wheat fields at harvest in North Dakota were estimated at a level to cause 20% or more yield losses in 40% of the fields in 1973, a year with high wild oat density. Indications exist that infestations may be nearly as great in Mexico in many years as in North Dakota and Canada. The food production losses from wild oats in North America are estimated at a staggering 6,388,000 metric tons annually (Table 1).

Table 1. Estimated wild oat infestations and production losses in wheat and barley throughout the world.

Area	Estimated wild oats: Infestations Wheat (%)	Infestations Barley (%)	Yield losses Wheat (%)	Yield losses Barley (%)	Annual yield losses in wheat and barley (Metric tons)	
North America						
Canada	--[a]	--	--	--	3,500,000	
Mexico	--	--	--	--	188,000	
U.S.	--	--	--	--	2,700,000	
Total						6,388,000
South America						
Chile	5		30		15,000	
Columbia	40	30	20	15	9,200	
Equidor	25	15	20	16	4,200	
Peru	20	15	15	12	6,900	
Argentina	10	5	15	12	114,000	
Total						149,300
Europe						
Belgium	25	25	10	10	37,400	
France	25	25	10	10	617,500	
W. Germany	35	35	10	10	441,000	
Italy	10	10	10	10	103,600	
Netherlands	25	25	10	10	28,400	
Austria	No Information					
Denmark	35	35	10	10	212,000	
Finland	25	20	10	10	33,000	
Greece	35	30	15	15	146,000	
Ireland	Minor Problem					
Norway	30	30	15	15	28,800	
Portugal	10	10	10	10	9,100	
Spain	20	20	12	10	209,600	
Sweden	25	20	12	10	66,700	
UK	25	20	10	10	291,000	
Total						2,224,100
Russia	30	15	17	12		2,874,000
E. Europe	15	15	15	12		848,000
Asia	1	1	12	10		103,000
Australia	15	10	15	10		242,100
Africa						
Algeria	15	10	15	12	25,500	
Egypt	Minor Problem					
Ethiopia	5		10		1,400	
Kenya	5		10		1,600	
Moracco	10	5	15	10	44,000	
S. Africa	15		12		28,800	
Tunisia	10	10	15	12	10,300	
Total						111,600
GRAND TOTAL						12,940,100

[a] Assumption was that 11 million hectares are infested of which 6 million are at economically important levels in the U.S. -- and 13 million moderately infested in Canada. The value for Mexico is based on surveys and competition experiments.

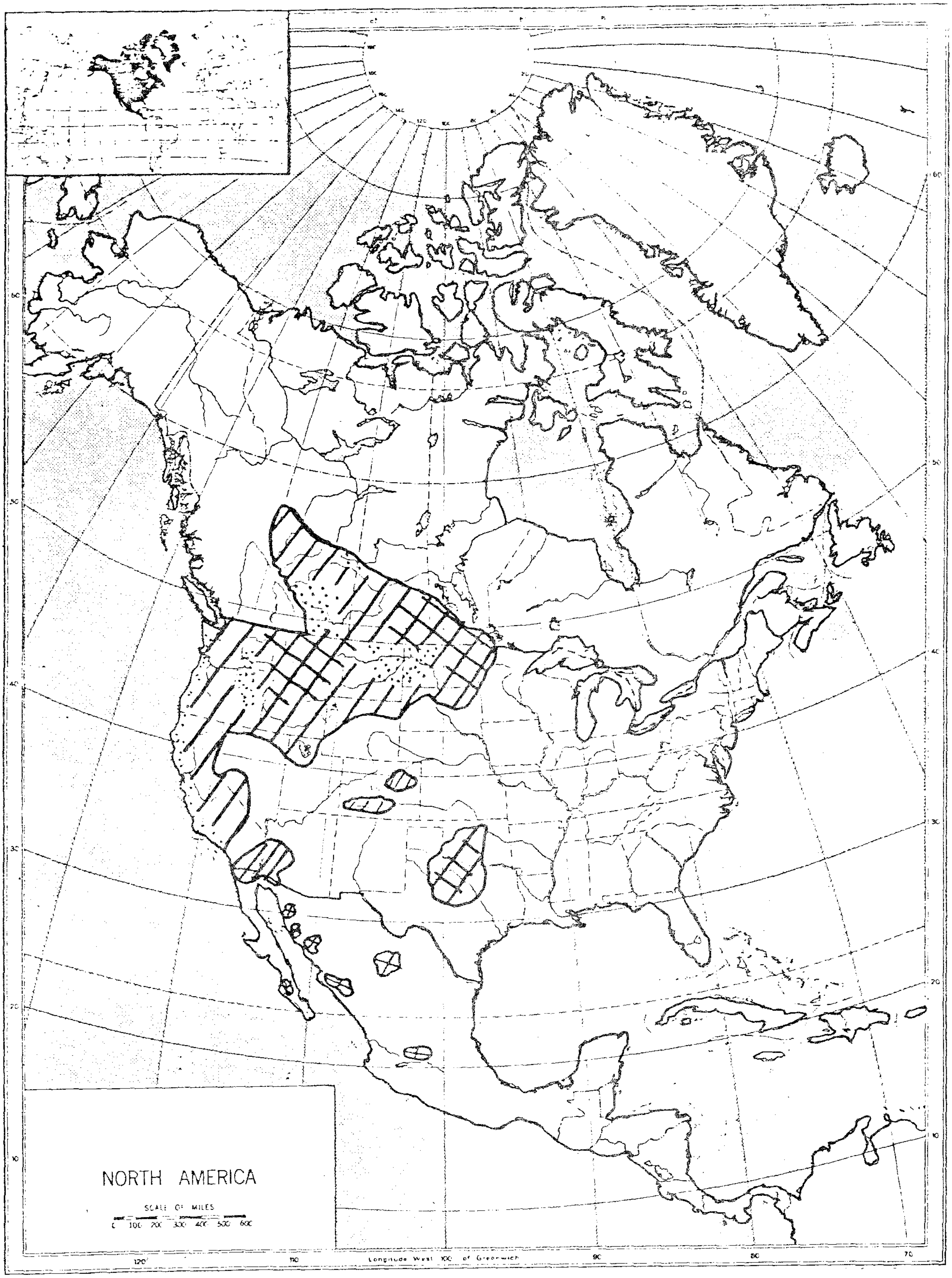

Figure 1. Distribution of wild oats in North America. Crosshatching represents area of heaviest infestation and dotting area of lighest infestation.

South America

Primary wild oat infestations occur in Columbia, Chile, Argentina, Peru, and Ecuador. Infestations are heavy in a high percentage of the small grain fields in Columbia (Figure 2). In Chile, the main infestations are in the areas growing small grains intensively south of Santiago with high crop yield losses in the infested fields. Infestations of wild oat in Argentina apparently are less dense but still important in the small grain region in the south central part. Apparently wild oat is of no consequence in Brazil or other countries of South America not mentioned above.

The total wheat and barley production loss from wild oats in South America is estimated at 149,300 metric tons. This estimate is less than the loss estimated for Mexico which was based on field surveys. Thus, the production loss from wild oats for South America may be greatly underestimated.

Europe

The areas of wild oats infestation, the species, and density are all well documented for Europe (1, 4). Wild oats, considering all species and subspecies as a group, extensively infests agricultural land from Denmark, Norway, and Sweden to the Mediteranian Sea, and from the United Kingdom to East Europe including most of Russia (Figure 3). Reports indicate that infestations occur in East Europe extending into Asia. Precise data on infestations in East Europe are for the most part limited. However when considering the sporatic reports, the cropping sequences, and the type of farming, the assumption is that wild oats could be a major problem in much of the area. Wild oat has been reported in South Bulgaria, Czechoslovakia, East Germany, Southern Poland, Romania, Russia, and Yugoslavia.

Estimates on yield losses from wild oats in Europe were not given in the literature or volunteered by the people surveyed. However, values for wheatand barley losses from wild oats were estimated by the author and are given in Table 1. The percent yield losses were estimated at a lower level than for North America because of the higher yield levels, possibly greater use of control herbicides, and greater use of winter type grains.

The wheat and barley production loss estimated for Western Europe was 2,224,100 metric tons or a loss slightly less than that estimated for the United States (Table 1). The loss in production in Eastern Europe and Russia was 3,722,000 metric tons. The yield losses were estimated to be slightly higher than for Western Europe and degree of infestation slightly lower than in Western Europe.

Africa

Wild oat infestations are apparently scattered throughout small grain growing regions of Africa. However, the total area infested appears to be rather small, possibly relating to areas of small grains (Figure 4). Specific reports indicated that wild oat infestation was light but widespread in Ethiopia. Kenya has a small area with moderate infestations but some wild oats may occur throughout the area.

Figure 2. Distribution of wild oats in South America. Crosshatching represents area of heaviest infestation and dotting area of lightest infestation.

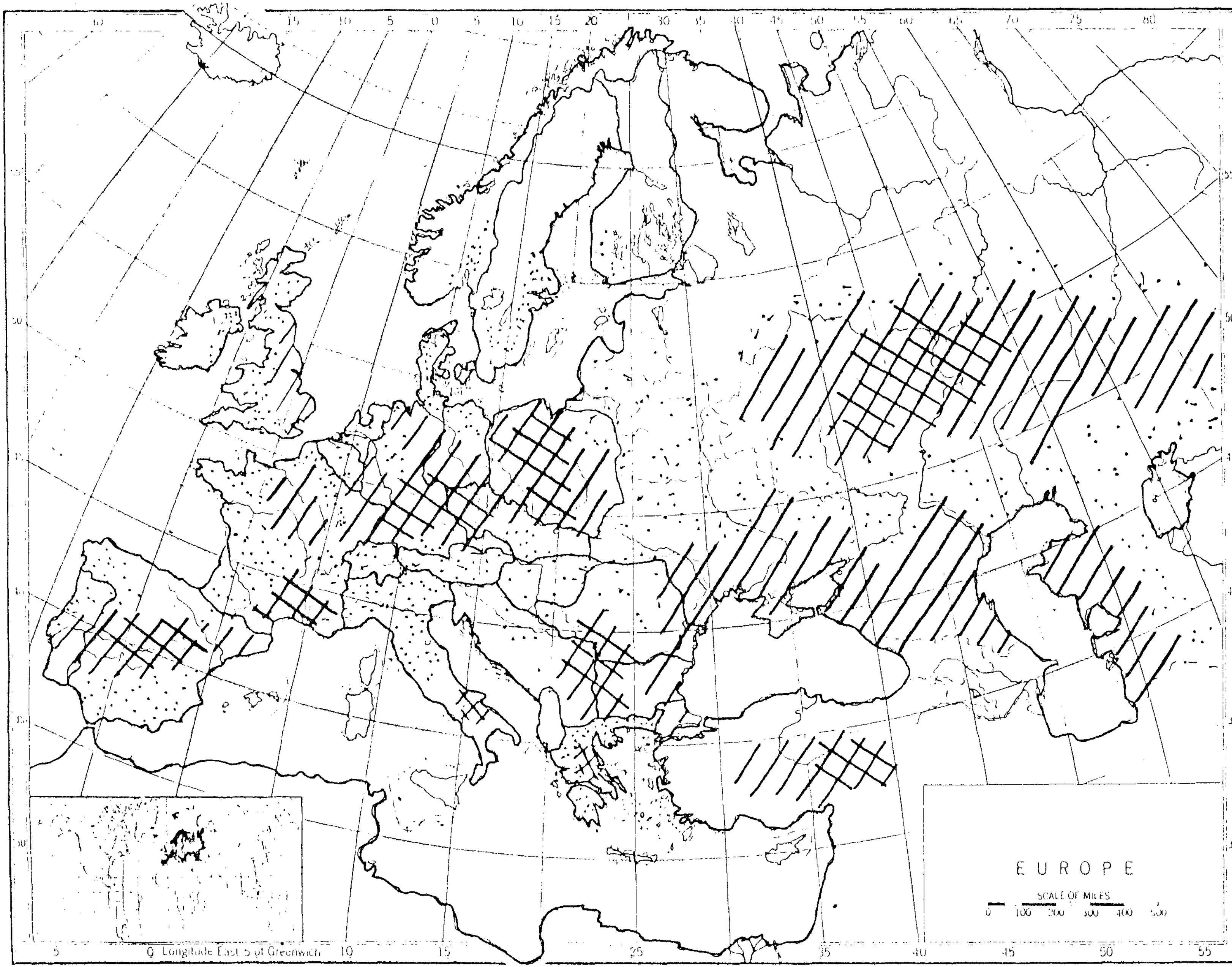

Figure 3. Distribution of wild oats in Europe. Crosshatching represents area of heaviest infestation and dotting area of lighest infestation.

South Africa has light to moderate wild oat infestations in the Cape Province. Moracco apparently has a heavy infestation in Fex-Meknes region and some infestations throughout cereal growing regions. Tunisia has known infestations near Tunis. Wild oats infest the lower lands of Algeria, and is known to be present around Tripolitania and Cyrenaica in Libya, and Kilimanjaro in Tanzania, with some infestations possibly throughout the country. Egypt may have some wild oat but is not acknowledged as a problem in agricultural production. Rhodesia has only a small area infested. The production loss for Africa was estimated at 111,600 metric tons. This value probably is low as the percent yield losses for the infested area are very conservative.

Asia

Wild oats is widespread throughout Asia (Figure 5) as might be expected for the area considered as the origin of the species. Infestations occur in the north, south, and west areas of Turkey. Wild oat infestations in Iran are light, occurring mainly in Khuzistan in the south central near the Persian Gulf, an irrigated area, and Azerbaijan which is in the north. India is now recognizing a problem in the northern area, but wild oat infestations may still be light. Apparently, wild oat infestations are increasing here with the growing of short strawed wheats. Pakistan has only light infestations in the Punjub region. Syria has wild oat infestations in the Aleppo-Ragga, El Hascki regions. Iraq was reported to have fairly heavy infestations of wild oats-Lolium mixture. China is known to have wild oats especially in the north. However, reports indicated that human labor is used extensively and quite effectively for wild oat control. Wild oat was reported to occur in Korea, but levels of infestation were not indicated. Cereal production losses for Asia (not including Russia) are estimated at 103,000 metric tons. Infestations were estimated at only one percent because of apparent good control in China and limited infestations in India, areas of rather high wheat production.

Australia

Fairly extensive wild oat infestations occur throughout the southern coastal regions of Australia with densities ranging from light to moderate (Figure 6). New Zealand has infestations; but, small grain production is rather limited.

No attempt was made to determine the actual acres infested. In Table 1, area infestation percentages are given, but if these were multiplied by the crop areas, the total area infested would probably be underestimated. The percentages of acres infested with wild oats did not necessarily include all infested areas.

The total wheat and barley production loss from wild oat competition world wide was estimated at more than 12 million metric tons. Thus, wild oat is preventing the production of food enough to feed 52 million people at the subsistance level. Fifty two million is the entire population of a country like Mexico or nearly 100 times the population of North Dakota. The devastating impact from this weed on human food production is astounding when considering that wild oat also infests crops other than wheat and barley and causes many indirect agricultural costs. Great

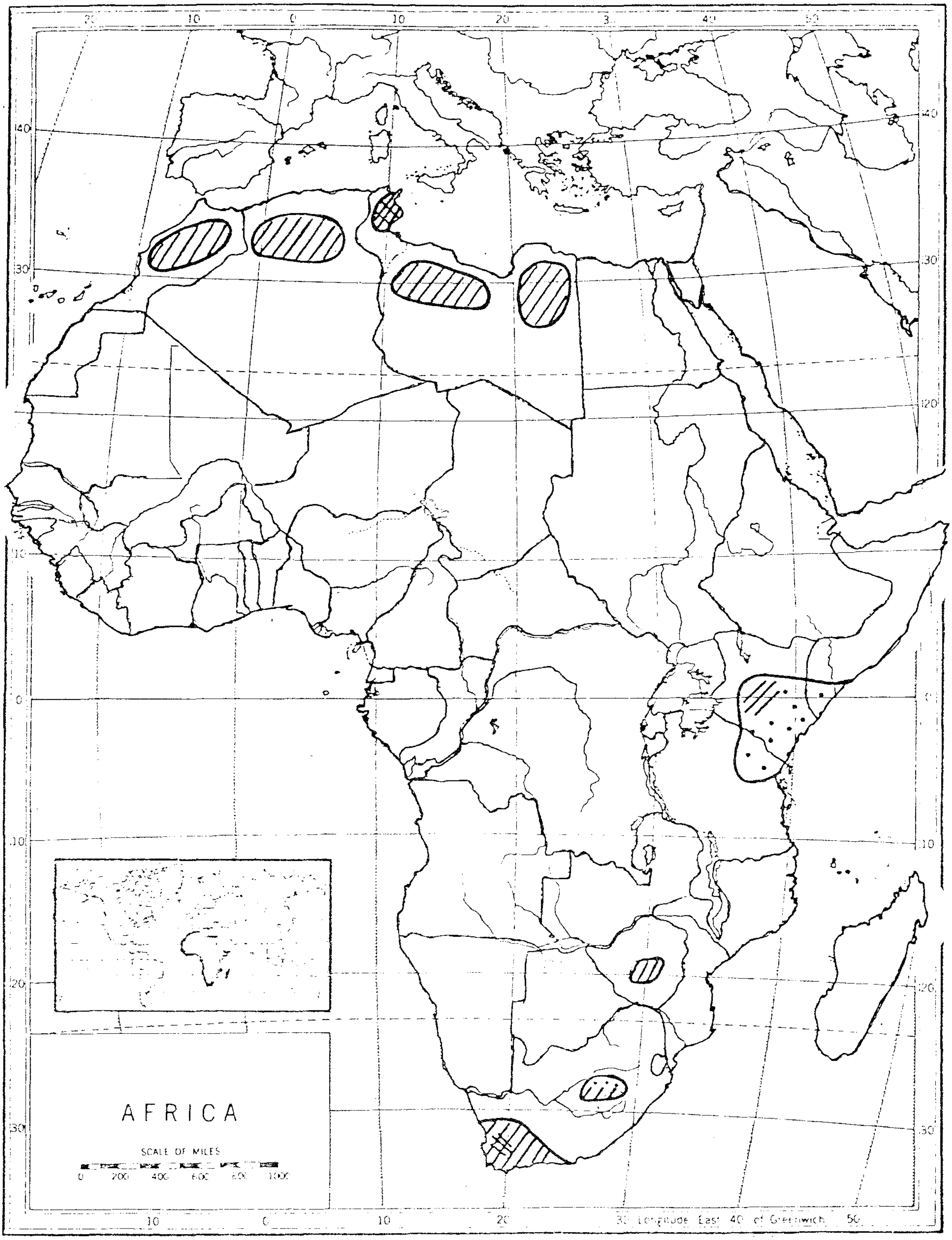

Figure 4. Distribution of wild oats in Africa. Crosshatching represents area of heaviest infestation and dotting area of lightest infestation.

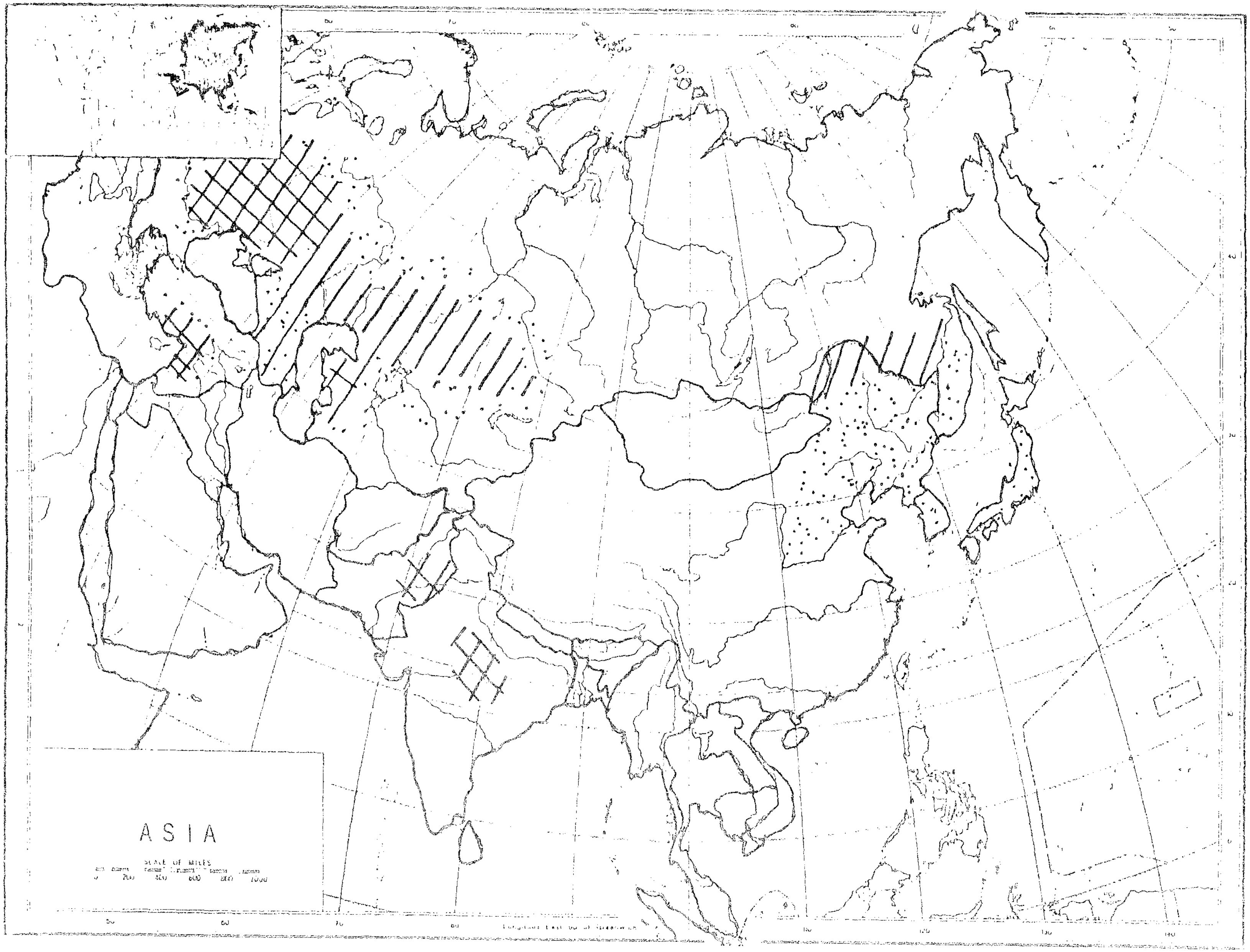

Figure 5. Distribution of wild oats in Asia. Crosshatching represents area of heaviest infestation and dotting area of lightest infestation.

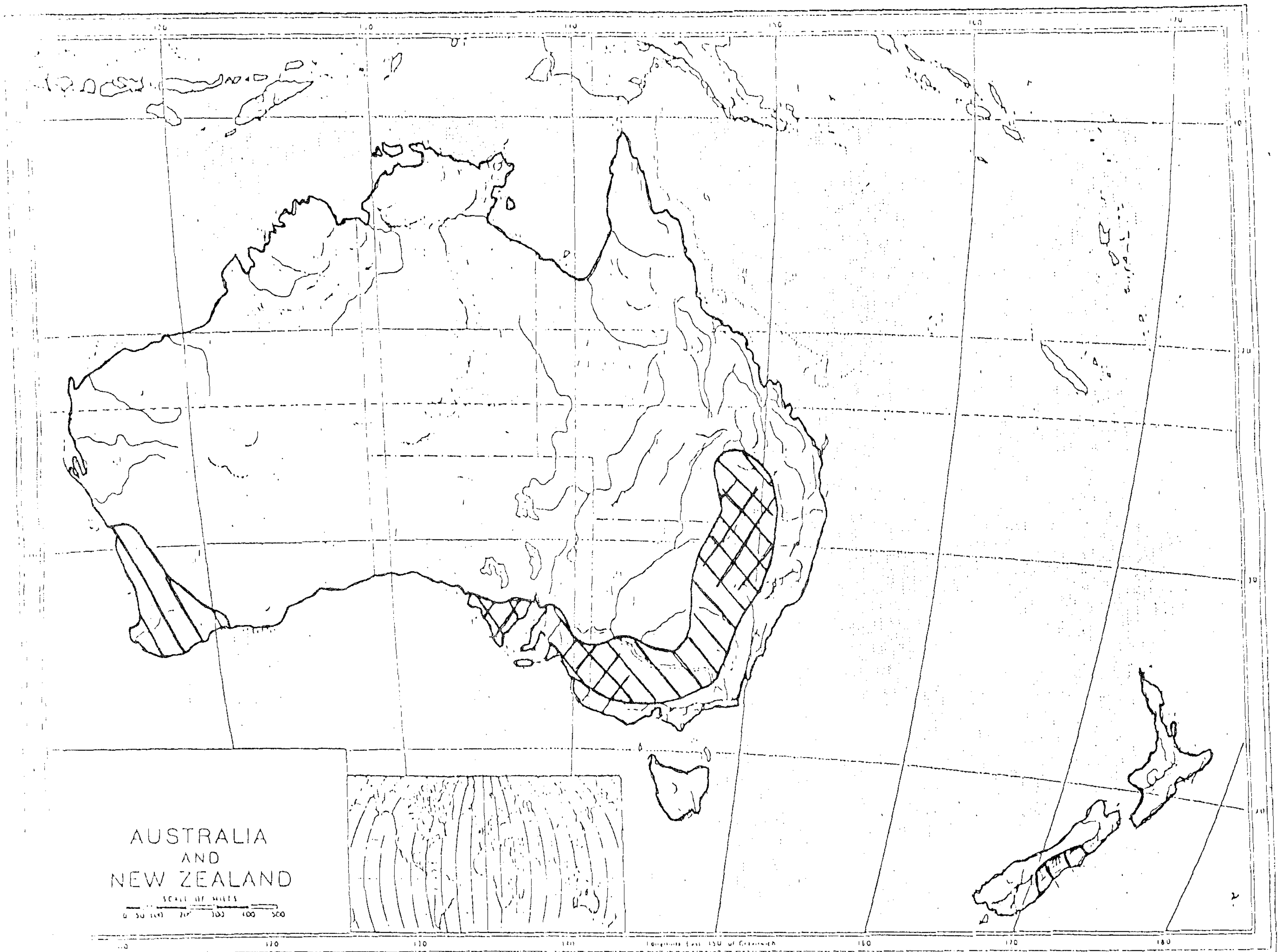

Figure 6. Distribution of wild oats in Australia. Crosshatching represents area of heaviest infestation and dotting area of lightest infestation.

expenditures of human, chemical, and mechanical energy are required in agricultural production and marketing because of wild oats. For example, estimates were reported that in 1969-1970 nearly 600,000 tons of dockage were shipped to terminal elevators in Canada. A high percentage of the dockage was wild oats. The wheat and barley losses would have been even greater had 1976 production values been used.

Wild oat apparently has been increasing around the world in recent years. The indicated increases in wild oats may have been partly from greater awareness of the importance of weed competition in reducing crop yield. However, wild oat infestation increases probably have actually occurred because of the increased use of the combine for harvest which unfortunately returns a higher proportion of the wild oat seed produced directly back to the soil. The reduction in crop rotations in some areas and better control of other competing weeds have led to increased wild oat infestations. The introduction of short strawed crops has been reported to reduce crop competitiveness and increase wild oats. The relatively high cost of herbicides has prevented their wide spread usage for wild oat control in crops with low infestations or where yields are low. Thus even through available, herbicides have not greatly reduced areas of wild oat infestations.

In summary, wild oat is found in every corner of the world where mainly small grains are grown and is reducing world food production. Wild oat varies greatly in genetic make-up giving wide adaptability to various climatic regions as well as characteristics for future survival as an economically important weed.

ACKNOWLEDGEMENT

The author wishes to acknowledge the prompt and exceptional helpfulness of the many people contacted around the world. Many of these people were obviously very concerned and spent a lot of time from their busy schedules for the preparation of a detailed response to my request for information on wild oats. They are not listed individually, as I did not obtain permission from them for citation.

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SEED DORMANCY IN WILD OATS

C. I. Seely[1]

Seed dormancy has been recognized as a major factor in wild oat (*Avena fatua* L.) control and has been studied by many workers, using many methods since the excellent work of Atwood was published in 1914. This discussion will attempt to give a report on what is known about dormancy and to a degree some of the methods used to study it and some of the possible reasons for the lack of agreement in results. No attempt will be made to credit individuals with their specific accomplishments.

In discussing dormancy perhaps it would be well to agree on a common terminology since many classifications have been used. I shall use the classification used by the committee of the National Academy of Science which divided dormancy into innate, induced, and enforced. Broadly speaking, innate dormancy is immediately expressed inherited dormancy such that seed will not germinate when placed under favorable conditions of moisture, temperature, oxygen, and light. It includes immature embryos, impermeable seed coats, mechanical compression, inhibitors, etc. Induced dormancy is also inherited but requires some factor in the environment to activate it. Enforced dormancy is caused by a lack of one or more essential factors in the environment such as moisture, unfavorable temperature or lack of oxygen.

Enforced dormancy in many cases is the most important of the three types and should receive more consideration than it has in control programs. Since it is largely a question of management, it will not be further discussed here.

Induced dormancy was probably first recognized in Canada in the late thirties when it was pointed out that alternate light wetting and drying could induce dormancy and suggested working the soil after harvest to completely cover the seed and protect it from light showers. Later other workers showed that placing moist seed at favorable growing temperatures in an atmosphere of pure nitrogen would induce dormancy. Others showed that excessive moisture (restricted oxygen supply) would also induce dormancy. The effect of low temperatures in inducing dormancy is not clear but excessively high temperatures apparently induce dormancy. Further work certainly needs to be done with induced dormancy so that it can be avoided in the field.

Innate dormancy has been the most widely studied form of dormancy and various methods have been used in studying it. Atwood showed that there was dormancy after ripening of the embryo which was independent of the water content. He suggested that impermeability of the seed coat to oxygen was a major factor in dormancy but that exclusion of water was not a factor. Since that time many workers have confirmed his work and have used his suggestion of breaking the seed coat and increasing the oxygen concentration in the atmosphere to reduce dormancy. Others have shown that the addition of gibberellic acid reduces dormancy and also treatment with KNO_3 has some benefit. Apparently light has not been a factor. Unpublished work by the writer has shown that stratification

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of the seed at a temperature of 4 C between moist blotters for 3 weeks will almost completely eliminate dormancy. The removal of the hulls has given inconclusive results as well as studies of the length of dormancy. Some genetic studies have indicated that "delayed germination" is an inherited recessive character in crosses between tame and wild oats. The writer crossing different strains of wild oats arrived at the conclusion that there was little if any dominance or that dormancy was slightly dominant.

Hybridization has been a very useful tool to this writer in studying dormancy although there are a couple of difficulties associated with the method. The peduncles of wild oats are rather delicate and this combined with rather tightly adhering lemmas and paleas makes hybridization difficult and especially with some strains which are poor pollen producers. The net result was some crosses had less than 1 percent set, and the average for all hybrids was only 9 percent. Since rather high populations are necessary for accurate germination tests, the number of florets that must be crossed becomes very large. The other difficulty is the large amount of rather tedious work required in dehulling and pricking seed coats and that this must be done in a relatively short period of time. Together the two problems limit the use of the method largely to an indicator of what may be involved in dormancy. However, this combined with studies of naturally occurring strains can lead to information that would be very difficult to arrive at without hybridization. Since in the wild oat the hull and seed coat are maternal tissue, the endosperm is 2/3 maternal and 1/3 paternal, and the embryo is 1/2 maternal and 1/2 paternal, by making reciprocal crosses it is possible to determine the location of the dormant factor in the seed by comparing the reactions of the reciprocals to that of the parents. If the reciprocals germinate alike, the factor is in the embryo. If they behave like the maternal parent, it is in the hull or seed coat and by removing the hull one can determine which. If it is in the endosperm, the reciprocals will not be alike; but each will tend to be like the maternal parent but not be like it. By this means it was determined that there was an endosperm factor in dormancy as well as a hull factor. Further studies on the hybrids indicate that there are probably two genetic factors for dormancy in the hulls. One of these is an inhibitor, but the other may be a factor for tightness of hull which would restrict oxygen exchange. The presence of the inhibitor was indicated by removing and replacing the hulls which loosened them and permitted the entrance of oxygen. One hybrid studied in the F_2 generation indicated two factor segregation. At least one of these may be a lack of gibberellin in the embryo which requires time for activation. Atwood suggested that an increase in embryo acids might be a factor in reducing delayed germination, and the effect of added gibberellic acid would support this. In this test 5 classes of dormancy were indicated, ranging from very low to very high dormancy with transgressive segregation taking place.

In studying some 60 different collections from Washington, Oregon, Idaho, Utah, Montana, North Dakota, and Alberta the presence of at least 3 types of dormancy was demonstrated with a high probability of 5 and perhaps 6. Of these one was an inhibitor in the hull, a second a factor for seed coat impermeability to oxygen, a third immature embryo, and a fourth an inhibitor in the endosperm. Some of these factors appear to be localized to certain areas while others appear to be pretty generally distributed. In all it appeared that 5 classes of dormancy could be distinguished in the population which was similar to that found in the genetic studies. The variability in strains and areas no doubt accounts for the lack of consistency in reported studies on wild oat dormancy by different workers. Three other factors that have been studied also contribute to the general confusion. these are location of the seed in the panicle, the condition under which the seed was produced, and the length of time after harvest that the tests were run.

The position of the seed in the panicle has a very marked influence on the dormancy exhibited and hence its selection may well determine the results obtained. Within the spiklet the lowest (primary) floret produces the least dormant seed, the second (secondary) floret the next most dormany and the third (tertiary), when present, the most dormant. This appears to be true irrespective of strain or condition under which produced and may differ by as much as 2-3 years.

The position of the spikelet in the panicle also influences dormancy with the upper portion usually the most dormant, the middle intermediate, and the lowest the least dormant; but this may vary somewhat depending upon strains and the condition under which the seed was produced.

The conditions under which the seed is produced can have an appreciable effect on dormancy although it is not highly predictable. Generally, seed produced in thin stands are less dormant than in stick stands, seed produced in peas is less dormant than in winter wheat, and seed produced in spring wheat less dormant than in peas.

In general, it would appear that seed which has the shortest period between flowering and maturation is the most dormant; but as indicated above, there are exceptions depending on strain and perhaps other factors.

The length of time that innate dormancy will continue is obviously a function of the type of dormancy involved. Immature embryos alone usually last for only a few weeks and both inhibitors and impermeability to oxygen for a few months. The inhibitors in the endosperm appear to be oxidized, and hence when combined with a seed coat impermeable to oxygen, the effect is cumulative and dormancy may last for a year or more. If this is further combined with a factor for tight lemmas and paleas which further restricts oxygen penetration, dormancy may extend for a couple of years or more. Secondary and tertiary seed from dormant strains have shown little germination for two years, and in some cases only small germination in three. Obviously, when a germination test is run will determine the results obtained.

In my own studies to avoid some of the variables only plump primary seed usually from the lower half of the panicle were used in the tests, and these were normally germinated twice, first about 2 to 3 months after maturity and again about 6 months after maturity. In most cases two check samples were used, one from a highly dormant strain and one from a relatively non-dormant strain. When the former was just showing 1 or 2 percent germination and the latter was in excess of 85 percent, the full range of dormancy could usually be evaluated.

WILD OAT PROBLEMS AND CONTROL--EASTERN ROCKY MOUNTAIN REGION

R. L. Zimdahl[1]

This paper briefly explores WHAT the wild oat problem is, HOW it is presently being controlled and WHY our control efforts are not more successful on the eastern slope of the Rocky Mountains. Some suggestions for future research are cited.

The Problem

Wild oats can be a problem in barley, oats, spring wheat, winter wheat, sugarbeets, alfalfa and corn. They are not a bad problem in winter wheat and can be controlled with available herbicides in the other crops mentioned. The availability of herbicides to do the job does not mean that it is done only that it is possible to do it. However, the most important problem in our region is in spring grains, particularly barley, because it is the most important spring grain. Our experience has been that the wild oat problem arrives with spring grains and increases when they are grown.

A significant portion of the problem in barley is due to the fact that most but not all of the wild oat seed shatters and falls to the soil prior to harvest. Thus, maintaining the soil seed supply and contaminating harvested grain.

Control

Cultural control is a viable option but is not the complete solution. It is often not practiced for rotational reasons and never offers dramatic results. There are adequate data to show that wild oat populations are lower when spring grains follow sugarbeet or potatoes as opposed to corn or another small grain crop. We do not recognize any advantage for techniques of delayed planting or spring cultivation because of yield losses that ensue. Growers of brewing barley do use clean seed but some other growers may still be planting wild oats and increase their own problem by ignoring this fundamental principle of cultural control.

Triallate is the only preplant incorporated herbicide available. It is commonly used at 1 to 1.25 lb ai/A and results in 50 to 90% control. Barban is one of two postemergence herbicides. It is widely used, often with two applications, but it is not always successful. Use of barban is always better than doing nothing, but it never gives perfect control. Part of the reason for its lack of success is the well known periodicity of wild oat seed germination. Another reason is that ground sprayers usually apply more than five gallons of solution per acre which is the maximum recommended.

Difenzoquat, the second presently available postemergence herbicide, is not used widely because it is so new and has a high cost. It has the advantage of being active when the plant has from 3 to 5 leaves. Use of difenzoquat will reduce the wild oat problem but it is not a complete solution. HOE-23408 has shown excellent promise and seems to be active when the wild oat has from 1 to 5 leaves which is an added advantage. We think the greater time during which effective control can be achieved, is good and earlier control will lessen crop competition which later

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applications may not do.

The greatest potential for excellent control from herbicides lies in judicious use of combinations. The goal should not be limited to control in the year of application, but should include the greatest possible reduction in seed returned to the soil and ultimately elimination of the soil's wild oat seed potential. Some growers are already exploiting the benefits of rotational control by using combinations of triallate and barban or difenzoquat. In many cases, good to excellent control can be obtained with triallate and no further herbicide applications are required. If needed, subsequent application of a post-emergence herbicide has proven to be beneficial. It has been difficult to show a yield increase from combinations but we usually show a significant decrease in wild oat seed yield--an equally important goal.

Future Research and Needs

1. Maintainance of the search for new and better herbicides. We have not found the perfect herbicide for wild oat control in small grains and the market is large enough to warrant further exloration.

2. More exploration of herbicide combinations and their advantages.

3. Greater understanding of the biology of the wild oat plant. Could we control or eradicate the wild oat more effectively if we understood it better? What are the possibilities for inhibiting or stimulating seed germination? At present the possibilities are limited but this seems to be a fruitful area for future research.

4. We need better extension. This is not a stated or implied criticism of the present extension effort but rather a recognition of the fact that we in research have not provided the information extension needs to "sell" wild oat control. What are the benefits of control? Do we have sufficient competition data, including data on competition resulting from failure to control seed production, to establish the real benefits of control. I think not. We know the costs of control, but we do not know the costs of inadequate or no control. Perhaps my plea should be for longitudinal research. This is research that integrates, and extends over a long enough period to define all costs and benefits. Have we over emphasized what practice 'X' will do this year and failed to realize what it didn't do over several succeeding years?

WILD OAT PROBLEMS AND CONTROL--WESTERN ROCKY MOUNTAIN REGION

J. O. Evans[1]

The yield loss of grain, corn, sugarbeets, or potatoes infested with a moderate stand of wild oats (150/m^2) is from 20-25%. Losses begin very soon after germination by the competition of wild oats for water and plant nutrients. Competition increases with increasing wild oat numbers, probably due to the greater demand for water and nutrients from wild oat growth. Some investigators have reported, however, that wild oats spaced at greater distances between plants simply tiller more abundantly and consequently produce about the same amount of dry weight on a unit area basis.

The prospects for controlling the spread of wild oats or for controlling them in the Western Rocky Mountain Region are disappointing. It will likely continue to infest additional acreage. Presently about half of the irrigated barley and oats has some degree of wild oat infestation. this will undoubedly increase unless a new technique or herbicide is introduced, which is superior to the procedures now in effect. Their control will also require that growers become more aware of the significance of wild oats and interested in their control.

Wild oat control is extremely difficult. Seed dormancy and afterripening are complicating factors, together with the natural variability that exists in a population, making it extremely unpredictable in any given period of time. The persistence of seeds in the soil and their ability to sprout over a period of years is frustrating. It is a rewarding experience for the individual who arrempts to control wild oats and is successful but disappointing when he tries to repeat his success and fails miserably. It appears that no control program is absolutely reliable and, in fact, effective means for control of wild oats is likely to fail about as often as it succeeds. A good stand of grain will compete strongly with wild oats but is not capable in and of itself of keeping wild oats efficiently in check. In addition, a good stand of grain established ahead of the wild oat germination is nearly impossible due to other climatic or agronomic problems associated with the intermountain region. Farmers have relied upon fall planted grain as a means of control. Recent surveys have shown wild oats are increasing in the fall grown wheat and barley, possibly as a result of new or different types of wild oats developing in the area. Cultural control of wild oats in row crops such as corn, potatoes, and sugarbeets has proven to be very effective. Cultural practices have been helpful in small grains but are limited since tillage operations cannot be accomplished once the crop is up. Delayed planting in spring wheat and barley has been extensively practiced and quite successful but limited due to a rather limited period of spring grain planting to realize the potential grain yield. Shallow cultivations during the early spring period can eliminate previously germinated oats and encourage a new flush to appear and repeated tillage can be important steps to satisfactory control. Post-planting tillage can be important and is being used satisfactorily to eliminate some wild oats which germinate ahead of the crop and to incorporate herbicides for

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continued control.

Diallate, triallate, and barban share the primary role of chemical control of small grains in the region. Triallate is probably the most popular pre-plant or pre-emergence treatment used. The herbicide is applied before planting and mixed into the soil with a tandem disc to a depth of 2.5 inches or used immediately after planting and incorporated with a flex-tine harrow about 1-1.5 inches deep. Diallate is used in a similar manner but recently has had application only in crops other than small grains. Most producers are pleased with the performance of these herbicides. Wild oat control ranges from 80-95% in nearly all treated fields. The greatest objection to triallate is the possibility of injury to wheat or barley. Under conditions of environmental stress such as cold, wet spring weather, which delays the emergence of the grain crop, the herbicide can cause severe loss of stand and vigor.

Barban is used rather extensively in the area with limited success. Attempts are made to apply it while the wild oats are in the two-leaved stage, using high pressure spray and limited gallonage of water with the nozzles pointed forward about 20^{0}. The optimum results with barban are observed if the wild oats are in the one- or two-leaf stage. Since wild oats generally germinate over a two-three week period after seedbed preparation, the results with an herbicide that is dependent upon the wild oat reaching a uniform stage is limited. At 6 oz per acre, barban treatment controls a high percentage of the wild oats, nearly 100% of those in the two-leaved stage. Since not all wild oats are in the two-leaved stage simultaneously, and the germination interval may be over a three-week period under certain conditions, the average wild oat control at season end in fields treated with barban is not as high as with triallate. Limited research has indicated that combination of herbicides such as post-emergence treatment with barban following pre-plant applications of either triallate or diallate are very effective. Additional studies are in order to determine dosage required for crop safety and registration.

New herbicides for wild oat control are being evaluated by researchers and farmers. Difenzoquat and HOE-23408 look promising. Difenzoquat can be applied when the wild oats are in the three to five-leaved stage. Earlier treatments tend to favor higher yields of wheat and barley but not as good wild oat control. Wild oat control improves when the plants are in the five-leaved stage but the grain yields suffer. HOE-23408 is an exciting compound in that wild oat control is excellent and grain shows excellent tolerance to the herbicide.

The greatest problem in controlling wild oats in this region stems from the great variation in germination of the weed and its unpredictable character as a weed. We do not know the biology of the plant including the many facets of seed dormancy. In addition, the presently available herbicides are unsatisfactory because of wild oat's unusual behavior.

WILD OAT PROBLEMS AND CONTROL - EASTERN PACIFIC NORTHWEST REGION

D. G. Swan[1]

Wild oat is an increasing problem. The short strawed wheat varieties and possible herbicide resistance by wild oat biotypes are factors in this increasing problem.

There are an estimated 1,000,000 acres infested with wild oat in this area and the acreage is increasing. For example, in the Ritzville, Washington, area where sprinkler irrigation is expanding, wild oat is becoming a problem. Percentage infestation by crop is:

Crop	%
Wheat	47
Barley	23
Peas	20
Lentils	10

The estimated loss from wild oat is $15 million per year.

Table 1. Herbicides used for wild oat control.

Herbicide	% Acreage Sprayed	Appl. System	Rate lb/A	Range of Control %
Diallate (Avadex)	15	Pre or Postplant incorporated	0.75-1.00	60-90
Triallate (Avadex BW)	30	Pre or Postplant incorporated	1.00	60-90
Trifluralin (Treflan)	3	Pre or Postplant incorporated	.50-1.00	60-80
Barban (Carbyne)	10	Postemergence	.38	50-70
Difenzoquat (Avenge)	Registered 1977	Postemergence	0.75-1.00	70-90
HOE-23408 (Hoelon)	Not Registered	Postemergence	.75	60-80
MSMA (Phytar or Bueno 6)	Not Registered	Postemergence	3.00	80-90

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Combinations of these herbicides are being tested in research plots. Moreover, herbicides for selective broadleaf weed control are being combined with the wild oat control materials.

Future problems include:

1. The spread of wild oat.
2. Herbicide resistance by wild oat biotypes.
3. Wild oat control in reduced and no-till cultures.

WILD OAT CONTROL IN WESTERN PACIFIC NORTHWEST

Arnold P. Appleby[1]

Wild oat problems west of the Cascade Mountain range in Oregon and Washington continue to increase. The majority of the wild oat problems occur in small grains but can also infest several other crops including the grass seed crops. Since most of the small grains in this area consist of winter wheat, I will direct my comments primarily toward wild oat control in winter wheat. There are slightly over a quarter million acres of wheat in western Oregon, with a much smaller acreage in western Washington, perhaps 20,000 to 30,000 acres. Wild oats are much less of a problem in Washington, perhaps because of a greater tendency for rotation to spring row crops in that area.

The winter wheat yield average in western Oregon is approximately 70 bu/A with 120 bu not uncommon. This means that a 30-40% reduction in yield from wild oats can be very costly in terms of dollar losses per acre.

Wild oats seem to be on the increase in this area. This may be due to less rotation of crops and more continuous wheat. Also, as the wild oats increase, undoubtedly there tends to be more spread by contaminated seed wheat. Thus, the increase tends to accelerate itself.

Italian ryegrass grows in virtually every wheat field in the area so each wild oat control program must take ryegrass into account.

Besides crop rotation, there is not much that can be done through cultural control programs that would be practical and economical. Wild oats can germinate in this area any time, at least between September through May, so delayed tillage has not been successful. Tall varieties tend to be more competitive than short varieties, but this is not the complete answer, either. We have measured wild oats standing nearly 7 feet tall and completely over-topping our tallest commercial variety.

Several herbicides are available or appear promising for eventual commercial use. Sequential treatments of triallate followed by either diuron or barban has given good to excellent control of both wild oats and ryegrass. Acceptance of this program has been limited to date because the growers tend to consider it inconvenient and time-consuming, but its use seems to be increasing. Difenzoquat has given good wild oat control, particularly under good growing conditions, i.e., warm, sunny

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weather. It does not control ryegrass which seriously limits its usefulness as a single treatment in this area. We believe that it will continue to serve a useful purpose, however, for control of spring-germinating wild oats in fields which had been treated with other herbicides in the fall.

HOE 23408 has been outstanding in this area for control of both ryegrass and wild oats. It is much more effective against wild oats applied postemergence than preemergence, but its residual in the soil can help retard wild oat germination through most of the winter. If the wheat stand is adequate, the spring-germinating wild oats are not able to become established sufficiently to cause reductions in yield.

Other herbicides which have some activity against wild oats and are, or perhaps will be, registered include trifluralin, metribuzin, and nitrofen.

We seem to have several good herbicides now available or soon to become available for control of wild oats in small grains. We need to know more about how to manipulate and manage our farming practices so the right herbicide is used at the right time to fill a particular situation. We also need to get back to some of our good farming methods -- crop rotations, better seedbeds, use of clean seed, etc.

I am quite optimistic that a combination of good cultural management and herbicides can bring the wild oat problem under reasonable control in the near future.

BENTAZON IN DRY BEANS - RESULTS OF 1976 EXPERIMENTAL USE PERMIT PROGRAM

J. E. Orr, C. W. Carter, R. D. Kukas[1]

ABSTRACT: Bentazon [3-Isopropyl-1*H*-2,1,3-benzothiadiazin-4 (3*H*)-one 2,2-dioxide] was tested extensively in the United States in 1976 in an Experimental Use Permit Program for postemergence broadleaf weed control in dry beans (*Phaseolus* spp.). Ninety-nine trials were established in the bean growing areas in the United States including 62 in the West. Plots averaged about 5 acres and were treated with commercial or grower equipment.

Bentazon was applied to 15 kinds of beans, including 45 varieties at rates from 3/4 to 2 lb/A, either single or split applications, and displayed outstanding selectivity to all varieties. Control of susceptible weeds ranged from poor to excellent during the program. When label directions were followed control was generally good. When applications were made during warm weather, with good soil moisture, to susceptible weeds at the correct stage of growth, adequate control was achieved. Day and night temperatures below 80 and 60 F, respectively, were common during peak application times in much of the West and were not conducive to bentazon activity. Weeds effectively controlled by bentazon included common purslane (*Portulaca oleracea*), common ragweed (*Ambrosia artemisiifolia*), wild mustard (*Brassica kaber*), Pennsylvania smartweed (*Polygonum

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[1]BASF Wyandotte Corporation

pensylvanicum), hairy nightshade (*Solanum Sarrachoides*), cocklebur (*Xanthium pensylvanicum*), yellow nutsedge (*Cyperus esculentus*), and Canada thistle (*Cirsium arvense*). The latter two generally received split applications.

Bentazon is presently fully registered only on soybeans. Registrations are pending, however, for the 1977 growing season on corn, rice, peanuts and dry beans.

SENCOR: A PROMISING NEW WEED REMOVER IN ALFALFA PRODUCTION

A. C. Scoggan and Jack Warren[1]

ABSTRACT: Sencor is an effective and selective herbicide in alfalfa hay and seed production. In hay production the preferred rate in most areas is 0.5 lb ai/acre. At this rate most winter annual weeds are controlled, and protein increases of 3% or more are common.

In alfalfa seed production, 1.0 lb ai/acre is preferred for extending control to both winter and summer annual weeds. Preliminary trials using Sencor after crop emergence to provide weed control and chemical delay of bloom has met with some success. Crop tolerance in dormant, established stands has been excellent, with a 2X margin on most soils. There are no apparant varietal differences.

[1]Chemago Agricultural Division, Mobay Chemical Corporation

EVALUATION OF NC 8438 (NORTRON) IN GRASS SEED CROPS UNDER AN EXPERIMENTAL USE PERMIT

M. G. Day and W. L. Ekins[1]

NC 8438 (Nortron), a broad spectrum herbicide, has been tested during the past several years in sugarbeet plantings. These tests have been conducted through university personnel and more recently by grower cooperators under Experimental Use Permits granted in 1975 and 1976.

In 1969, Orvid Lee, U.S.D.A. weed specialist at Oregon State University, became interested in tests which indicated the selectivity of NC 8438 applied to annual and perennial ryegrass varieties. After extensive greenhouse tests, Dr. Lee began field testing NC 8438 in 1972 and discovered that NC 8438 was extremely effective in controlling

[1]Fisons Corporation

wild oats, volunteer small grains, rattail fescue, and especially annual bluegrass--the number one roadblock in the production of quality ryegrass seed crops. During these tests it was also found that NC 8438 was selective in established stands of Kentucky bluegrass.

Based on these test results, an Experimental Use Permit was granted by the EPA in 1975 allowing grower cooperators to test NC 8438 pre and post-emergence in ryegrass and prior to regrowth and weed emergence in established stands of Kentucky bluegrass. A total of 71 grower trials were conducted in the Skagit Valley of Washington and the Willamette Valley of Oregon with outstandingly uniform results throughout the 1975-76 season.

A rate range of 0.8 to 1.7 kg/ha was found effective for controlling most problem weeds when applied pre-emergence (Table 1). Rates above 1.0 kg/ha are required for control of rattail fescue and wild oats. A rate of 0.75 kg/ha has proven satisfactory for use in annual ryegrass where most chemical weed control programs are not practical due to the low value of the crop and where a lesser standard of weed control is acceptable.

TABLE 1

NC 8438 (kg/ha)	Number of experiments	Control[1] Annual bluegrass (%)	Rattail fescue (%)	Italian Ryegrass stand (%)
Preemergence				
0.8	3	100	55	100
1.1	9	100	80	95
1.4	3	100	85	100
1.7	4	100	84	96
2.2	9	100	100	92
2.8	3	100	100	92
3.4	7	100	100	87
4.5	5	100	100	75
Postemergence				
1.1	5	100	72	97
1.7	3	100	85	98
2.2	5	100	100	97
2.8	3	100	100	100
3.4	5	100	100	90
4.5	5	100	100	83
Untreated check	9	0	0	100

[1]Plot data from Orvid Lee, USDA/OSU, Corvallis, Oregon

Rates of 1 to 2 kg/ha have been found to be effective when applied after weed emergence, especially for controlling annual bluegrass and small grains.

Crop tolerance has proved to be excellent (Table 2). Even at rates of 2 to 4 kg/ha where stand thinning occurred in annual ryegrass, yield increases were generally obtained. In practice, even if no increase in yield is achieved, the premium paid for weed-free seed more than justifies the herbicide application.

TABLE 2

NC 8438 (kg/ha)	Italian ryegrass seed production[1] No. plots averaged	Seed yield (kg/ha)	Increase over standard (kg/ha)
Preemergence			
0.8	2	2070	723
1.1	8	1763	416
1.4	2	2205	758
1.7	3	2131	784
2.2	8	1875	528
2.5			
2.8	2	1861	514
3.4	6	1752	405
4.5	4	1856	511
Postemergence			
1.1	4	1598	251
1.7	2	1936	589
2.2	4	1616	269
2.8	2	1783	436
3.4	4	1635	288
4.5	4	1675	328
Untreated check	8	1347	

[1]Table summarized from plot data accumulated by Orvid Lee, USDA/OSU, Corvallis, Oregon

Table 3 indicates the magnitude of cleaning weed seed from harvested grass seed. Several operations are necessary to gain acceptable levels of weed seeds, each one taking its toll in good seed lost.

TABLE 3

Treatment	Seed Purity[1] Annual bluegrass seed per one pound sample (ave.)	Ryegrass seed purity % of sample
1.5 kg/ha NC 8438	360[2]	92±
Check strip	267100	65

[1]Commercial trial, Clyde Montgomery farm, Shedd, Oregon, Yorktown perennial ryegrass.

[2]Treated area actually weed free, but inundated by river water late in season causing cross contamination.

Recent studies indicate that NC 8438 is also selective in established stands of creeping, tall and hard fescues, bentgrass and orchardgrass. This versatility coupled with the ability of NC 8438 to control annual bluegrass, the number one weed problem in grass seed crops, opens a new era for the seed producer. For the first time, he will be able to produce annualgrass-free grass seed.

Annual bluegrass grows everywhere in the grass growing areas of the Northwest. It grows in and along ditches, in fields, and even on fence posts. It has become such a problem that in the southern areas of the U.S. where annual ryegrass is regularly used to overseed golf courses during winter months, and the incidence of annual bluegrass is already high, consumers are rejecting with increasing regularity seed lots contaminated with weed seed which would augment an already serious problem.

The effective control of annual bluegrass with NC 8438 will improve measurably the quality of grass seed crops being produced in the Northwest.

Again in 1976-77, Fisons Corporation has been granted an Experimental Use Permit which will enable side by side comparisons to be made of a new flowable formulation with the now familiar emulsifiable concentrate.

Applications have been submitted to EPA for full registration of NC 8438 to be used in sugarbeet, annual and perennial ryegrass, and Kentucky bluegrass grown for seed.

THE EFFECTS OF FIVE HERBICIDES APPLIED AT FIVE DIFFERENT GROWTH STAGES OF ANZA WHEAT

William H. Isom and V. K. Weng[1]

Herbicides registered for use on small grains are usually labeled with specific instructions for methods of application, rates to be applied, and timing in relation to both crop growth and weeds. Most herbicides used on wheat have had their labels developed in the major wheat-growing regions of the U.S.A., Canada and other wheat-growing regions of the world. Labels have developed somewhat independently of varietal tolerance studies, though some consideration has been given to spring-grown wheat versus winter wheat.

The semi-dwarf "Mexican" wheats commonly grown now in California and Arizona, grow somewhat differently than the old standard varieties previously grown. For one thing, most are not sensitive to day length. They are of short stature at maturity, and some start heading barely a foot above ground. Some reports of crop injury due to applications of 2,4-D suggest that we either do not understand the developmental stages of these "Mexican wheats" or there are true differential varietal responses to herbicide applications. The purpose of this study was to define the optimum growth of Anza wheat with the major registered herbicides.

MATERIALS AND METHODS

Herbicides and rates tested were: Bromoxynil 0.5 lbs. per acre, MCPA amine and 2,4-D amine each at 0.75 lbs.per acre, Dicamba at 0.25 lbs. per acre, and Bifenox at 2.0 lbs. per acre. All herbicide rates are on an active ingredient basis. All herbicides were applied to Anza wheat at the following growth stages of the wheat: 0 to 1 leaf 2 to 3 leaves, 4 to 5 leaves, 6 to 7 leaves, and the pre-boot stage. For the sake of brevity, these stages will hereafter be designated as stages 1 through 5 respectively. Leaf stages were based on the cotyledon for stage 1 and on true leaves of the primary tiller thereafter. The pre-boot stage, stage 5, was established as that point after jointing and stem elongation had started but before the upper leaf sheath had begun to swell to form the "boot".

Anza wheat was planted with a conventional 20 x 7 John Deer-Van Brundt grain drill at 80 pounds of seed per acre. The test area was pre-fertilized with 100 pounds per acre actual nitrogen supplied from amonium nitrate. A topical application was broadcast at early joint stage providing an additional 40 pounds of N per acre. Irrigations were made by a solid set sprinkler system.

The experimental design was a split plot with growth stages as whole plots and herbicides and control treatments as sub plots. Individual plots were five feet wide by 48 feet long and all plots were replicated

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four times. Treatments were made perpendicular to the drill rows of the wheat with a one-foot buffer strip between sides of adjacent plots. At maturity, the central four feet of the five-foot width of each plot was harvested from 45 feet of plot length with a Hege 125 plot combine.

Spraying of plots was done with a backpack sprayer pressurized with carbon dioxide. The spray boom was hand held and fitted with three 8004 T-jet nozzles. Spraying pressure was 40 psi and walking speed was calibrated to apply 40 gallons of spray per acre. Boom height was adjusted for each growth stage to deliver broadcast single coverage at wheat canopy height. Effects of herbicides were evaluated by taking of data on the following variable: Grain yields in pounds per acre, test weight of grain in pounds per bushel, heading and maturity dates, percent lodging, mature height, and phytotoxicity and weed control ratings on the crop and weeds at maturity.

RESULTS

The findings reported herein are from one year's data, hence they should be considered only as a progress report. Results will be discussed by individual herbicides.

Bromoxynil

When applied at stage 1, bromoxynil reduced grain yield to 88 percent of the untreated control. By contrast, treatments at stages 2 through 5 increased grain yields significantly, the best treatment, stage 3, yielded 134 percent of the control.

Weed control with bromoxynil was complete at stage 3. It tapered off in both directions from stage 3 with a rating of 8.0 for stage 5 and 9.0 for stage 1. This would suggest that optimum time for applications of bromoxynil would be at the 4 to 5 leaf stage.

Crop phytotoxicity ratings were negligible with bromoxynil with only traces of injury observed at stages 2 and 4.

Heading and maturity dates were unaffected by treatments at different growth stages.

Grain test weight was highest at stage 3. Earlier treatments tended to cause lower test weights, with a significantly reduced test weight when bromoxynil was applied at stage 1.

Mature plants were tallest (94 cm) from stage 3 treatments and shortest (86 cm) from stage 5.

Lodging (falling down of stems) was most severe at stages 1 and 5. This may have caused difficulty in measuring plant height and could have accounted for the shorter stature of plants in stages 5 and 1.

MCPA Amine

Grain yields from plots treated at stage 1 were not significantly lower than for the control treatment. However, treatment at all other growth stages gave yields decidedly superior to the control treatment and to stage 1. Differences in yield were not significant for stages 2 through 5.

Weed control ratings varied from 8.5 to 10.0 with no significant difference between growth stages.

Crop phytotoxicity ratings were slight with traces of injury seen at all stage treatments except stage 3, the 4 to 5 leaf stage.

Heading was delayed one day at stage 3 and two days at stage 5, but maturity was delayed only one day at stage 5.

Grain test weight was lowest from stage 1 treatments but was only significantly lower than test weight from stage 5 treatment which was the highest.

Mature plant height and percent lodging were not affected by growth stage treatments.

2,4-D Amine

The highest grain yield from treatments with 2,4-D were obtained when treatment was made at stage 3. Yields were 129 percent above the control treatment and 118 percent above treatment made at stage 1. There was no significant difference between treatments made at other growth stages.

Weed control ratings improved as growth stage treatments were delayed but differences were not statistically significant.

Crop phytotoxicity ratings were very low for 2,4-D despite significant difference values for the different growth stages. Greatest injury ratings were observed at growth stages 2 (1.25) and stage 5 (.75). These phytotoxicity ratings were not reflected in yield. There was no injury rating for 2,4-D applied at stage 4.

Heading date was delayed by two days when 2,4-D was applied at stage 5. Maturity was delayed two days from treatment at stage 2.

Test weight of the grain was highest from treatment at stage 5 but was variable and insignificantly different for growth stages except for the comparison of stage 2 (low) with stage 5 (high).

Treatments with 2,4-D at stages 1 and 2 significantly reduced plant height. Stage 2 was shortest and in this case was not the effect of lodged wheat. Lodging was least and negligible at stage 2 treatment.

Dicamba

Grain yields did not differ significantly for the different stages of treatment with dicamba. From stage 1 to stage 4 yields tended to increase but declined with stage 5. Yields were always slightly higher for dicamba-treated plots than for their corresponding control plots but only significantly higher for stages 3 and 4.

Weed control ratings were similar for all growth stage treatments.

Crop phytotoxicity ratings were highest at stage 5 and lowest at stages 1 and 4. Injury at stage 2 was more severe than for stages 1, 3 or 4.

Maturity and heading dates were generally delayed as treatment stage was delayed. Maturity, however, was delayed less than heading time, 2 versus 4 days.

Test weight increased as treatments were delayed. The highest test weight was achieved at stage 5 and this was significantly higher than test weights of stages 1 or 2.

Mature height was reduced from 89 cm for stage 1 to 81 cm for stage 5. The average heights for the corresponding control treatments were 92 and 89 cm respectively.

Lodging was unaffected by dicamba treatments.

Bifenox

Grain yields did differ significantly for stage of treatment with bifenox, with growth stage 3 being best and stage 1 poorest. All yields were better than for the untreated check though not significantly better at stage 1.

Weed control ratings tapered off linearly as time of treatment was delayed. Weed control became unacceptable if bifenox was applied after stage 3.

Test weight of grain, mature height, heading dates, maturity dates, and crop phytotoxicity were unaffected by growth stage applications of bifenox.

Lodging on bifenox plots was variable and not significantly different for the different stages of treatment though there was a trend toward more lodging as treatments were delayed.

Control Treatments

There were individual control treatments for each replication of the stages of treatment. As would be expected, there were no significant differences for stage treatments amongst the controls for any of the variables of yield, test weight, crop phytotoxicity, plant height, lodging, heading dates or maturity dates. Weed control ratings, however, were different and almost linear ranging from a high of 4.2 for stage 1 to a low of 0 at stage 5. The only explanation may be the lack of soil cover and stability at the earlier growth stages and sheet erosion from irrigations and rainfall moving sufficient chemicals from treated to not treated plots to give partial weed control.

SUMMARY

Since high yields and weed control are the primary concerns in herbicide applications to wheat, the following stages for treatment would appear to be best for the different herbicides:

- bromoxynil, stage 3, 4 to 5 leaf stage
- MCPA amine, stages 3 or 4
- 2,4-D amine, stages 3 or 4
- dicamba, stages 3 to 5
- bifenox, stage 3

Overall, best weed control was achieved by treating at stage 2 but the difference is so slight between stages 2 and 3 that the decided yield advantage of stage 3 over stage 2 justifies the delay in time of application.

THE USE OF METRIBUZIN FOR WEED CONTROL IN WHEAT AND BARLEY IN THE PACIFIC NORTHWEST

J. W. Warren and D. S. Parrish[1]

ABSTRACT: Research over several years in most of the major wheat and barley areas of the Pacific Northwest has shown that metribuzin can control a wide variety of grass and broad-leaf weeds, with acceptable crop tolerance. Proper timing is important to obtain weed control without crop injury. Application must be post-emergence after crop tillering and secondary root development has occurred, at rates of four to eight ounces active per acre, depending on soil type and weed species present. Combinations of metribuzin with various other herbicides has also shown considerable promise, with broadened spectrum of weed activity and greater crop safety as the result. Barley has greater crop tolerance for metribuzin than does wheat, and can even withstand two post-emergence applications 14 to 21 days apart. This split-application has shown excellent activity against some grasses such as wild oats and rye grass.

[1]Chemagro Agricultural Division, Mobay Chemical Corporation

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THE INFLUENCE OF TWO SURFACTANTS ON THE EFFICIENTY OF DICHLORFOP METHYL AS A WILD OAT HERBICIDE

R. S. McAllister and J. O. Evans[1]

ABSTRACT: Dichlorfop methyl shows excellent promise as a wild oat herbicide in small grains, sugar beets, alfalfa and other crops. The chemical dosage necessary to satisfactorily control wild oats may be reduced by adding surfactants (Triton XA and Renex 36) with the herbicide lowering the cost of wild oat control, the quantity of chemical released onto a given area and possibly extending the treatment to less herbicide-tolerant crops.

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THE ROLE OF THE AWN IN SHATTERING AND SURVIVAL OF WILD OATS

J. O. Evans and R. S. McAllister[1]

ABSTRACT: An important factor in the success and persistence of wild oat as a weed is its ability to drop the seed before the crop is fully mature. This assures reinfestation of the soil with seed for future wild oat crops. The twisted geniculate awn of the seed may serve as a mechanical means to accomplish shattering and subsequently as an aid in seed position in the soil. Field observations have shown the twisted awn contributes to preharvest shattering of wild oat seed.

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DINITROANILINE HERBICIDE PERSISTENCE UNDER FALLOW AND IRRIGATED CONDITIONS

Richard D. Gibson and K. C. Hamilton[1]

Each year cotton continues to be a leading crop in Arizona. In 1972, 93% of Arizona growers included herbicides in their weed control programs. To many, a dinitroaniline herbicide was an important part of their program. Because of the frequent use of dinitroaniline herbicides, we felt it important to determine the soil persistence of several of these chemicals.

On the 31st of May, 1976, butralin and oryzalin at 2 Kg/ha and dinitramine, ethalfluralin, fluchloralin, penoxalin, profluralin, trifluralin, and USB 3153 at 1 kg/ha were soil applied and disked into plots 4 meters wide and 7 meters long on two borders at Tucson, Arizona. One border was fallow and the other included in a normal cotton irrigation schedule. Each chemical and a check were replicated four times in each border in a randomized complete block design. The soil was composed of 60 percent sand, 24 percent silt, and 16 percent clay with 0.6 percent organic matter. The irrigated border received a total of 49 cm combined rainfall and irrigation moisture while the fallow border received a total of 23 cm rainfall. In the second month, July 8, 8 cm of rainfall were received and 10 cm in the fourth month, September. In the first, third, and fourth months, June, August, and September respectively, 11, 10, and 5 cm of moisture were applied to the irrigated border.

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Plots were sampled prior to herbicide application to determine soil uniformity. After the applied chemicals were soil incorporated, plots were sampled immediately--and then once a month thereafter. Five samples from each plot, taken to a depth of 7 cm, were removed to the greenhouse, thoroughly mixed, and screened. The soil samples from each plot were seeded with twenty R-S 610 sorghum seed. When seedlings reached approximately 16 centimeters in length in the checks, shoot height and shoot weight were determined. Percent emergence was also calculated. Data was submitted to an "F" test and the means separated by Duncan's Multiple Range Test.

The results, I feel, were interesting. Data presented is based on shoot height. To obtain an indication of the pattern of soil persistence, this parameter has been graphed as a percent of control against time elapsed in months. The "F" test on data from a bioassay of soil taken from the plots prior to chemical application showed no significant difference in the growth of plants on all plots. However, after application, dinitramine retarded growth to twenty percent of the check. This sharp decrease was common in all chemicals tested. Because of the sharp increase in shoot height in subsequent months, dinitramine was determined to be the least persistent chemical tested, showing normal growth of sorghum after one month. This is illustrated by a comparison of sorghum growth in dinitramine immediately after incorporation at twenty percent of the check with fallow and irrigated growth at two months at eighty-five and ninety percent of the check respectively.

Butralin, ethalfluralin, and fluchloralin showed similar persistence patterns, each supporting sorghum growth indistinguishable from that of the checks at approximately two months. Butralin did not depress shoot growth as deeply as did dinitramine, however, the rate of recovery of sorghum height was not as rapid as that of dinitramine. After two months, it was difficult to distinguish between sorghum grown on soil from the fallow and irrigated borders. Fluchloralin showed similar patterns up to the second month. At three months, plant growth was normal.

Oryzalin deeply retarded plant growth at ten percent of the check after application and demonstrated similar patterns through the first month. At the second month, the fallow plots were still inhibited significantly while the irrigated plots showed sorghum growth of ninety percent of the check. It wasn't until the sixth month that oryzalin failed to restrict plant growth in the fallow plots at seventy percent.

Penozalin showed similar data except that the chemical in the plots of the fallow border continued to persist beyond six months. The highest percent of growth in the fallow border was during the fourth month at sixty-four percent and the irrigated border showed sorghum growth at ninety percent of the check.

It wasn't until the third month that profluralin showed no chemical activity in the irrigated border with ninety-eight percent growth rate. The fallow border became inactive at the fourth month with a growth rate of seventy percent.

Trifluralin also persisted under irrigated conditions until the third month, when it showed a growth rate of ninety-seven percent; but, like penoxalin, continued to limit sorghum growth through the sixth month under fallow conditions.

USB-3153 was determined to be the most persistent chemical tested showing persistence patterns extremely similar under both fallow and irrigated conditions. The highest percentage of growth in the irrigated border was fifty-eight percent at the fifth month, while the fallow border showed fifty-five percent of the check at the third month. USB-3153 was found to be limiting shoot height through the sixth month in soil from each border.

The months at which no significant difference in shoot height was noted as compared with the check through the Duncan's Multiple Range Test. Dinitramine ceased to limit sorghum growth after one month. Butralin caused no effect after one month in the irrigated border and two in the fallow, ethalfluralin at one and three, and fluchloralin at three and one. Oryzalin persisted for two months under irrigated conditions and six under fallow. Penoxalin went two and over six, profluralin at three and give, trifluralin at three and over six, and USB-3153 was over six under each condition.

In October 1971, Siegfried Gagnon experimented similarly. His results for the persistence of dinitramine and trifluralin have been compared and graphed with the data from the May application. Dinitramine from the October application was found to persist at approximately stable rates until a sharp decrease in persistence occurred between eight and twelve months. The May application, however, showed an immediate decline in persistence at two months. Similar conclusions can be reached concerning trifluralin although the rate of persistence decrease was somewhat slower.

It is concluded then that dinitramine was the least persistent chemical. Butralin, ethalfluralin, and fluchloralin showed similar persistence patterns and were more persistent than dinitramine. Oryzalin, penoxalin, profluralin, and trifluralin were more persistent than the first two groups while USB-3153 was the most persistent of all.

INFLUENCE OF ENVIRONMENTAL FACTORS ON GLYPHOSATE ACTIVITY IN BERMUDAGRASS

C. H. Fernandez and D. E. Bayer[1]

ABSTRACT: Penetration in amounts required to induce severe phytotoxicity was achieved after 8 hours following application. Simulated rainfall occurring within 4 hours following application resulted in a significant reduction of herbicide activity. No detrimental effect on herbicide activity was found when rainfall occurred after 8 hours.

Partial coverage of shoots with a 1% solution of glyphosate was found to be inadequate to kill the plant. Phytotoxicity increased, as evidenced by development of visual symptoms, as the coverage increased.

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Following foliar penetration, the herbicide was translocated throughout the plant in both the symplast and apoplast. Preferential acropetal movement toward the main stolon tip was evident. Herbicide accumulation in this region was higher, as measured by visual symptoms, than in stolon tips on lateral shoots along the main stolon. Movement to underground tissue was effective and quite rapid, requiring only 28 hours for levels necessary to induce severe symptoms or kill the plant.

No differences were observed when solutions of 1 and 1.5% glyphosate were applied at 10 and 40 gal/A. However, a greater herbicide activity was obtained when 0.5% solution was applied at the higher volume.

The effect of water stress prior to, during, and following, application of glyphosate suggests that a severe water stress at the time of treatment would reduce the final herbicide effect.

DEGRADATION OF GLYPHOSATE IN AVOCADO FRUIT

L. S. Hasegawa, J. Kumamoto, and L. S. Jordan[1]

INTRODUCTION

The information being presented is taken from the dissertation research of Leslie S. Hasegawa. The project is being conducted with the cooperation and financial assistance from the California Avocado Advisory Board. The synthesis of the radiolabelled herbicide glyphosate was performed by Monsanto Company, who also provided the directions of developing assay methods for its detection as well as for its main degradation product aminomethylphosphonic acid.

$HO_2CCH_2NHCH_2PO_3H_2$	$H_2NCH_2PO_3H_2$
GLYPHOSATE	METABOLITE

Avocados are native to the American continent. They are grown in a relatively small area, the southern coastal region. They are a gourmet's delight in salads and sandwiches.

MATERIALS AND METHODS

Trees with forming fruit have been treated in the field by painting a selected leaf with ^{14}C-glyphosate, approximately four feet of branch was removed and assayed for any radioactivity. The only place where any activity was found was on the painted leaf.

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A glass fiber disc taped onto a leaf was wet with aqueous radioactive glyphosate and kept wet with water for 10 days with the same result. We next attempted to determine independently the fate of glyphosate when it entered an avocado fruit. A mature avocado was picked with 6 cm of peduncle. A cavity with a .1 to .2 ml capacity was drilled into the end of the peduncle. The fruit was placed in a respiration chamber and the cavity filled with an aqueous solution of radiolabelled glyphosate. The cavity was refilled at 3 hour intervals until 453,000 cpm had been added and then kept filled with distilled water for the remainder of the 10 days. The radioactivity in the flowing air stream was continuously monitored with a Cary model 31 vibrating reed electrometer connected to an ionization chamber. The respiration of the fruit was monitored by gas chromatography, using thermal conductivity to measure the carbon dioxide and flame ionization to measure the ethylene. The air stream was passed through a phenylethylamine trap and all the carbon dioxide was isolated as the phenylethylammonium phenylethylcarbamate salt.

After 10 days the fruit was ground with an osterizer and the radioactivity extracted with water. The aqueous extract was passed through an anion exchange resin and the eluate discarded. The anions were displaced with ammonium bicarbonate and the solution evaporated to dryness. The salts were dissolved in a minimum of water and fractionated by column chromatography through a Dowex 50 X-X8 cation exchange resin. The fractions containing the glyphosate and the degradation product were assayed for radioactivity by scintillation counting in a Beckman LS 100.

RESULTS AND DISCUSSION

Table 1 summarizes the results obtained in a typical experiment.

Table 1. Recovery of Radiolabel from ^{14}C-glyphosate treated Avocado Fruit.

	Recovered Counts		
Fruit Segment	Parent glyphosate	Metabolite	Misc.
190.4g mesocarp	290,378	1,179	4,330
24.9g exocarp	31,029	0	363
53.9g seed	202	0	2,107
2.6g peduncle	69,057	340	2,162
paper	4,225	0	98
TOTALS	394,891	1,519	9,060
%	87.2	.34	2

CO_2 cpm - 16,239 (3.6%)

Total recovery 93%
(452,880 cpm applied)

The overall recovery of radioactivity was 93%. The major activity, 94% of the recovered activity was found in the fraction that contains glyphosate, carbon dioxide accounted for 3.8% of the recovered activity and 0.36% of the recovered activity was found in the fraction that contains aminomethylphosphonic acid.

ACKNOWLEDGEMENT

We express our appreciation to Dr. R. M. Kramer of Monsanto Company for technical assistance and Dr. B. O. Bergh for providing avocado trees fruit and his expert advice.

SOME ASPECTS OF THE MECHANISM OF ACTION OF GLYPHOATE

B. E. Abu-Irmaileh and L. S. Jordan[1]

ABSTRACT: Greenhouse and laboratory research was conducted to study some aspects of the mechanism of action of the herbicide *N*-(phosphonomethyl)glycine (glyphosate) in purple nutsedge (*Cyperus rotundus* L.). Phytotoxic symptoms appear on the central leaves 24 to 48 hours after treatment. White spots and white striations develop on the treated leaves especially at the base. In a controlled environment growth chamber, darkness delays the appearance of chlorosis on the treated foliage. Chlorosis appears after the treated plants are placed in light. It appears that light is necessary for enhancing glyphosate activity. Histological studies with light microscope reveal that cells of treated leaves have misshapen chloroplasts.

Glyphosate causes inhibition of catalase activity in bean leaves. Catalase activity was not followed in purple nutsedge for the low yields which are normally obtained because of the very severe grinding required to get measurable activity of catalase.

INTRODUCTION

Purple nutsedge is considered to be the most troublesome perennial weed. It is adapted to a wide variety of soil types and environmental conditions. This weed infests cultivated crop areas throughout more than 60 tropical and subtropical countries (11). Vegetative reproduction is both rapid and vigorous. Under favorable conditions a single tuber can produce 146 tubers and corms within 3.5 months (17).

Glyphosate has fairly recently been introduced as a post-emergence weed killer for the control of many perennial weeds (2), including purple nutsedge (24). Glyphosate is best applied to the rapidly growing foliage of weeds. After 24 hrs, the treated area can be tilled (4) and a crop can be planted immediately because of the rapid inactivation of this herbicide by soil adsorption (18). Glyphosate is

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readily translocated to areas of highest metabolic activity in many weeds (19). The herbicide causes inhibition of rhizome regrowth of quackgrass 6-8 hours after treatment (6).

Few studies have been performed to determine the mechanism of action of glyphosate. The results vary with the systems used in each study. Jaworski (12) suggested that glyphosate inhibits chorismate mutase and/or prephenate dehydratase in the aromatic amino acid pathway of *Lemna gibba*, and *Rhizobium japonicum*. Roish and Lingens (16) found that glyphosate caused 50% inhibition of the first two enzymes of the aromatic amino acid pathway (3-deoxy-2-oxo-arabino heptonic acid-7-phosphate synthetase, and 5-dehydroquinic acid synthetase) while the other enzymes including chorismate mutase and prephenate dehydratese were not affected. Haderlie (9) found that glyphosate has no effects on amino acid levels or protein synthesis in carrot and tobacco plants for the first two days. However, in tobacco pith cell or carrot root cell cultures, the total amino acid pool increased within six hours of glyphosate treatments, indicating a slowdown of protein synthesis. Respiration of root mitochondria and roots of bean plants was not significantly affected even after the visual symptoms had appeared (10). Most recently, Brecke (3) found that glyphosate inhibited all metabolic processes measured in isolated cells from bean leaves, including photosynthesis, RNA and protein synthesis, respiration, and ion absorption. However, ion absorption was the earliest to be inhibited (within 1-1/2 hrs after treatment) and he concluded that glyphosate directly inhibits ion absorption in bean cells.

Glyphosate was also found to cause damage as a complete disruption of the chloroplast envelope and swelling of the rough endoplasmic reticulum (5). High light intensities enhanced glyphosate activity on johnsongrass and caused johnsongrass to respond faster to glyphosate than at low light intensities (23).

Research was performed to study the development of phytotoxic symptoms of glyphosate, histological effects, and dark interaction with glyphosate in purple nutsedge. Also glyphosate effects on catalase activity in bean leaves were investigated.

MATERIALS AND METHODS

A uniform stock of purple nutsedge plants was prepared before treatment time. Single sized tubers were planted 1 inch deep in styrofoam cups containing UCR Soil Mix #2. The cups were punctured from bottom for drainage purposes.

Development of phytotoxic symptoms of Roundup and glyphosate on purple nutsedge

Uniform purple nutsedge plants were selected at the 8-9 leaf stage. Each 10 plants were sprayed by a small hand sprayer, with one of the following treatments: Roundup at 4.5 kg ai/ha, and glyphosate as isopropyl amine salt at 4.25×10^{-2}M. Visual observations on the development of phytotoxic symptoms were recorded.

Histological studies:

The shoots of purple nutsedge plants were dipped in 5 mM isopropylamine salt of glyphosate for few seconds, then taken out and allowed to drip the excess. Leaf sections were taken from the bleached areas of the treated plants and from comparable areas of the check plants at 24, 48, 72 and 96 hr after treatment. The leaf tissue was then fixed, sectioned, and stained according to Reguad's method (15). Chloroplasts were examined under light microscope.

Dark interaction with glyphosate activity

Uniform plants were selected and half of the plants were dipped in 4.25 X 10^{-2} M (active ingredient) Roundup for a few seconds. The excess was allowed to run off. The plants were then left in light for three hrs to assure enough uptake before the dark incubation was performed. The other half of the plants were left untreated to be included as check plants with each dark treatment. Dark incubation was carried out in growth chamber with the following conditions: RH 90% day temperature 30 C, night temperature 25C. Dark incubation periods were: 0, 12, 24, 45, 72 hr. Each treatment of dark incubation consisted of 10 treated plants and 10 untreated plants. After each dark period, the plants were taken out to similar growth chamber illuminated by cool fluorescent lamps and incandascent bulbs to give quantum flux 440 μeinsteins/m^2/sec. The green color dissipation was measured every two days, as index injury. Measurements were made by Wallihan reflectance meter for estimating chlorophyll concentrations in leaves (22) until the death of the plants. The readings were taken from the center leaves of the plant.

Glyphosate effect on catalase activity

Bean seeds were planted in 8 flats, and placed in a growth chamber for 10 days. The plants of 4 flats were treated, and the other 4 flats were kept as controls. Fresh leaves were harvested at 0, 6, 12, 24, 48, 72 and 96 hr after treatments for each flat. Catalase activity was assayed for the leaves of each flat.

Catalase preparation

Samples of 0.5 gram of fresh leaves were ground in mortar and pestel in 0.1 M phosphate buffer pH 7.0 over ice. Small amounts of sand were used to help in grinding. The crude extract was centrifuged at 10,000 x g for 15 min to rid of cell debris and other large organelles. The supernatant was collected. 0.5 ml of the supernatant was diluted to 5 ml in 0.1 M phosphate buffer to be used for the assay.

Catalase assay

To prepare the assay solution, 0.16 ml H_2O_2 (30%) was brought to volume of 10 ml in 0.1 M phosphate buffer (pH 7.0). The reaction mixture composed of 0.8 ml buffer + 0.1 ml H_2O_2 solution + 0.1 ml enzyme. The reaction rate was monitored at 240 nm for two min. Lowry assay (13) was carried out in order to determine the amount of protein and to calculate the specific activity of the enzyme.

RESULTS AND DISCUSSION

Development of phytotoxic symptoms

Phytotoxic symptoms appeared on Roundup treated plants 24 hr after treatment. The center leaves of the plants had less green color as compared with the untreated plants. Leaves turned yellowish and wilting symptoms appeared 48 hours after treatment. The center leaves died long before the outer leaves even showed yellowing. The whole growth of the treated plants seem to stop and regrowth as new shoots did not appear. These results indicate that Roundup is less effective on the mature outer leaves than the expanding center leaves. Also, Roundup stopped the whole growth of the plant as was observed visually.

Symptoms on plants treated with isopropylamine salt of glyphosate appeared as bleached areas at the base of the center leaves 24-48 hr after treatment. The center leaves had white striations. The base of the center leaves turned white then became necrotic.

Histological studies

Since phytotoxic symptoms caused by glyphosate appeared to reduce the green color in the leaves, it was believed that glyphosate may cause destruction of the chlorophyll or may cause destruction of the chloroplast. Leaf cross sections were examined under light microscope from treated and untreated foliage. The treated leaves show that the chloroplasts have abnormal shapes varying from swollen shapes to clumped together. These changes could be detected 48 hr after treatment. As the bleaching progresses, the chloroplasts become smaller and cells appeared to have fewer numbers of chloroplasts. When cross sections were taken from the white spots, the plasma membrane seemed to be withdrawn inward. However, electron microscope studies are needed to be carried out to determine the exact nature of the changes that take place in the chloroplast.

Dark interaction with glyphosate phytotoxicity

The results indicate that dark incubation delays the appearance of chlorosis on purple nutsedge leaves. The longer the period of dark incubation, the longer it takes for chlorosis to appear. However, chlorosis appeared only when plants are removed from dark and placed in light. In other experiments that are not reported here showed that dark incubation of Roundup treated plants for two weeks inhibited the chlorotic symptoms to appear especially if plants were treated with 2.24 kg ai/ha or less. The plants looked comparable to check plants incubated for the same periods. These results indicate that light is essential for chlorotic symptoms to appear on the foliage of purple nutsedge, and darkness decreases and delays these symptoms.

Glyphosate effect on catalase activity

Catalase catalyzes the following reaction:

$$2\ H_2O_2 \longrightarrow 2\ H_2O + O_2$$

This enzyme is reported to be inactivated by sunlight under aerobic conditions (14). It is located in the microbodies (peroxisomes and glyoxysomes) (21). In plants that have photorespiration, peroxisomes are large and numerous in all cells with chloroplasts. In plants that have no photorespiration, peroxisomes are large (1μ) and numerous in the bundle sheath cells, while mesophyll cells have small peroxisomes and fewer in number. So far, low yields of catalase activity is obtained from C_4 plants (20) because some cells are not easy to break.

Catalase studies in association with chlorophyll development have been investigated (7). Genetic albino, variegated, and chlorotic plants have low chlorophyll content and low catalase activity. Appleman (1) found that in etiolated seedlings of barley, wheat and corn, catalase activity is always higher than in green seedlings by 2-10 X. The activity decreases upon illumination of the etiolated plants. Appleman suggested that when chlorophyll is being synthesized rapidly, catalase activity decreases. And when chlorophyll synthesis is blocked, catalase activity increases.

I have tried to extract catalase from purple nutsedge leave, but the activity obtained was low due to that most of the catalase is located in the bundle sheath which requires severe grinding to break it (20).

I have chosen beans to extract catalase because high yields of activity was obtained.

Glyphosate treatment appears to reduce catalase specific activity. The reduction was noticed as early as 6 hr after treatment. This effect appeared more clearly with time. At 96 hours after treatment, the specific activity of catalase from treated plants was less than 40% of the control.

Catalase destructs H_2O_2 produced in the plant. This is a major metabolic reaction. If H_2O_2 is not destructed, it would accumulate to high levels and become toxic to the plants, especially around the chloroplast (peroxisomes are found to be located in the rough endoplasmic reticulum (RER) and also found appressed to the chloroplast envelope (8).

Since glyphosate inhibits catalase activity, this may explain the effect of glyphosate on the ultrastructure of the chloroplast and the rough endoplasmic reticulum as was seen under light microscope here and as was seen under electron microscope (5).

Since glyphosate has no effect on the plants in the dark, as is judged by the visual symptoms, and since light is required for glyphoate phytotoxic symptoms to appear, this could be linked to the activity of catalase which is high (2-10 X) in the dark and low under sunlight. Glyphosate causes about 60% reduction of catalase activity when plants are grown under normal light dark cycles. This reduction could be compensated by the high catalase activity for the treated plants which are incubated continuously in the dark.

I would like to propose that this effect of glyphosate on catalase activity could lead to a better understanding to the mode of action of glyphosate.

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EFFECTS OF GLYPHOSATE ON TRANSPIRATION IN RED KIDNEY BEANS (*Phaseolus vulgaris*)

D. L. Shaner[1]

ABSTRACT: Experiments were conducted on primary leaves of 10- to 14-day-old red kidney beans (*Phaseolus vulgaris*) grown under controlled conditions to determine the effects of glyphosate on transpiration. Transpiration rates declined beginning 4 to 5 hours after treatment and decreased to 50% of the control level in 7 to 8 hours after treatment where the transpiration rate remained until the plants. died. This effect on transpiration only occurred when lethal doses of glyphosate were applied to the leaves. The effect was independent of the form of glyphosate used (i.e. glyphosate in the acid or isopropylamine salt form) and the surface of the leaf that was sprayed. However the time required

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For the decrease in transpiration was affected by the concentration used and by the presence or absence of surfactant. Transpiration of pea and sunflower leaves was also decreased by glyphosate treatments.

Glyphosate's effect on transpiration was accompanied by the induction of cycling in the leaf temperature which started at the same time the transpiration rate began to decline and reached a peak when the maximum effect on transpiration occurred.

This phenomenon represents one of the earliest reported responses of a plant to a glyphosate treatment that will eventually kill the plant.

CHEMICAL KILL OF COVER CROP FOR POTATO MINI-TILL

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

ABSTRACT: Production of potatoes with minimum spring tillage is receiving increased attention in the Pacific Northwest. Presently this practice involves planting potatoes directly into a small grain cover crop such as wheat. Modified planter adaptations and one early cultivation with special sweeps have been used to mechanically eliminate the cover crop. However, this practice has been only partially successful at times. Chemical kill may either substitute for this mechanical kill or be necessary for any cover crop remaining following planting.

Trials have been conducted in 1975 and 1976 to screen and evaluate several compounds for efficacy of killing a wheat and rye cover crop and residual phytotoxicity on the potato crop. Research plots have been established both years on experiment station land, a Shano loam with 47-50% sand, 40-42% coarse silt, 2% fine silt, and 8-9% clay; pH 7.5; and 0.7-0.9% OM. Wheat and/or rye is planted and established in the fall; the chemical treatments applied in the spring prior to or within 7 days following potato planting. No other cultivation is practiced except in the cultivated checks.

Chemicals which have proven to be most effective in our trials include glyphosate, paraquat, and PPG-135. Glyphosate at 0.5 and 1.0 lb ae/A has given complete elimination of both cover crops with no residual effects to the potatoes. Paraquat at 1.0 ai/A has also given good control; however, at times this kill is only temporary and some regrowth problems have occurred. PPG-135 at 3 and 6 lb ai/A is very effective in stopping growth of the wheat cover and kill is very slow providing ground cover for a longer period of time until the potatoes have emerged and become established; however, this material must be applied at least 6 weeks ahead of potato planting to avoid residual phytoxicity problems.

Other compounds evaluated in our trials have either been ineffective in killing the cover crops, allowed excessive regrowth, or given residual phytoxicity to the potato crop. Dalapon must be applied when wheat is

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still in a very young stage (pre-boot) to be effective. In our areas this would require application in late winter when low temperatures would retard its effectiveness. The materials endothall, MBR 12325 (mefluidide), dinoseb, and SAN 9789 have not proven to merit further testing.

One additional challenge in this cover crop kill concept is the control of any wheat cover which "escapes" or is present following potato emergence and how to eliminate this from the potato field.

WEED MANAGEMENT IN KERN COUNTY POTATOES

Harold M. Kempen[1]

Over 30,000 acres of potatoes are planted each year in Kern County. Varieties include White Rose, Kennebec, Red LaSoda and Norgold. Competi- is greatest from Kennebec, then LaSoda and White Rose, whereas Norgold is a poor competitor.

Almost all acreage is now planted in the spring. Plantings begin in December and conclude in March. Harvests begin in May and conclude in July. The 1,000 acres or less of July plantings are harvested between December and March.

Soils are generally sandy loams with low organic matter content (about 0.1 to 0.8%). Essentially all fields are sprinkled with solid set systems. Plantings are on 30 or 32 inch centers. Usually rolling cultivators are used to form beds after planting. Many growers also use Rotary Corrugators to give high, wide beds in order to lessen "greenheads."

Harvesting is essentially all mechanically done. Two-row harvestors dig and elevate tubers directly to trucks. Some growers lift potatoes and move them laterally to two adjacent rows so that four rows are lifted and conveyed to trucks in one pass.

Weed programs utilize dinoseb and 10 gallons of diesel or weed oil most often on early plantings prior to potato emergence, and EPTC on later plantings. EPTC is often used twice during the season; the second application or both through sprinklers. Paraquat may be used as a pre-emergence contact herbicide or before harvest to desiccate and stop further nutsedge growth. Trifluralin or trifluralin plus EPTC is used where lovegrass is a problem or where Norgolds are planted, being incorporated into beds after planting with rolling cultivators.

Herbicides which have fallen by the wayside are prometryne, linuron, DCPA, dinoseb amine, and numerous numbered candidate compounds.

Observations on Weed Control Programs in Kern County

Most growers use herbicides very effectively on potatoes as can be attested by the many weed free fields. Often they worry too much about

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those unsightly weeds which can appear just before harvest. These weeds usually are not a competitive problem and yields are seldom increased by their absence. Certain weeds can be a harvesting problem (lambsquarters, knotweed, wild buckwheat, lovegrass, nutsedge) or reduce quality due to tuber penetration (nutsedge). Many do not produce viable seed before harvest unless cold weather delays harvest or reduces competitiveness from the crop.

However, maturity standards for White Rose potatoes tend to permit seeding of many annual weeds. American black nightshade and hairy nightshade seeds are viable, even when berries are not mature. Growers do want to keep weeds from seeding because of their adverse effects in subsequent crops, and wish to have programs that cover contingencies such as delayed harvest, frost, rains, cold growth periods, etc.

Timing of herbicide applications is more important than many think. Contact herbicides should be used when weeds are about one inch tall. EPTC is not effective on many emerged weeds. Therefore cultivation should precede application to dislodge weeds or a contact herbicide should be used to kill emerged weeds. EPTC will control emerged grasses or nutsedge if small, under many irrigation conditions; but I don't know all the conditions required. If nutsedge is to be controlled, applications should be completed by March 1. This might mean a preplant application or a post-plant application.

One grower technique in use for seven years when potatoes are planted in early February is to plant, list beds, Rotary Corrugate every other set of four rows, put sprinklers into corrugated rows, finish the corrugation job, apply EPTC through the sprinklers; then apply a contact herbicide if weeds resistant to EPTC emerge before potatoes. A second application of EPTC often is applied through the sprinkler system about 45 days after the first application to extend control.

If nutsedge emerges prior to harvest, paraquat plus wetting agent sometimes is applied with ground equipment after rolling beds.

Norgolds are less competitive; therefore trifluralin is helpful in keeping lovegrass under control. Combinations with EPTC are often used, using a rolling cultivator to incorporate but not following with a Rotary Corrugator. The Corrugator tends to concentrate trifluralin over the row and under adverse conditions may reduce shoot growth and yield. No more than 1/2 lb/A of trifluralin should be used and I suspect that 1/4 lb/A might be adequate on many potato soil types.

Where EPTC is metered through sprinklers, care must be exercised to properly apply it. Simple in-line orifice disks are used where the venturi principle can be applied. Avoid wind as it quickly reduces uniformity. Apply for at least 1 1/2 hours, preferably near the end of an irrigation cycle. Clean the line for 30 minutes to avoid movement of treated water to susceptible crops such as tomatoes, cereals, onions or cotton. No adverse effects on wells or irrigation district systems have been encountered.

Evaluation of New Herbicides

Alachlor has shown effective control on yellow nutsedge, nightshades and most other weeds excepting lambsquarters. Safety on potatoes has been satisfactory except at high rates. Surface applications prior to potato emergence are most effective. Post applications appear to cause some leaf damage. Hopefully it will be registered in California like it has in the remainder of the United States. Compounds related to alachlor are CGA 24705, VCS 5052 and H 26910. Perhaps these will be registered.

Studies with metribuzin continue to indicate its safety on Kern County potatoes is inadequate. Factors causing performance variability are primarily soil organic matter, then variety, then irrigation and temperature. Thus considerable variability in safety and results could be expected were it used. Yet its excellent effectiveness makes it intriguing.

Dinitro-anilines related to trifluralin offer some advantage over trifluralin. Butralin or dinitramine might be surface-applied and are shorter lived than trifluralin. Perhaps other dinitro-anilines are safer on potatoes, but considerable research would be necessary to evaluate that adequately. Differences seem small at this time.

Glyphosate continues to show safety and effectiveness as a pre-emergence herbicide for emerged weeds. Combinations of napropamide with EPTC or alachlor have looked good but the long persistence of napropamide will need further evaluation. It is unlikely that napropamide will be registered for use on potatoes.

Studies in 1976 indicated Dowco 295 and bifenox may be safe enough on potatoes and may control nutsedge and winter broadleafed weeds, respectively. Studies in 1975 and 1976 on eight varieties indicated alachlor, H 26910 and napropamide at 4 lb/A were safe on low organic matter sprinkler irrigated soils when applied pre-emergence. Metribuzin at 1/2 lb/A was safe on Norgold, LaSoda, perhaps White Rose and Kennebec, but not Centennial or Chieftan.

Weed Management Aspects

Nothing is more evident to the consultant who supervises weed management on a diversified ranch than the importance of a vigorous crop. When early frosts, long periods of cold weather or herbicide damage reduce growth, weeds abound. Such a season reinfests a field for several years.

Varieties show this crop competition effect markedly. White Rose is probably the best competitor although Kennebec is usually a close second. However, because Kennebecs are harvested "green", late season weeds are less of a problem than with White Rose. Tubers need to mature to get better periderm and weeds can mature during that period of 1-2 weeks. Red LaSodas are very competitive but the new Centennial russet is a more upright plant and definitely less a competitor. Norgolds often do not cover the middles. Norgolds also need late season growth without weed competition (shading) in order to develop size.

Weed management consultants need to know what weeds are present in fields. To do this, they need to record weeds which are seeding in previous seasons. How many seasons of record keeping is necessary to make a valid prognostication of the weeds expected has not been established yet. Preliminary studies indicate three years is the minimum for most broadleafed weeds but one season is often an excellent indicator on annual grasses.

The following weed record system I use is effective but is perhaps too complex for most weed management practitioners. Yet much of the

EFFECTIVENESS OF HERBICIDES IN KERN COUNTY

C = Controlled
P = Partial Controlled
N = Not Controlled

	Preplant: Eptam	Preplant: Paraquat	Postplant pre-emergence: Paraquat	Postplant pre-emergence: Dinitro* + Oil	Postplant pre-emergence: Eptam	Postplant pre-emergence: Trefan	Postplant pre-emergence: Dymid	Postplant pre-emergence: Enide	Post: Eptam
BROADLEAF WEEDS									
Cheeseweed (Mallow)	N	N	N	P	N	N	N	N	N
Chickweed	C	C	C	C	C	C	C	C	C
Clover (Melilotus)	N	P	P	C	N	N	C	C	N
Cocklebur	N	C	C	C	N	N	N	N	N
Fiddleneck	P	C	C	C	P	C	C	C	P
Filaree	P	N	N	C	P	P	C	C	P
Goosefoot	C	C	C	C	C	C	C	C	C
Groundcherry	C	C	C	C	C	N	N	N	C
Groundsel	C	C	C	C	C	N	P	P	C
Hen bit	C	C	C	C	C	N	C	C	C
Knotweed	P	P	P	C	P	C	C	C	P
Lambsquarters	C	P	P	C	P	P	C	C	P
London rocket	P	P	P	C	P	P	P	P	P
Marestail (horseweed)	C	C	C	C	C	N	P	P	C
Monolepsis	C	C	C	C	C	C	C	C	C
Mustard	N	C	C	C	N	N	N	N	N
Nettle	C	C	C	C	C	P	C	C	C
Nightshade, hairy	P	C	C	C	C	N	N	N	C
Nightshade, black	P	C	C	C	P	N	N	N	P
Pigweed, prostrate	C	C	C	C	C	C	C	C	C
Pigweed, tumble	C	C	C	C	C	C	C	C	C
Pigweed (carelessweed)	C	C	C	C	C	C	C	C	C
Pineappleweed	C	C	C	C	C	N	P	P	C
Prickly lettuce	C	C	C	C	C	N	N	N	C
Purslane	P	C	C	C	P	C	C	C	P
Russian thistle	N	C	C	C	N	P	P	P	N
Shephedspurse	P	C	C	C	P	N	P	P	P
Sowthistle	C	C	C	C	C	N	N	N	C
Wild buckwheat	C	C	C	C	C	C	P	P	C
GRASSES									
Annual bluegrass	C	C	C	C	C	C	N	C	C
Barnyardgrass	C	C	C	C	C	C	N	C	C
Bermudagrass	C	P	P	N	C	P	P	P	C
Bromegrass	C	C	C	C	C	P	C	C	C
Cereals	C	C	C	P	C	N	C	C	C
Crabgrass	C	C	C	C	C	C	C	C	C
Foxtail (bristlegrass)	C	C	C	C	C	C	C	C	C
Johnsongrass	C	P	P	N	C	N	N	P	C
Lovegrass (ticklegrass)	C	C	C	C	C	C	P	P	C
Nutsedge, purple	C	C	C	P	C	N	N	N	C
Nutsedge, yellow	C	C	C	P	C	N	N	N	C
Ryegrass	C	C	C	C	C	C	C	C	C
Wild oats	C	C	C	P	C	P	C	C	C
Period of Control (weeks)	6	contact	contact	contact	6	16	10	10	6

This chart is based on observations in Kern County when rates and application techniques on labels are propely followed.

* Dinitro formulations: Dow General; Sinox General; "Contact" types.

WEED RECORD

CROP YEAR ____________ RANCH ______________________ FIELD ______________

NOW ____________ HERBICIDES USED ______________________________________

PRIOR ____________ PERFORMANCE ______________________________________

PRIOR ____________ ROTATION RESTRICTIONS ______________________________

no.*	WINTER WEEDS	weed density now L	M	H	next yr. L	M	H
65	Annual bluegrass						
35	Barley volunteer						
26	Bassia, 5 hook						
67	Bromegrass						
34	Canarygrass						
20	Cheeseweed						
50	Chickweed						
61,105	Clover						
25	Cudweed						
51	Dock (S)						
48	Fat hen (S)						
6	Fiddleneck						
111	Filaree						
3	Groundsel						
17	Henbit						
1	Lettuce, prickly						
5	London rocket						
16	Marestail (S)						
49	Monolepis (S)						
8	Mustard						
46	Nettle						
15	Pineapple weed						
37	Rabbitsfoot grass						
14	Red Maids						
10	Shepherdspurse						
4	Sowthistle (S)						
36	Wild oats						

(S) Summertime germination also

no.*	SUMMER WEEDS	weed density now L	M	H	next yr. L	M	H
33	Barnyardgrass						
19	Cocklebur						
62	Dodder						
84	Foxtail, Summer						
13	Groundcherry						
7	Jimson weed						
80,12	Knotweed						
22	Lambsquarters						
86	Lovegrass						
112	Morningglory						
56	Nettleleaf goosefoot						
	Nightshade, Black						
9	Nightshade, hairy						
57	Pigweed, prostrate						
79	Pigweed, Tumble						
53	Pigweed, careless						
24	Puncture vine						
27	Purslane						
21	Russian thistle						
40	Sandbur						
39	Sprangletop						
28	Spurge						
11	Sunflower						
55	Turkey mullein						
	PERENNIAL WEEDS						
72	Bermudagrass						
74	Bindweed						
71	Johnsongrass						
82	Nutsedge, purple						
73	Nutsedge, yellow						

L=light H=heavy M=medium

* Page no. in Weed Identification Handbook

Advisor ______________________________

REMARKS:

data recorded is needed for making good recommendations. The consultant can give the grower an estimate of the severity of the next season's unwanted plants based on previous year's and earlier years' observations. Some consultants, however, would not reveal this data to clients but instead provide growers recommendations only, just as medical doctors do.

A special feature of this record is that it ties the weed to the University of California's "Growers' Weed Identification Handbook" by Fischer, et al.--a most excellent contribution to weed management.

Growers are incapable of keeping track of weeds what with government regulations on safety, labor, noise abatement, water management, etc. impinging on their precious time. But they have even more difficulty keeping track of which weeds are controlled by specific herbicides. Consultants can fill this gap using university developed data on weeds present in the area. An example is "Effectiveness of Herbicides in Kern County."

This summary helps considerably inasmuch as companies cannot risk adding weeds on labels unless ninety plus percent control is achieved. Until universities get sued for such "recommendations", this will be most helpful to weed management consultants and growers.

Other characteristics of herbicides could be included in such a chart as toxicity category, persistence, flammability, volatility, etc.

The consultant can collect this kind of information for growers and help them time their applications properly, spot-check equipment calibration and setups, advise them of relative risks and relieve them of worry over herbicides. Advertisements about fantastic new alias sister compounds can be short circuited saving time and confusion with new products not needed. A long term "experience" can be developed. But a rapid change to new herbicides needed for new weed problems can be logically field tested and implemented as well.

Finally the weed management program brings another overseer into the field. A man with experience, contacts and broad exposure to new and different techniques, can aid new and old farm managers alike. The fee of $2.50 to $3.00/A is one he cannot afford not to pay.

CONTROL OF NIGHTSHADE AND NUTSEDGE IN TOMATOES

A. H. Lange, R. Goertzen, W. Bendixen, R. Mullen, J. Orr, H. Agamalian, F. Ashton and H. Carlson[1]

ABSTRACT: The problem of weeds tolerant to herbicides used in tomato culture is becoming more prevalent as a result of the increased use of herbicides weak on Solanaceae and Cyperaceae. The object of this study was to evaluate the available herbicides for the control of *Solanum sarachoides*, *S. nigrum*, *S. nodiflorum*, *Cyperus esculentus* and *C. rotundus*. Those herbicides showing the most promise were pebulate, prelant incor-

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porated and preemergence; chloramben, preemergence at planting; alachlor, GS 24705, and chloramben, postplant after the tomatoes are established; chloramben, postemergence directed or over the top; and 1,3-D and methyl bromide gel fumigation, preplant.

USE OF MBR 12325 TO RETARD WEED GROWTH IN FILBERT ORCHARDS

H. B. Lagerstedt[1]

ABSTRACT: MBR 12325 (*N*-[2,4-dimethyl-5-([(trifluoromethyl)sulfonyl]amino)phenyl]acetamide) is a growth retardant that also acts as an herbicide on some plants when applied in high concentration. It was used in the summer and full of 1976 to retard weed growth in the aisles of non-tilled filbert orchards. Summer applications of 0.28, 0.56, and 1.12 kg/ha ai were used in an effort to reduce the number of flail mowings required each growing season. Applications made prior to a flailing retarded growth satisfactorily for 4 weeks. The high concentration was only slightly more effective than the low. Applications made following flail mowing were not satisfactory. Fall applications of the above rates were used to retard weed growth prior to harvest. Nut drop occurs from early September to mid-October. No orchard travel is permitted during this time so the orchard floor must be prepared for harvest by September. Early fall rains may stimulate weed growth which in turn can impede nut sweeping and harvest operations. Pre-harvest applications of MBR 12325 were made August 26 and the treated aisles were flailed September 3. Growth retardation at this time of year proved to be of greater duration than with summer treatments. Very little regrowth of weeds occurred in treated aisles by harvest time as compared to control aisles. Grasses appeared to exhibit greater sensitivity to the growth regulator than did broadleaf weeds. It was noted that grass which germinated subsequent to the applications was killed. It is concluded that the duration of growth retardation from summer applications of MBR 12325 is insufficient to replace more than one flail mowing. However, fall applications were effective in checking vegetation regrowth until nut harvest was completed.

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CONTROLLING WEEDS IN PECANS BY SHEEP, GEESE, DISK, OR HERBICIDES

J. W. Whitworth[1]

ABSTRACT: New Mexico pecan growers are still looking for satisfactory methods of weed control. Grazing by sheep and geese puddled the soil and let unpalatable weeds escape, mechanical tillage caused tree damage and root pruning, the use of herbicides proved expensive and often caused tree injury, and the current system of a weedy ground cover controlled by flail mowing often resulted in unthrifty trees.

In 1971 the safety of 10 herbicide treatments was field tested by soil incorporating the herbicides into intimate contact with presprouted or with sprouting pecan nuts. Only DCPA proved really safe on pecans but along with the oxadiazon and trifluralin treatments failed to control infestations of annual morningglory (*Ipomea* spp.), spurred anoda [*Anoda cristata* (L.) Schlecht], and yellow nutsedge (*Cyperus esculentus* L.). Norflurazone, S-6706 (a norflurazone related compound), napropamide + S-6706, EPTC + S-6706, simazine, DCPA + simazine, and trifluralin + simazine gave weed control ranging from 97 to 79% but reduced the stand and growth of the seedling pecans. In 1972 DCPA and a dinitramine + simazine combination proved safe but gave poor weed control. The other 14 treatments gave inadequate weed control and reduced stands and growth of pecans.

From our 1974 screening trials a triazine compound (3-cyclohexyl-6-[dimethylamino]-1-methyl-*S*-triazine-2,4[1*H*,3*H*]-dione) emerged with an excellent broad spectrum, long term weed control rating and a suggested selectivity on pecans. This compound was tested on a 5 acre tract of 3-year-old pecans in 1976 in comparison with four other pecan herbicides, and at 2.3 kg/ha maintained the plots free of weeds for the entire growing season except for rhizome johnsongrass (*Sorghum halepense* L.). Initial readings indicate this triazine compound is highly selective on pecans.

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THE EFFECT OF SOIL FUMIGATION ON EQUISETUM ARVENSE

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

ABSTRACT: Fall (November 1975) and spring (March 1976) applications of dichloropropene (Telone), SMDC (Vapam), and sodium azide (PPG-103) were made at different rates in a field know to be heavily infested with *Equisetum arvense*. Fall application of dichloropropene at 30, 40, and 60

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gal/A provided satisfactory to excellent control through the 1976 growing season. SMDC at 60 gal/A gave excellent control until mid-summer and was only satisfactory by harvest time. Sodium azide at 400 lb/A resulted in good *Equisetum* control but 100 and 300 lb/A were too light. None of the treatments demonstrated any harmful effects visually or on yield in the 1976 carrot crop. Spring treatments of dichloroprepene and SMDC were unsatisfactory due to an apparent loss of material from excessive moisture and inadequate sealing of the soil surface. Sodium azide was not applied as a spring treatment.

MILK THISTLE SEED GERMINATION

James A. Young, Raymond A. Evans, and Robert B. Hawkes[1]

ABSTRACT: A native of the Mediterranean region, milk thistle *(Silybum marianum)* has become very commin in agricultural sections of California. Studies of seed population and seedbed dynamics of this species offer insight into the factors that control distribution of large seeded (achened) thistles in agricultural environments. One month after harvest milk thistle seeds had temperature-related after-ripening requirements that limited germination to 10 to 20 C temperatures. The rate of breakdown of the afterripening requirements was dependent on temperature. Generally the higher the incubation temperature the longer the afterripening requirement was up to a maximum of 5 months. Once afterripening requirements were satisfied milk thistle seeds germinated over a wide range of temperatures from 0 to 30 C. Optimum germination occurred with cold (2 C) to cool (10 to 15 C) 16 hr periods alternating with 8 hr warm periods of 10 to 30 C. The vigorous seedlings of milk thistle had reduced emergence with increased depth of burial, but substantial emergence occurred from 8 cm deep. Germination on the surface of the soil or litter was greatly reduced compared to that with slight soil or litter coverage. Potassium nitrate (KNO_3) added to the germination substrate at 0.1 to 1.0 mmole enhanced the germination of milk thistle seeds at 2 and 5 C incubation temperatures.

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LITTER AS A FACTOR IN WESTERN JUNIPER COMPETITION AND CONTROL

James A. Young and Raymond A. Evans[1]

ABSTRACT: Western juniper (*Juniperus occidentalis*) has invaded sagebrush (*Artemisia*) grasslands and increased in density during the last 100 years. Competition from the established junipers has reduced stands of desirable browse and forage plants. In the semi-arid environments where western juniper grows, competition for moisture is usually of vital importance in determining survival of plant species. Preliminary studies indicate that western junipers are highly competitive users of available soil moisture. In any woodland situation light is usually an important competition factor. In western juniper woodlands the relatively open aspect of tree spacing apparently limits the importance of competition for light. The annual litter fall which for western juniper is composed of leaf and bark scales plus some small twigs, greatly exceeds the annual rate of decay. This results in huge accumulations of litter beneath the tree canopies. This accumulation of litter influences competition within the juniper woodlands both by providing a seedbed unsuitable for germination and growth of herbaceous vegetation and by accumulating large amounts of nutrients that are unavailable for plant growth. The nutrient aspect of competition is further complicated by the excessive amounts of nitrogen necessary for decomposition of the litter. The litter accumulations interact with control measures (1) by possible interferring with the activity of soil-applied herbicides and (2) because the recycling of the litter nutrient sinks must be accounted for in any conversion of western juniper woodlands.

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ENHANCING SURVIVAL OF PLANTED CONIFERS WITH HERBICIDES ON DRY SITES

Edward J. Dimock II[1]

ABSTRACT: Rehabilitation of forests decimated by fire or windthrow is often hampered by rapid development of grasses and forbs that outcompete newly planted conifers. Controlling vegetation with chemicals should enhance seedling survival in dry, grassy habitats, but only one herbicide - dalapon - is now registered for limited forestry use east of the Cascade Range.

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In one trial series begun in 1975, herbicides were sprayed topically over exposed and protected ponderosa pine and Douglas-fir seedlings shortly after planting at 4 locations on Oregon's Wallowa-Whitman National Forest. Dalapon at light (4 lb ai/A) and moderate (8 lb ai/A) rates gave fair to good grass control, but little forb control, the first summer after spraying. A mixture of dalapon (8 lb ai/A) and atrazine (4 lb ai/A) gave excellent grass control plus forb control ranging from fair to excellent at all locations. Moreover, residual effects of the dalapon-atrazine mixture clearly persisted with revegetation significantly delayed through the second growing season. No damage to conifers was evident with any treatment whether seedlings had been protected at time of spraying or not. Following two generally cool, moist summers, survival of ponderosa pine sprayed with dalapon-atrazine mixture (58%) significantly surpassed that of unsprayed pines (36%) or those sprayed with light rates of dalapon (32%). Survival of Douglas-fir, however, was high over the same time period and did not consistently vary between spray treatments.

A second trial series, begun in 1976 on the same Forest and also on Washington's Wenatchee National Forest, compared the same dalapon-atrazine mixture with dalapon (8 lb ai/A) and atrazine (4 lb ai/A) used alone. Vegetation control with the mixed herbicide formulation was again superior. No damage to ponderosa pine was noted, but dalapon used alone or in mixture slightly damaged Douglas-fir at one location. Survival of both conifers was excellent and did not differ by treatment after one year.

CONTROLLING RED SHANK REGROWTH WITH FOLIAGE AND SOIL APPLIED HERBICIDES

T. R. Plumb and J. R. Boozer[1]

ABSTRACT: Tests were conducted on two chaparral sites on the Cleveland National Forest in southern California to determine the effect of foliage and soil applied herbicides on sprouting red shank (*Adenostoma sparsifolium* Torr.). The brush on the test sites, at 3000 and 4500 feet elevation, was crushed by tractor chaining during the winter of 1973-74. A water emulsion containing 2 lb ae each of the butoxyethanol esters of 2,4-D and dichlorprop per 98 gal of water and 1 gal of diesel oil was sprayed on individual plants at both sites in January, May, and August 1975 with a 3-gal pressure sprayer.

Average plant kill 12 months after treatment was low, ranging from 20% for the January application to 6% for the August application. During this time, the average volume of the live plants decreased to 40 and 57% of the initial plant volume for the January and August application respectively. The volume of untreated control plants increased an average of 287% during the first 12 months of this study.

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Foliage applications of the triisopropanolamine salt of picloram at 1/2 lb ae plus 2,4-D at 2 lb ae per 99 gal of water and the triethylamine salt of triclopyer at 3 lb ae per 99 gal of water killed 70 and 95% of the plants respectively. Live volume of the surviving plants was reduced to about 1% of the initial volume.

Picloram pellets (10% ai) at 1/2 oz per plant and karbutilate (10% ai) at 1 oz per plant were applied in a narrow band around the root crowns of individual plants in January at the 4500-foot site. The 1/2 oz rate of picloram killed 98% of the plants. Results from a demonstration project on an adjacent area indicated that 1/4 oz of picloram was lethal to most plants. On the other hand, Karbutilate was ineffective; no plants were killed and 12 months after treatment, plant volume was 236% of the initial volume.

EVALUATION OF HERBICIDES IN WESTERN FOREST NURSERIES

R. E. Stewart[1]

ABSTRACT: Few herbicides are now registered or sufficiently proven for use in forest nurseries so expensive hand-weeding is often used to control herbaceous weeds in conifer seedling beds. Hand-weeding costs range from $50 to over $200 per acre even in fumigated beds. A study to evaluate herbicides for weed control was started at four nurseries in California, four in Oregon, and five in Washington during 1976 in an attempt to reduce seedling production costs.

Diphenamid, trifluralin, DCPA, chloramben, and an untreated control were tested at all 13 nurseries. In addition, propazine, chloroxuron, profluralin, oryzalin, napropamide, glyphosate, Velpar [3-cyclohexyl-6-(dimethylamine-1-methyl-1,3,5-triazine-2,4(1H,3H)-dione], butralin, methazone, bifenox, chloroprophan, perfluidone, and cyperquat were tested at a minimum of two nurseries. Conifer toxicity was evaluated on Douglas-fir, five species of pines, four species of true firs, coast redwood, and western hemlock; only two to four species were used at each nursery. Herbicides were incorporated before sowing, broadcast immediately after sowing, or broadcast 30 days after conifer seedling emergence. Treatments were applied using a small-plot pressurized sprayer to replicated 3 foot x 4.5 foot plots.

Weed control was evaluated by comparing total dry weight of weeds collected from treated plots with weed weight from untreated plots (6 to 12 replications per treatment at each nursery). Phytotoxicity to germinating and seedling conifers (3 replications per species at each nursery was evaluated in terms of seedling survival, total height, and damage rating at the end of the first growing season. These evaluations show diphenamid, DCPA, napropamide, butralin, methazol, and bifenox to be of sufficient effectiveness and safety to justify additional testing. Velpar produced excellent weed control at the rate tested but severely damaged conifers. It should be evaluated at much lower application rates.

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ALLELOPATHY OF LEAFY SPURGE

Deborah A. Steenhagen and R. L. Zimdahl[1]

ABSTRACT: Greenhouse studies were conducted to determine if leafy spurge (*Euphorbia esula*) would exert allelopathic effects on non-related plant species. In initial studies leafy spurge leaf material, that had been dried and ground, was incorporated into greenhouse soil (peat:sand: loam; 1:1:1) at a concentration of 1% (W/W). Four weeks after germination, tomatoes growing in the treated soil showed a 30% inhibition in growth when compared to plants growing in non-treated soil, based on plant height. Dry weight comparisons showed a 37% decrease for those plants growing in the treated soil. After determining this initial effect the following four parameters were studied: 1) The effect of specific plant parts of leafy spurge on growth inhibition of test species; 2) The influence of autoclaving dried and ground leafy spurge plant material on the subsequent growth inhibition of test species; 3) The effect of varying levels of soil fertility in the bioassay on the degree of growth inhibition obtained; 4) The degree of inhibition obtained using different test species in the bioassay. All leafy spurge plant parts listed exhibited an inhibitory effect on the test species, with leaves being slightly more toxic than roots or stems. Autoclaving the leafy spurge material prior to addition to the soil did not influence the growth inhibition obtained. The degree of inhibitory response varied with the species tested, with some plants not being as sensitive as others. Results thus far obtained indicate that leafy spurge does exhibit allelopathic characteristics.

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MOVEMENT OF WATER SOLUBLE HERBICIDES ON SEMIARID RANGELANDS

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ABSTRACT: The Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500) require that we restore and maintain our water quality. For agricultural activities on rangelands this means that we must understand the hydrologic systems present under any given set of conditions, and be able to predict the effects of various land uses including livestock grazing and range improvement practices.

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In July, 1976, two adjacent watersheds on the Santa Rita Experimental Range were each divided into four geomorphic zones of differing slope and degree of gully erosion. Dimethylamine salt of 2,4-D was applied to a relatively flat zone within each watershed. Triethylamine salt of 2,4,5-T was applied to a second relatively flat zone within each watershed; however, these zones were adjacent to the gullied zones of the watersheds. Picloram and dicamba were applied to zones which were deeply incised by gullies and were the zones closest to the measuring flume. All herbicides were applied by hand sprayers at rates of 1.12 kg/ha in water (carrier) at total volume of 93 L/ha. Herbicide concentrations in the soil and vegetation on each zone were determined 0, 1, 2, 4, and 8 weeks after application. Continuous records of rainfall and runoff were obtained from recording equipment. In addition, water and sediment were sampled at 3-min intervals throughout five events which occurred, and were analyzed by gas-liquid chromatography.

No 2,4-D was detected in runoff water or sediment from either watershed, but measurable quantities of 2,4,5-T were found in runoff water from four of the five rainfalls. Picloram and dicamba were detected in water from all five (runoffs). Total amounts of herbicides removed from the watersheds during the five runoff events (over a period of 78 days after treatment) amounted to less than one percent of the amounts applied. Severely eroded zones and zones closest to the measuring flumes yielded the largest quantities of herbicides.

HERBICIDES FOR WEED CONTROL IN WESTERN FOREST NURSERIES[1]

R. E. Steward[2]

Introduction

Use of herbicides in western forest tree nurseries is very limited at present. Weed control practices include fumigation, repeated sprays of diphenamid or DCPA, and extensive hand weeding. Herbicides that have potential or demonstrated applicability for nursery use are available. Before these chemicals can be registered and accepted by nurserymen, they must undergo thorough testing at various locations to develop effective and safe treatments. Such treatments must produce acceptable weed control (greater than 70-percent reduction in weeds) and must be safe for use with important conifer species (no significant damage or soil persistence at twice the dosage required for weed control).

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[1]This publication reports research involving pesticides. It does not contain recommendations for their use nor does it imply that the uses discussed have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

[2]Forestry Sciences Laboratory, USDA Forest Service, Corvallis, OR

No coordinated effort has been made to develop herbicides for forest tree nursery use in the Western United States. Sporadic efforts have occurred at individual nurseries (2, 3, 4, 5, 6, Newton[3] et al. 1976) but results have not been used at other nurseries because of differences in soils, climate, and tree species. The economic incentive for replacing hand weeding with chemical weeding is sizeable--as much as a 75-percent reduction in weed control costs and $6 per thousand in seedling production costs (5). Hand weeding costs for 1976 averaged $125 per acre at one nursery in western Washington after fumigation. Some beds are weeded as many as five times. A broad-based study with a common experimental design, installed at many nurseries is needed to identify promising herbicides and to develop data for registration. Such a study will also provide nurserymen with the information and confidence they need to use herbicides in local weed control practice.

This study and the results reported here are the initial phase of a 3-year research program designed to identify promising herbicides, develop data for product registration, and demonstrate safe and effective weed control practices. The entire program is described in a study by Ron Stewart, Steve McDonald, and Larry Abrahamson.[4] The objectives of this study are to evaluate the effect of various herbicides on herbaceous weeds and on 1st-year seedlings of five genera of conifers (*Pseudotsuga, Abies, Pinus, Tsuga, and Sequoia*) at western forest nurseries.

Methods

Herbicides were evaluated at 13 nurseries in California, Oregon, and Washington (Table 1). The nurseries had a variety of conifer species, herbaceous weeds, nursery management practices, climatic conditions, and soil types. Analysis of soil samples obtained from treated beds shows that the nurseries are typically located on light-textured sandy soils (Table 2).

Diphenamid, trifluralin, DCPA and chloramben are presently registered for nursery weed control. These four chemicals and an untreated control were tested at all 13 nurseries. An additional 14 herbicides were evaluated at two to five selected nurseries. All chemicals were applied at manufacturers' recommended dosages and timing (Table 3), and all prescribed application times for a herbicide were tested at the same nursery.

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[3]Newton, M., J. Lemhouse, and R. K. Hermann. 1976. Chemical weed control in western conifer nursery beds--research and program development. For. Res. Lab., Oregon State University, Corvallis. 18 p. (Unpublished).

[4]Stewart, R. E., S. McDonald, and L. Abrahamson. 1976. An Administrative Study for Herbicide Screening and Weed Control Demonstration in Western Forest Tree Nurseries 1976-1980. Pacific Northwest Forest and Range Experiment Station, Corvallis, OR (Unpublished).

Table 1. Location and ownership of western forest nurseries.

State	Ownership	Name	Location
California	U.S. Forest Service	Humboldt	McKinleyville
	U.S. Forest Service	Placerville	Placerville
	State of California	Ben Lomond	Santa Cruz
	State of California	Magalia	Magalia
Oregon	U.S. Forest Service	Bend	Bend
	State of Oregon	D. L. Phipps	Elkton
	Weyerhaeuser	Aurora	Aurora
	Weyerhaeuser	Klamath Falls	Bonanza
Washington	U.S. Forest Service	Wind River	Carson
	State of Washington	L. T. Webster	Olympia
	Industrial Forestry Assn.	Greeley	Olympia
	Industrial Forestry Assn.	Toledo	Toledo
	J. Hofert Company	Hofert	Olympia

Table 2. Properties of soils at western forest nurseries.

			Particle size distribution				
Nursery	Soil type	pH	Organic matter	Sand	Silt	Clay	Cation exchange capacity
Humboldt	loam	5.08	6.9	49.9	29.0	23.2	19.9
Placerville	clay loam	5.72	3.5	34.5	35.7	29.7	19.3
Ben Lomond	sandy loam	5.40	5.1	72.9	15.9	11.2	14.1
Magalia	clay loam	5.28	9.6	27.1	39.7	33.2	26.9
Bend	sandy loam	5.15	3.9	68.0	17.8	14.2	15.4
D. L. Phipps	sandy loam	5.33	1.4	73.5	12.9	13.6	11.3
Aurora	sandy loam	5.40	2.1	72.6	16.4	11.0	13.1
Klamath Falls	loamy sand	6.02	1.2	82.0	6.9	11.1	8.6
Wind River	loam	5.20	4.9	42.9	39.2	17.8	13.2
L.T. Webster	sandy loam	4.90	3.9	69.7	20.7	9.6	11.9
Greeley	sandy loam	5.28	6.5	63.1	24.3	12.6	19.1
Toledo	sandy loam	5.70	1.8	63.1	25.4	11.4	11.8
Hofert	loamy sand	5.50	3.5	78.2	12.9	8.9	12.6

Table 3. Herbicides, rates, and application timing of treatments tested at western forest nurseries.

Herbicide	Rate	Application timing: Pre-seeding incorporation	Post-seeding	Post-germination
	lb ai/A			
Standard Treatments				
Untreated	--[a]	--	--	--
Chloramben	4	--	--	X[b]
DCPA	10.5	--	X	X
Diphenamid	4	X	X	X
Trifluralin	0.75	X	--	--
Selected Treatments				
Bifenox	3	--	X	X
Butralin	2	X	X	X
Chloroxuron	4	--	X	X
Chlorpropham	3	X	X	X
Cyperquat	2.5	--	--	X
Glyphosate	0.75	--	--	X
Methazole	1	--	X	X
Napropamide	3	X	X	X
Oryzalin	3	--	X	X
Oxadiazon	3	--	X	X
Perfluidone	2	--	X	--
Profluralin	0.75	X	--	--
Propazine	1.5	--	X	X
Velpar	1.5	--	X	X

[a]No application
[b]Application

Nursery bed space limitations restricted the total number of treatments to 16 for each conifer species. Treatments were applied to 3-foot-long plots in 4-foot-wide nursery beds with a 1-foot untreated buffer strip between plots. All 16 treatments were applied to three contiguous 64-foot-long sections of bed in a randomized block design with three replications for each species. Herbicides were applied with a small plot pressurized sprayer. The herbicides were mixed with a water carrier at a volume equivalent to 85 gpa. Granular chloramben was applied from a shaker.

Herbicides were evaluated on one to four species at each nursery (Table 4). Pre-seeding incorporated treatments were applied no more than 1 day before seeding and incorporated into the top 2 inches of soil using a garden rake. Post-seeding treatments were applied within a few hours after seeding; post-germination treatments were applied 4 to 5 weeks after conifer seedling emergence.

Table 4. Conifer species tested at each nursery.

	Pseudotsuga	Pinus					Abies				Others	
Nursery	Douglas-fir	Ponderosa pine	Lodgepole pine	Sugar pine	Scotch pine	Monterey pine	Noble fir	White fir	Red fir	Grand fir	Coast redwood	Western hemlock
California												
Humboldt	x[1]	x	-	-	-	-	-	-	x	-	-	-
Placervile	-[2]	x	-	x	-	-	-	-	x	-	-	-
Ben Lomond	x	-	-	-	-	x	-	-	-	-	x	-
Magalia	x	x	-	-	-	-	-	x	-	-	-	-
Oregon												
Bend	-	x	x	-	-	-	-	-	-	-	-	-
D. L. Phipps	x	x	-	-	-	-	-	-	-	-	-	-
Aurora	x	-	-	-	-	-	-	-	-	-	-	x
Klamath Falls	-	x	x	-	-	-	-	-	-	-	-	-
Washington												
Wind River	x	x	-	-	-	-	x	-	-	-	-	-
L. T. Webster	x	-	-	-	-	-	-	-	-	-	-	-
Greeley	x	-	-	-	x	-	x	-	-	-	-	x
Toledo	x	x	-	-	-	-	x	-	-	-	-	x
Hofert	x	-	-	-	x	-	-	-	-	x	-	-

[1]Tested
[2]Not tested

All plots except those receiving post-germination sprays of glyphosate, Velpar[5] [3-cyclohexyl-6-(dimethylamino)-1-methyl-1,3,5-triazine-2,4 (1*H*,3*H*)-dione], chloroxuron, and cyperquat were hand weeded several days before application of post-germination treatments. Plots were then periodically weeded during the remainder of the growing season. Weeds were collected from each plot, dried for 72 hours at 70 F, and weighed in order to estimate weed weights. Herbicidal damage to conifers at the end of the first growing season was evaluated using a 10-point scale (0 is complete kill, 10 is no effect) proposed by Anderson (1). Height of nine randomly selected rows in each plot was also measured to determine chemical effects on seedling growth and survival.

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[5]The use of trade, firm, or corporation names is for the information or convenience of the reader. Such use does not constitute an official endorsement or approval by the U. S. Department of Agriculture.

Results

Broadleaf herbaceous species were the most common problem at all 13 nurseries. The most important and most frequently occurring weeds were jerusalemoak goosefoot, common purslane, corn spurry, sandspurry, shepherdspurse, filaree, redroot pigweed, Australian burnweed, common groundsel, common lambsquarters, and common dandelion. Annual bluegrass was the most common grass and a cover crop of winter wheat was a problem at one nursery.

Dry weight of weeds collected from plots at all nurseries is summarized in Table 5; data are averaged for all conifer species. Twelve treatments from eight herbicides produced at least 70 percent season-long reduction in weeds. The herbicides were: bifenox, chloroxuron, chlorpropham, napropamide, oryzalin, oxadiazon, propazine, and Velpar. In addition, DCPA, butralin, and methazole produced more than 50 percent weed control. These results suggest that monthly applications of herbicides will not be necessary to obtain good nursery weed control.

Incorporated treatments are more difficult and expensive to apply than broadcast sprays. In this study, incorporated treatments did not produce weed control sufficiently better than broadcast sprays to warrant further testing. Post-seeding sprays were usually more effective than post-germination sprays for total season weed control reflecting the greater number and vigor of weeds that emerge earlier in the season. Propazine, oryzalin, oxadiazon, and chlorpropham, however, reduced late season weed populations by at least 70 percent. Five other herbicides reduced late season weeds by 50 percent or more (bifenox, butralin, DCPA, methazole, and Velpar).

Damage ratings resulting from treatment of conifers are summarized in Tables 6, 7, and 8. Of the herbicides producing satisfactory weed control, only bifenox, DCPA, methazole, napropamide, and propazine did not significantly damage Douglas-fir and true firs (Table 6). There were, however, some exceptions: methazole on true firs, napropamide post-seeding on noble fir, and propazine post-seeding applications on Douglas-fir.

Pines seem to be more resistant than other species to the herbicides tested (Table 7). Eight herbicides (bifenox, butralin, chloroxuron, DCPA, napropamide, oxadiazon, profluralin, and propazine) were promising for weed control on most pine species. Exceptions were oxadiazon post-seeding treatments on Monterey and Scotch pine, profluralin on lodgepole pine, and propazine and bifenox post-seedling on lodgepole pine.

Western hemlock and coast redwood, both minor species in most bare-root nurseries, were most sensitive to herbicides (Table 8). Only butralin, DCPA, and napropamide show promise for weed control in beds of these two species. Even then, post-germination sprays of DCPA and all applications of butralin caused some damage to coast redwood at the rates tested.

In general, herbicides were more damaging when applied at the time of seeding. Sprays applied 4- to 5-weeks after conifer seedling emergence were less damaging. Unfortunately, most weed problems need treatment at time of seedling.

Table 5. Effect of herbicides on dry weight of herbaceous weeds.

Treatment		Nurseries	Dry weight of weeds as a percentage of untreated		
			Post seeding	Post germination	Total season
		Number	Percent		
Untreated		13	100	100	100
Bifenox	- post-seeding	5	4	42	29
	- post-germination	5	100	38	60
Butralin	- incorporated	4	28	41	34
	- post-seeding	4	31	59	45
	- post-germination	4	67	39	53
Chloramben	- post-germination	13	90	56	70
Chloroxuron	- post-seeding	5	6	42	20
	- post-germination	5	--[1]	405	159
Chlorpropham	- incorporated	2	14	37	28
	- post-seeding	2	14	23	19
	- post-germination	2	85	27	49
Cyperquat	- post-germination	2	--	168	164
DCPA	- post-seeding	13	27	44	37
	- post-germination	13	102	42	68
Diphenamid	- incorporated	13	39	92	66
	- post-seeding	13	28	77	56
	- post-germination	13	86	60	72
Glyphosate	- post-germination	5	--	277	184
Methazole	- post-seeding	5	29	46	38
	- post-germination	5	91	38	61
Napropamide	- incorporated	4	32	26	28
	- post-seeding	4	24	30	28
	- post-germination	4	89	56	70
Oxyzalin	- post-seeding	3	10	11	11
	- post-germination	3	78	11	29
Oxadiazon	- post-seeding	3	10	24	16
	- post-germination	3	67	13	43
Perfluidone	- post-seeding	2	8	43	43
Profluralin	- incorporated	5	25	103	52
Propazine	- post-seeding	4	3	22	13
	- post-germination	4	97	29	61
Trifluralin	- incorporated	13	24	56	42
Velpar	- post-seeding	5	16	4	7
	- post-germination	5	--	35	25

[1]Not tested

Table 6. Effect of herbicides on seedling Douglas-fir and true firs.

Herbicide		Average damage rating by species[1]				
		Douglas-fir	Noble fir	Grand fir	Red fir	White fir
Untreated		9.3	9.9	8.0	9.4	10.0
Bifenox	- post-seeding	9.1	10.0	9.3	--[2]	10.0
	- post-germination	9.2	9.7	8.0	--	9.3
Butralin	- incorporated	8.3	10.0	--	--	--
	- post-seeding	9.2	10.0	--	--	--
	- post-germination	9.6	10.0	--	--	--
Chloramben	- post-germination	9.4	9.1	8.0	7.9	9.3
Chloroxuron	- post-seeding	4.9	2.0	--	9.3	9.0
	- post-germination	6.1	2.3	--	5.3	7.0
Chlorpropham	- incorporated	6.2	7.7	1.3	--	--
	- post-seeding	6.3	3.7	1.0	--	--
	- post-germination	6.2	6.0	3.3	--	--
Cyperquat	- post-germination	9.7	--	--	7.5	--
DCPA	- post-seeding	8.4	9.4	7.0	9.4	9.7
	- post-germination	9.2	9.9	8.3	8.0	9.7
Diphenamid	- incorporated	9.5	9.9	8.7	7.2	10.0
	- post-seeding	9.6	9.7	8.7	10.0	9.3
	- post-germination	9.4	10.0	8.3	9.0	9.7
Glyphosate	- post-germination	8.5	9.3	--	7.3	9.3
Methazole	- post-seeding	9.5	3.3	--	9.3	--
	- post-germination	9.8	0.3	--	6.3	--
Napropamide	- incorporated	9.4	10.0	8.0	9.3	9.3
	- post-seeding	9.0	7.0	8.3	9.3	10.0
	- post-germination	9.9	10.0	8.3	9.7	10.0
Oryzalin	- post-seeding	2.5	--	--	--	--
	- post-germination	4.0	--	--	--	--
Oxadiazon	- post-seeding	3.0	3.7	--	5.0	--
	- post-germination	7.3	7.3	--	7.0	--
Perfluidone	- post-seeding	6.0	--	--	9.7	--
Profluralin	- incorporated	8.1	10.0	--	7.0	--
Propazine	- post-seeding	5.4	10.0	--	--	--
	- post-germination	10.0	10.0	--	--	--
Trifluralin	- incorporated	7.2	9.9	8.0	8.9	10.0
Velpar	- post-seeding	3.4	--	--	1.3	--
	- post-germination	6.0	--	--	2.7	--

[1]10 is no effect, 0 is complete kill

[2]Not treated

Table 7. Effect of herbicides on seedling pines.

Herbicide		Average damage rating by species[1]				
		Ponderosa pine	Lodgepole pine	Sugar pine	Monterey pine	Scotch pine
Untreated		9.8	9.0	7.3	10.0	8.0
Bifenox	- post-seeding	9.9	7.5	--[2]	--	8.7
	- post-germination	9.3	9.5	--	--	8.7
Butralin	- incorporated	9.7	8.0	--	10.0	10.0
	- post-seeding	9.8	8.0	--	10.0	10.0
	- post-germination	8.7	8.5	--	10.0	10.0
Chloramben	- post-germination	9.2	6.7	7.3	10.0	8.7
Chloroxuron	- post-seeding	9.7	--	--	--	--
	- post-germination	8.2	--	--	--	--
Chlorpropham	- incorporated	--	--	--	--	6.3
	- post-seeding	--	--	--	--	5.5
	- post-germination	--	--	--	--	6.0
Cyperquat	- post-germination	10.0	--	--	--	--
DCPA	- post-seeding	9.8	8.7	7.3	10.0	9.8
	- post-germination	9.5	8.2	7.0	10.0	9.0
Diphenamid	- incorporated	9.6	8.0	8.0	10.0	9.5
	- post-seeding	9.7	8.5	8.3	10.0	9.7
	- post-germination	9.6	8.9	7.3	10.0	8.8
Glyphosate	- post-germination	8.9	--	7.7	--	--
Methazole	- post-seeding	9.5	6.3	7.0	--	--
	- post-germination	7.8	3.3	7.0	--	--
Napropamide	- incorporated	9.7	--	7.0	--	7.3
	- post-seeding	9.9	--	8.0	--	7.3
	- post-germination	9.8	--	7.3	--	8.7
Oryzalin	- post-seeding	7.7	4.3	--	--	--
	- post-germination	5.7	5.0	--	--	--
Oxadiazon	- post-seeding	8.7	--	--	8.0	2.3
	- post-germination	9.7	--	--	10.0	10.0
Perfluidone	- post-seeding	9.0	--	--	--	--
Profluralin	- incorporated	9.7	7.0	--	10.0	--
Propazine	- post-seeding	8.2	3.3	--	10.0	--
	- post-germination	10.0	9.3	--	10.0	--
Trifluralin	- incorporated	9.9	8.2	7.3	10.0	9.3
Velpar	- post-seeding	1.9	0	1.0	--	--
	- post-germination	7.4	0	3.0	--	--

[1]10 is no effect, 0 is complete kill

[2]Not tested

Table 8. Effect of herbicide on seedling western hemlock and coast redwood.

Herbicide		Average damage rating by species[1]	
		Western hemlock	Coast redwood
Untreated		9.7	10.0
Bifenox	- post-seeding	--[2]	--
	- post-germination	--	--
Butralin	- incorporated	10.0	7.3
	- post-seeding	10.0	7.7
	- post-germination	10.0	8.3
Chloramben	- post-germination	7.2	7.3
Chloroxuron	- post-seeding	6.3	--
	- post-germination	4.0	--
Chlorpropham	- incorporated	4.7	--
	- post-seeding	3.7	--
	- post-germination	7.0	--
Cyperquat	- post-germination	--	--
DCPA	- post-seeding	9.4	9.7
	- post-germination	9.3	7.0
Diphenamid	- incorporated	9.3	1.7
	- post-seeding	9.2	3.3
	- post-germination	9.7	7.3
Glyphosate	- post-germination	--	--
Methazole	- post-seeding	4.0	--
	- post-germination	0.8	--
Napropamide	- incorporated	10.0	--
	- post-seeding	10.0	--
	- post-germination	10.0	--
Oryzalin	- post-seeding	0	--
	- post-germination	2.0	--
Oxadiazon	- post-seeding	7.7	8.3
	- post-germination	7.7	6.0
Perfluidone	- post-seeding	--	--
Profluralin	- incorporated	5.3	7.7
Propazine	- post-seeding	4.0	7.3
	- post-germination	7.7	8.7
Trifluralin	- incorporated	6.8	5.7
Velpar	- post-seeding	1.0	--
	- post-germination	1.3	--

[1] 10 is no effect, 0 is complete kill

[2] Not tested

Based on the results of this study, the following herbicides and treatments should be eliminated from future tests: all incorporated treatments, chloroxuron for use on conifers, glyphosate post-germination, and oryzalin. The effectiveness of Velpar at 1.5 lb for weed control suggests that lower rates may be possible to obtain acceptable weed control and greater safety on conifers. The following rate and application changes are suggested for future tests: Velpar reduced to 0.5 lb, oxadiazon reduced to 1 lb, chlorpropham reduced to 1 lb, and glyphosate changed to a fall application for late season weed control.

Tests conducted during 1977 in western forest nurseries will examine conifer phytotoxicity and weed control effectiveness of 3 lb ai per acre bifenox, 2 lb butralin, 10.5 lb DCPA, 4 lb diphenamid, 3 lb napropamide, and 0.5 lb Velpar. Post-seeding and post-germination 1X and 2X rates of each herbicide will be tested on conifers; a 1X rate only will be tested on large plots for weed control. Effects of repeated sprays on both conifers and weed control will be examined using 1X post-seeding + 1X post-germination applications of each chemical. In addition, glyphosate will be tested as a fall treatment at 0.75 lb ai per acre in nurseries with a significant fall weed problem. Herbicides eliminated in the second year of testing may be added again during the third year if they prove promising in nursery tests now being installed in the Rocky Mountain-Great Basin Region.

Scientific Names of Species

Weeds

jerusalemoak goosefoot *Chenopodium botrys*
common purslane *Portulaca oleracea*
corn spurry *Spergula arvensis*
sandspurry *Spergularia* spp.
shepherdspurse *Capsella bursa-pastoris*
filaree *Erodium* spp.
redroot pigweed *Amaranthus retroflexus*
Australian burnweed *Erechtites prenanthoides*
common groundsel *Senecio vulgaris*
common lambsquarters *Chenopodium album*
common dandelion *Taraxacum officinale*
annual bluegrass *Poa annua*
winter wheat *Triticum aestivum*

Conifers

Douglas-fir *Pseudotsuga menziesii*
ponderosa pine *Pinus ponderosa*
lodgepole pine *Pinus contorta*
sugar pine *Pinus lambertiana*
Scotch pine *Pinus sylvestris*
Monterey pine *Pinus radiata*
noble fir *Abies procera*
white fir *Abies concolor*
red fir *Abies magnifica*
grand fir *Abies grandis*
coast redwood *Sequoia sempervirens*
western hemlock *Tsuga heterophylla*

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PROPER PERSPECTIVES OF PESTICIDE TOXICOLOGY

Alice Ottoboni[1]

In order to put the subject of pesticide toxicology into proper perspective, we must first consider what is pesticide toxicology. Is it different from food toxicology, or cosmetics toxicology, or drug toxicology? Is there something unique or special about pesticides that makes them follow toxicologic principles that are different from those for all other chemicals? The answers to these questions is an unequivocal "No".

Toxicology is that branch of science that deals with the harmful effects of chemicals. And pesticides are just chemicals, as are foods, drugs, household products, the walls, floor and furniture in this room, the plants outside, and we humans ourselves. Our whole physical world is chemical.

Then why do we single out pesticides from all other categories of chemicals and label them as poisons? It is because of our practice of classifying chemicals according to the use to which we put them, the functions they perform, or the shape in which they occur naturally. Thus, we have the categories mentioned above - foods, cosmetics, drugs, household products, plants, etc. Pesticides are just one category of chemicals in our lives - and a relatively small category at that. They

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are a group of chemicals that we use to kill the things that we categorize as pests, and to the average person, anything that kills something is a poison. However, the classification of chemicals is a very flexible and arbitrary process. Many chemicals, including pesticides, fall into more than one category. For example, boric acid is a herbicide when it is used to kill weeds, an insecticide when used to kill cockroaches, a household product when used to wash clothes, and a drug when used as an eyewash. The use to which a chemical is put does not change its properties; boric acid has the same toxicity when it is used as a drug as when it is used as an insecticide. There is nothing special, unique or magic about pesticide toxicology. Pesticides follow the same laws of nature, the same laws of toxicology, as do all other chemicals.

What makes a chemical harmful (toxic)? Probably the most important factor in whether or not a chemical will do us harm is what is known as the dose-time relationship. How much of the chemical are we exposed to - a little bit or a lot - and how often are we exposed -- one time or many times? Acute toxicity refers to the ability of a chemical to do harm as a result of a one-time or brief exposure, such as in the case of an accidental ingestion by a child or an accidental spill of a chemical in a work situation or in transportation. Chronic toxicity refers to the ability of a chemical to do harm as a result of repeated exposures over long periods of time. Exposures of this sort would be, for example, food additives, pesticide residues in foods, or chemicals in the workplace. There is no chemical, including pesticides, that is always harmful in every combination of dose and time. Small amounts of the anticoagulant compounds that are classed as rat poisons are used and are essential to prevent blood clotting after surgery. And small amounts of fluoride, a very highly toxic chemical acutely, are essential for good dental health. Conversely, there is no chemical that is always harmless. We have had several deaths in California among children who have eaten too much table salt, all at one time, when mother wasn't looking.

The importance of the dose-time relationship (how much and how often) in determining whether or not a chemical will be harmful is best illustrated by the fact that every one of us ingests many lethal doses of many chemicals in our lifetime. There is a lethal dose of caffeine in about 100 cups of coffee. Thus, we coffee drinkers ingest a lethal dose of caffeine about once a month. There is a lethal dose of oxalic acid in 10 to 20 pounds of spinach or rhubarb. There is a lethal dose of the alkaloid solanine in 20 to 40 pounds of new potatoes. There is a lethal dose of Vitamin D in about 100 pounds of sardines or in about 1600 gallons of irradiated milk. The list is endless. How can we eat so many lethal doses of so many things and not even get sick, much less die, from them? Because of the dose-time relationship - we don't eat them all at once, but rather in divided amounts over a period of time. Our bodies are capable of handling these amounts and getting rid of them. It is only when we take in more than our bodies can handle, when we exceed the body's natural capacity to detoxify, that harmful effects occur. This is true for all chemicals, including pesticides.

You have perhaps noticed that most of the chemicals I have mentioned thus far are naturally occurring chemicals. There is a common misconception on the part of the general public that natural chemicals are good and man-made, or synthetic, chemicals are bad. Actually, Mother Nature is far more ingenious at devising toxic chemicals than man could ever be. Our bodies can't distinguish between natural or man-made chemicals. Our bodies can only distinguish between chemicals they can use to make more of themselves -- more muscle, blood, bones, etc.-- and those they can't use. The former we call biochemicals and the latter foreign chemicals. No animal, including man, could survive without the elaborate mechanism, present in each one of us, that is designed specifically to detoxify foreign chemicals, natural or man-made.

Another factor that is very important in determining whether or not a chemical will do us harm is how we are exposed -- how the chemical gets into our bodies. Do we eat it -- do we breathe it in -- does it go through our skin? The three ways a chemical can enter our bodies are by ingestion, inhalation, and dermal (skin) absorption. Many chemicals are toxic only by ingestion. They do not penetrate the skin, which, as a general rule is a pretty good barrier, and they are not dusty or do not have sufficient vapor pressure to become airborne so that we can inhale them. Some chemicals that do become airborne, such as the organic solvents, may be toxic by ingestion and inhalation. And still others, such as the organophosphate pesticides, may be equally toxic by all three routes of exposure.

People who work with chemicals are not usually exposed by the oral route -- they don't eat the chemicals they work with unless they are sloppy about not washing their hands before eating or smoking or getting their lunches contaminated on the job. Thus, the prime concern of people who work with chemicals is for their dermal and inhalation toxicities. Pesticides, like all other chemicals, vary widely in dermal and inhalation toxicity. The only general rule that can be given to protect against adverse effects from these types of exposures is to read the label. The label will tell what protective measures should be taken.

The general rule of "Read the Label" applies to all chemicals that you use, whether it be in your hobbies, house maintenance, painting and cleaning, automobile maintenance, garden care, or in the medications you take. All chemicals, including pesticides, can cause harm if misused, and can be safe when used properly.

PROPER PERSPECTIVES OF WEED SCIENCE IN AGRICULTURE AND PUBLIC AFFAIRS

Dick Beeler[1]

Modern scientific farming and all of the vast food producing community are in trouble today. Weed science is an integral part of agriculture, and everyone in the field of weed science is in the same kettle of soup. You all share in the trouble and grief that plagues agriculture.

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How do we know we are in trouble? When it takes from 10 to 15 million dollars to put a new agricultural chemical on the market, and over half of that expense is caused by the EPA, you most certainly know you are in trouble. There are several reasons why our industry is in the mess, and all of them are over-regulation. There is only one reason for that over-regulation. Ignorance. There is only one cure for the ignorance. Education. The ignorance is ignorance of agriculture, of biological science, of chemicals and economics.

Appalling ignorance of those matters exists at every level in American society and throughout the national congress and the state legislatures. On the other hand, there certainly is no ignorance of those matters in this room. The real educational job is outside those doors -- nearly everywhere you go out there you can find appalling ignorance of nearly everything you talk about in here. Yet you are spending three days here in this room talking among yourselves. Perhaps the worst part of it all is that the ignorance among those people out there has been encouraged and increased by a relatively small, energetic, highly vocal percentage of our population.

American agriculture is the victim of a word war: years of unfavorable writing and distorted reporting have brought on gross misconceptions, a tarnished image, crippling penalties, and, worst of all, over- regulation. It is bad enough to be unloved, but when you find the cops on your back all day long, innocent or not, you simply have to do something about it.

We all know how we got into this predicament. We all know in great detail about how Rachel Carson started the ball rolling and how the Sierra Club, the Environmental Defense Fun, Arthur Godfrey, Jane Fonda, Teddy Kennedy, the New York Times, and all the rest of them have been on our backs ever since. What we can't understand is how they managed to do this to us -- and to all the rest of America. They did it with words.

Words can be the most powerful destructive force known to man. Words can render impotent the mightiest war machines and bring the greatest of nations to their knees. Words are the only weapons that can conquer the minds of men. Clever words, skillfully strung together and repeated often enough can make you into a Nazi, a Moonie, a Socialist or a sucide. They can sell you the Brooklyn Bridge, Vitamin E, Technocracy, ESP, or an Edsel car. They can defeat not only armed force but scientific fact, philosophical truth and even moral law.

On the other hand, words can also be an overwhelming force for good. Use them with facts, the truth, and good moral inspiration, and they are the only effective defense against misrepresentation and lies.

In mounting a word campaign that is designed to correct a wrong -- in our case to set facts straight and defend an industry -- it naturally helps to use words well and to write skillfully, but such artistry is not essential, and it will never be a satisfactory substitute for a solid foundation of knowledge and for adherence to the truth on the part of the speaker or writer. The successful propagation of a lie depends upon the way it is told, but the truth thrives on simplicity.

In the past few years the agricultural community, and particularly those of us concerned with the uses of agricultural chemicals, has suddenly awakened to the need for some kinds of public relations activity. Unfortunately, as is sometimes the case when one ventures outside his field of expertise, there are misconceptions about public relations. These range from mystery and fear to overconfidence in theories that are completely off the tract. The truth of the matter is that the kind of public relations program that will work for agricultural chemicals and weed science is disarmingly simple. And the keys to its success are surprisingly similar to those in any other legitimate endeavor: hard work, perserverance, dedication, honesty and common sense.

Most suggestions we hear for an agricultural public relations program involve gimmicks like bumper stickers, tricky slogans, posters, farm-city live-in exchanges, TV commercials by John Wayne, and so forth. The job that needs to be done is educational. Many of you are educators. Would you suggest bumper stickers, John Wayne and farm-city live-ins as educational devices?

As educators, you know how gimmicks are a waste. You know that one-time flash in the pan shots are also ineffective. In public relations, as in the classroom, a beautiful presentation is no substitute for good facts. A poor speaker or writer of the truth is more convincing than a silver-tongued liar. But, of course, the liar will win out if he is the only one who mounts the rostrum. Joseph Goebbels proved that.

Since World War II there has been a growing avalance of anti-business and anti-science demagoguery in the United States. It comes in large measure from the same people who gave us the environmentalist mystique: populist politicians, sensation peddling journalists, labor leaders, professional consumer advocates and a wide range of anti-establishment activists.

What they lack in facts and understanding, they make up in their zeal and their colossal gall. Few of them are ladies and gentlemen, and it is easy to reason that they don't deserve the dignity of an answer. But they are dedicated and persistent, and all too often, theirs are the only voices heard. Almost without exception, these are people who lack knowledge of agriculture, chemistry, biology and even the basic economic facts of life. Our public relations objectives must be clear: to try to educate some of these people about agriculture, about science, and perhaps even a little economics. Better yet it would be if we could educate the great masses of citizens who hear from these people constantly and never hear from us. Finally, we must recognize our limitations of time and money, and we must concentrate in the most effective places.

No segment of agribusiness will ever have the time or money to conduct a massive compaign aimed directly at the American public. Fortunately, that probably is not necessary. We can concentrate on fewer, more potent targets: Senators, congressmen, state legislators, and the news media. The agricultural community has thousands of members who are expert in the fields of biology, chemistry, and agricultural economics. Everyone in this room falls into that category. You are qualified to defend agriculture from those who attack it and to reverse much of the harm that has been done. You are better qualified to do that job than you realize -- more qualified than almost everyone else.

Of course it is not enough to know the truth and to be on the right side of things. Nearly all of us have been too timid for too long. We who have the scientific and factual ammunition have abandoned the battlefield to a Coxey's army of empty-headed noise makers.

Many of us have expected the few big corporations that serve agriculture to come forth with a proper defense and thereby save us all.

Surely, one might think, those outfits have the money, legal talent, and seasoned public relations experts to do the job. Their vested interests would seem to warrant a hugh, overwhelmingly effective effort. While we have had some strong, encouraging help from these quarters, the corporate leaders, just like politicians, are often intimidated or misled by the strident cries of a few dissident stockholders and street marchers. They are afraid to speak out about the absolute necessity of profits, the need to take risks, the obligations of labor, and the damages done by too much government.

Many in middle management positions are afraid of retribution from government regulatory agencies. As a result, corporate public relations and advertising programs often become bland in attempts to present corporate music in harmony with the crazy sounds they hear from the TV, radio, and street rallies. In some cases corporations have pulled out of agricultural chemicals altogether rather than pour capital into what appears to be a lost battle. Any man, whether he be a big business leader or a minor employee, who fails to defend his own industry when he himself sould seem to stand to gain the most, is all the more vulnerable to false accusations and public misunderstanding. If you won't defend yourself, who will?

One of the beneficial side effects of agriculture's political misfortunes has been a strengthening of the ties between industry and the agricultural colleges: in our case, between agricultural chemicals manufacturers and land grant and extension weed scientists. Each has gained a healthy respect for the other and for the advantages of a close working relationship. This close tie has extended into the area of government and public relations. It is gratifying and productive to have industry throw its weight behind the agricultural extension service for example, and for the extension service to support commercial herbicide products from industry. Each of us needs the other, and that is particularly true in this matter of public relations.

We must defend ourselves. The American public and the American congress desperately need an education about agriculture, including weeds, weed control, and herbicides. Few are equipped better than you in this room to do the job. You don't need a slick Madison Avenue operator. You probably couldn't use him if you had one. How do you start? Make an appointment with the editor of your local home-town newspaper. Establish yourself as a reliable reference source; tell him you want to help every time he gets a story that involves weeds, weed killing pesticides, or whatever else you are qualified to explain. Sit down and write a letter to your senators and your congressmen. If you wonder what to write about, just watch the papers for a day or so and you'll have plenty of material. Most of you belong to a church, civic group, or a service club. They are all looking for speakers, and nothing is of more interest to them than the food situation. Offer to talk.

Those are just a few ideas, and they are simple. But they will work, and the thing for you to keep in mind is that they are just about the only things that will work. So far the only thing you lack is the inclination.

Good Luck!

PROPER PERSPECTIVES OF THE EPA ROLE IN WEED SCIENCE

Ellery L. Knake[1]

At the national and regional levels we have always considered research, education, and regulation as three major roles for members of the weed science team.

With the creation of EPA we found ourselves with a new young team member. This youngster was a composite of lawyers, some experienced professionals, some young "environmentalists," and administrators with varied backgrounds. The "growing-up stage" has been a little difficult. But considerable progress has been made and EPA is now in about that difficult "teenage" stage. I'm optimistic that by encouraging mutual respect and cooperation, we can help EPA to play their role for the benefit of our entire team and for the benefit of those we serve.

I urge you to invite EPA staff to professional meetings and "out to the country." As we learn to work together, we'll find solutions to the seemingly complex problems.

One of the major roles of EPA is registration of pesticides. Industry, and more recently the registration division, have both undergone some rather traumatic experiences. EPA keeps reminding us that they have over 30,000 pesticides to register or reregister. However, with only about 150 active ingredients for herbicides, that portion would not seem too complex with a little Trumanistic administration.

Experimental use permits have caused some concern for public-supported scientists. However the current regulations or guidelines appear to be sufficiently ambiguous and contradictory to allow most public-supported scientists considerable freedom if we don't panic.

Providing an information retrieval system such as the Herbicide Compendium is one responsibility of EPA, even if not mandated by law. A contractor for EPA recently started working on the Compendium. If brought up to date, hopefully EPA staff can maintain it. Microfiche is currently available and might gain some acceptance if accuracy can be improved and potential users can be convinced that it is convenient. However, microfiche should not be considered a replacement for the compendium.

Some progress is being made on classification of pesticides. Hopefully EPA will continue to seek assistance from the scientific community and user groups.

Training programs are being established and accepted fairly well. Unfortunately there are signs that EPA plans to decrease emphasis on their educational role. If so, training, which should be on a continuing long range program, may falter. Certification of pesticide applicators has been accepted fairly well where procedures have been kept relatively simple. Progress has been hampered by lack of classification of pesticides and because some state plans have not yet been approved.

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[1]Department of Agronomy, University of Illinois, Urbana, IL 61801

Enforcement actions thus far have been aimed primarily at industry. Actions against applicators could increase, depending on EPA's posture.

Issuance of Pesticide Enforcement Policy Statements (PEPS) has been an innovation of the Enforcement Division. They are intended to allow some flexibility. However, many of the PEPS would not be necessary if regulations reflected the intent of the law (FEFPCA) more accurately and were less restrictive. One problem has been finding someone willing to assume the responsibility of a "knowledgeable expert." However, the definition of "knowledgeable expert" has been broadened in more recent PEPS.

The RPAR (Rebutable Presumption Against Registration) and benefit-risk assessment programs will likely result in increased funding and staff for USDA. Hopefully, much needed pesticide use surveys can be initiated to help provide essential information. Both EPA and USDA will need to be on guard so that their adversary roles on some issues do not hamper cooperation.

Although seemingly plagued with deterrents to progress, EPA is helping to assure the judicious use of an increasing amount of pesticides. There has been some evidence of a desire to base decisions on scientific facts rather than emotion even when "political pressure" has been applied.

EPA might well place more emphasis on encouraging research on new alternative control methods for weeds. The surface has hardly been scratched.

Although USDA will likely play the primary role in Pest Management, encouragement and cooperation from EPA would seem appropriate. Pest Management can provide one of the most viable and practical means for adding increased precision to weed control on the farm. Increased involvement by weed scientists should be encouraged.

EPA is playing a role in weed science. They can be villains or heroes. Most individuals prefer to be heroes. Weed scientists can help EPA assume their proper role if we maintain a positive, optimistic attitude and encourage mutual respect and cooperation.

METABOLISM AND DEGRADATION OF DIFENZOQUAT IN PLANTS, ANIMALS AND THE ENVIRONMENT

I. P. Kapoor and J. E. Boyd[1]

ABSTRACT: Difenzoquat [1,2-dimethyl-3,5-diphenyl-1H-pyrazolium methyl sulfate] wild oat herbicide is a quaternary salt which is highly water soluble, partitions strongly in favor of water, has negligible vapor pressure and is quite stable to hydrolytic conditions. It is strongly adsorbed to soil particles and does not leach or run off appreciably. It is readily degraded photolytically as thin films on glass and soils to yield the

[1]American Cyanamid Company, Princeton, J. J.

demethylated tertiary amine analog, 1-methyl-3,5-diphenyl pyrazole (which is volatile and only slightly toxic) and small amounts of hydroxylated analogs which retain the quaternary group. Difenzoquat is metabolically inert primarily due to its inherent quaternary salt properties and is not degraded by biological systems. It is excreted intact and is not accumulated in the tissues of treated animals. When applied to foliar surfaces of wild oat, barley and wheat, the penetration is rapid and translocates mainly in the acropetal direction. It disappears from plant and soil surfaces primarily by the demethylation-volatilization mechanism and does not leave significant non-difenzoquat residues. Under field conditions, follow-crops do not take up any detectable residues from soil treated the previous season. Apparent difenzoquat residues in soil are not significantly altered when it is used as a tank-mix combination with MCPA, bromoxynil or MCPA plus bromoxynil. Difenzoquat does not persist in an aquatic environment and has a low order of acute toxicity to fish. Difenzoquat does not accumulate in fish and is relatively nontoxic to mallard ducks, bobwhite quail or honeybees.

A RESEARCH REPORT ON TEBUTHIURON

B. J. Eaton, J. D. Magnussen, D. P. Rainey, and G. C. Todd[1]

ABSTRACT: Tebuthiuron is a new broad spectrum herbicide being developed by Eli Lilly and Company. Tebuthiuron has a low order of toxicity in mammals, birds, and fish. The acute oral LD_{50} was determined to be 579 mg/kg in mice, 644 mg/kg in rat, 286 mg/kg in rabbit, and LD_{50} was greater than 500 mg/kg in dog, chicken, quail and duck. The TL_{50} was 144 ppm in trout and 112 ppm in bluegill. In three-month oral subacute studies, tebuthiuron at 1000 ppm had no apparent effect in rat and dog. Two-year chronic studies in rat revealed no important adverse effects. Tebuthiuron at 200 mg/kg caused no dermal irritation in rabbit and 71 mg/eye in rabbit caused no significant effects. Rat, rabbit, dog, mallard and fish readily absorb, metabolize and excrete tebuthiuron. There is no major binding of tebuthiuron or its metabolites in animal tissues.

Tebuthiuron is stable on soil, surfaces and in aqueous solutions. It is non-volatile, non-corrosive and non-flammable. The half-life of tebuthiuron in soil is approximately 12 months in temperate regions that receive about 40 inches annual rainfall. Tebuthiuron or its metabolites have rarely been detected below 12 inches in soil after more than three years in radio-labeled field studies.

Tebuthiuron is readily absorbed from soil and translocated by plants. Phytotoxicity symptoms suggest tebuthiuron inhibits photosynthesis. Two metabolic pathways have been defined in plants. Demethylation and hydroxylation of tebuthiuron appear to be the primary metabolic processes involved.

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[1]Eli Lilly and Company, Greenfield IN 46140

Tebuthiuron controls a broad spectrum of plants including woody plants. Tebuthiuron at 1.0 to 12.0 lb/A a.i. has demonstrated good activity against 93 species of annual broadleaf weeds, 60 species of perennial broadleaf weeds, 33 species of annual grass weeds, 21 species of perennial grass weeds and 58 species of woody plants. Tebuthiron is registered for use as a total vegetation control herbicide. Experimental use permit programs are in progress for weed control in sugarcane and control of undesirable woody plants in rangeland and pastures. Other possible uses include annual weed control in pastures and control of undesirable woody plants for reforestation.

An 80 percent wettable powder formulation and a 20 percent pellet formulation are available.

MINUTES OF THE WSWS BUSINESS MEETING
March 17, 1977

President Elmore called the meeting to order at 10:20 a.m. Minutes of the 1976 WSWS business meeting were accepted as printed in the Proceedings of WSWS, Vol. 29, by unanimous vote.

Officers for 1977-78 and Fellows elected were announced as follows:

President	L. S. Jordan
President-Elect	R. D. Comes
Secretary	A. H. Lange
Business Manager/Treasurer	J. L. Anderson
Chairman, Research Section	A. G. Ogg, Jr.
Chairman-Elect., Research Section	R. F. Norris
Chairman, Education and Regulatory Section	H. Kempen
WSSA Representative	G. A. Lee
Fellow	J. L. Anderson
Fellow	A. H. Lange

J. LaMar Anderson

LaMar Anderson was born in Wisconsin and grew up in Idaho were his father was a plant research scientist with a major western seed company. LaMar returned to Wisconsin for graduate school and received his Ph. D in Plant Pathology from the University of Wisconsin in 1961. He is a 15 year veteran of the Western Society of Weed Science and has contributed substantially to the success of this society.

LaMar currently is Professor of Plant Science at Utah State University in the Plant Science Department. He is currently serving as President of the Faculty Association at Utah State University as well as being involved in weed science research and teaching in horticultural crops. His current weed science research activities include studies on the sustained use of herbicides on plant sommunities and computer modeling of growth of weed species.

LaMar has served as Treasurer-Business Manager of WSWS for the past 12 years. He has been active in WSSA where he has served on the editorial board of Weed Science and several other committees

Arthur H. Lange

Art Lange received his B.S. and M.S. degrees in Horticulture from Oregon State University and his Ph.D. in Plant Physiology from UCLA. He has been an Assistant Professor at the University of Arizona, on the staff at the University of Hawaii and worked for the Pineapple Research Institute in Honolulu, Hawaii. In 1962 he joined the University of California Cooperative Extension Service and has worked as a weed specialist in California since that time.

Art has served WSWS as Chairman of the Education and Regulatory Section, Chairman of Project 4--Horticultural crops, and is currently Secretary of the Society. He has been very active in his weed control research and extension activities in California.

TREASURER-BUSINESS MANAGER REPORT

The following financial statement was presented by LaMar Anderson, WSWS Treasurer-Business Manager. The report sovers the period March 1, 1976 to March 1, 1977.

Income

Registration, Portland Meeting (274)	$ 1379.00
Dues, members not attending Portland Meeting (85)	170.00
1976 Research Progress Report Sales	1572.62
1976 Proceedings Sales	1655.21
Sale of old publications	95.00
Payment of outstanding accounts	15.00
Luncheon tickets	858.00
Advance order payments	76.00
Interest on savings	47.38
Total Income	5859.21
Assets, March 1, 1976	5195.67
	$ 11,054.88

Expenditures

Annual meeting incidental expenses	$ 229.85
1976 Research Progress Report printing costs	876.69
1976 Proceedings	2273.70
Office Supplies	265.03
Business Manager Honorarium	250.00
Luncheon, Coffee break expenses	1091.05
Postage	558.74
Luncheon Speaker	152.00
Placques	49.45
Refunds	5.00
Total expenditures	$ 5751.51

Assets

Savings Certificates	3200.00
Checking account	2053.37
Cash on hand	50.00
	$ 5303.37

FINANCE COMMITTEE REPORT

R. H. Callihan (Chairman), A. F. Gale, L. L. Whitendale

Chairman Bob Callihan reported that the audit of the books and financial report indicated that both were accurate. The motion to accept the report was seconded and carried unanimously.

SITE SELECTION COMMITTEE REPORT

G. Massey (Chairman), J. O. Evans, S. Heathman

Hawaii, excluding Honolulu, was presented as the first choice of the committee with San Diego, California and Salt Lake City, Utah as second and third choices, respectively. After considerable discussion and an indication that the Hawaii location would limit attendance, this site was rejected by the majority of WSWS members in attendance. A motion was made, seconded, and passed to accept Salt Lake City as the site for the 1980 WSWS meetings.

PLACEMENT COMMITTEE REPORT

Stassen Soong (Chairman), R. A. Fosse, S. Radosevich

The placement room was open for two days with books from WSWS available showing positions open and positions desired.

RESOLUTIONS COMMITTEE REPORT

J. L. Reed (Chairman), S. R. Radosevich, H. Hepworth

The following resolution was proposed and accepted to be sent to all State Experiment Station Directors in the Western States: "Be it resolved, that the Experiment Station directors be requested to increase the priority of applied and production research and that immediate attention be given to crop production, soil and water management, and weed control."

WSSA REPRESENTATIVE REPORT

Representative Gary Lee prepared a report which was presented by Clyde Elmore in Gary's absence. Items discussed were as follows:

1. The page charge for Weed Science will remain at $30 per page, which is in the lower 10% charged by comparable societies. The Finance Committee recommended that WSSA continue to provide financial support for Weeds Today. The charge for the new Herbicide Handbook will be increased from $5 to between $7.50 and $10.00.

2. Dr. L. L. Danielson will replace D. E. Davis as Editor of Weed Science. A new colored brochure entitled "Careers in Weed Science" will be completed in the near future and will be available to colleges and universities for dispersal to students. A new monograph, entitled Adjuvants and Herbicides, is being prepared and will be published in 1977. A monograph dealing with vegetative management in limited tillage systems is also being prepared.

3. WSSA will continue active participation in the Inter-Society Consortium for Plant Protection (ICPP). Funds have been made available for a WSSA representative to attend the ICPP meetings.

4. The 1978 WSSA meetings will be held February 7 - 9 at the Dallas Hilton Hotel in Dallas, Texas. the 1983 meeting will be held in Seattle, Washington.

EDUCATION AND REGULATORY SECTION

Chairman Alvin Gale reported that Harold Kempen would be Chairman for the 1978 WSWS meeting.

Harold Alley moderated a panel discussion concerning participation of Federal Government in State Weed Control Programs. George Hittle, Wyoming Department of Agriculture, discussed how Wyoming obtained money from the federal government for noxious and designated weed control on federal lands. Wyoming sent a state delegation to Washington D.C. to meet with their Congressional delegation and agency heads of BLM, U.S. Forest Service and other agency heads to obtain federal assistance. George Hittle said, "They did not know the Wyoming group when they arrived in Washington D.C., but they damm sure knew who they were when they left".

Also as part of this panel, Dennis Isaacson, Oregon Department of Agriculture, discussed three Federal Acts that states should be aware of before trying to obtain federal assistance. These Acts were the Carlson-Foley Act, Forest and Rangeland Renewable Resource Act and Federal Noxious Weed Act. A lively discussion followed the presentations.

Chairman Gale said that he hoped all states in the Western Region had a representative at the session. He was disappointed that more people did not attend this excellent session.

RESEARCH SECTION REPORT

L.C. Burrill, Chairman

The reports were summarized by the Project Chairman during the business meeting. Chairmen for 1978 and Chairmen-Elect for 1979 are noted in each project report.

PROJECT 1 REPORT: Perennial Herbaceous Weeds, Stanley Heathman, Chairman

There were 77 in attendance at the Perennial Herbaceous Weeds Section. Discussions followed in three main areas of interest. Steve Kimball is the Chairman for 1978, with Wayne Belles as Chairman-Elect.

A discussion concerning the use of fumigation for control of perennial herbaceous weeds was led by A. H. Lange. A gel formulation of methyl bromide injected into moist beds, with the bed tops then removed and the crop planted in the treated areas had been relatively successful in controlling yellow nutsedge. However, temperature, soil type and the amount of soil moisture present will influence the results. The high cost and variation in control has continued to limit the use of soil fumigation.

K. C. Hamilton presented data indicating that where glyphosate was applied at 2 or 3 month intervals during two growing seasons to purple nutsedge or bermudagrass grown under ideal conditions and with no competition or cultivation, eradication could not be achieved. Discussion indicated that crop competition, cultivation and use of other herbicides improved the probability of weed eradication.

W. B. McHenry described some of the environmental factors that influenced the response of perennial herbaceous weeds to glyphosate and other herbicides. It was evident that the environment had an important effect on plant response. Dry weather and cold temperatures were known to affect weed control. It is difficult to isolate these responses because of their complexity or control them, but they must be considered.

H. P. Alley reported that Dowco 290 had good activity on Canada thistle and Russian knapweed with some selectivity on native grasses. Dowco 233 was mentioned as showing excellent control of field bindweed.

PROJECTS 2 and 3 REPORT: Herbaceous Weeds on Range and Forest/Undesirable Woods Plants, H. L. Morton and T. N. Johnsen, Jr., Co-chairmen

A joint meeting of these two projects was held. Roger Rohbough and L. E. Warren are co-chairmen for the 1978 joint meeting. T. R. Plumb is Chairman-Elect for the reorganized project meeting in 1979. An average of 56 persons attended the sessions, 33 registered.

Brief generalized statements of problem areas and concerns followed by informal discussions were led by R. E. Stewart on Brush and Weed Control on Forest Sites, T. R. Plumb on Chapparal Woodlands, T. M. Johnsen on Pinyon-Juniper Woodlands, R. A. Evans on Sagebrush-Rabbitbrush and Herbaceous Range Weeds, H. L. Morton on Southwestern Mesquite Ranges and M. C. Williams on Poisonous Range Weeds. Very informative exchanges of information took place during the sessions. In general, concern was expressed about the safety of various control methods along with a need to understand what these methods do to the total environment and the multiple products produced. There was much discussion of the need for alternative control methods and techniques and the use of integrated systems approaches to range and timber management with brush and weed control being considered part of the overall management system. Conflicting management goals and changing land use patterns were mentioned as concerns in planning brush and weed control projects. A need to determine the total economics of losses due to brush and weeds was discussed, especially with poisonous plants which cause losses other than animal deaths. The danger of introducing untested plants into rangeland areas without knowing their potential as possible poisonous plants was emphasized.

Limitations imposed by losses of the use of certain herbicides, a restriction on uses of fire and mechanical control measures was also discussed. It was noted that we must inform others of our work and aims in order to obtain understanding and possible backing of what we are doing.

After discussion it was unanimously recommended to formally join Projects 2 and 3 into a single project with the same amount of time for meeting together as presently allotted. This was presented at the WSWS business meeting as a recommendation to the Executive Committee for appropriate action.

It was also recommended to request $300 from WSWS for the cost of typing the Woody Plant Control manuscript, funds to be returned through the sale of the Manual. Steve Raddivich is to Chair this project, Ron Stewart having consolidated the materials.

PROJECT 4 REPORT: Weeds in Horticultural Crops, Robert H. Callihan, Chr.

Ron Oliver is the Chairman for 1978 and Larry Hiller was elected Chairman for 1979.

PROJECT 5 REPORT: Weeds in Agronomic Crops, Donald R. Colbert, Chairman

Paul E. Keeley is the Chairman for 1978 and J. Wayne Whitworth was elected Chairman for 1979.

Subject 1. Herbicides and Techniques for Nutsedge Control in Cotton, H. Kempen. The use of alachlor + charcoal is giving good nutsedge control but cotton tolerance is poor. Growers using rolling cultivators for incorporating herbicides at planting (ROECAP) could use this technique to improve crop safety. Using this technique; H 26910, DowCo 295, and DowCo 333 show promise. If chemicals are rototilled in prior to planting, the following gave good nutsedge control: H 26910, DowCo 295, DowCo 333, CGA 24705, and alachlor.

Subject 2. Preplant Herbicides in Alfalfa Establishment, W. McClellan. The following PPI herbicides gave good weed control in establishing a stand; benefin, butralin, profluralin, and EPTC. The seasonal effect of these herbicides is not an increase in yield but a healthier crop stand with increased protein.

Registered postemergence herbicides used are 2,4-DB ester and dinoseb. Post applications of bromoxynil have been looking good and hopefully will be registered in the future.

Presently, the most economical treatment in establishing an alfalfa stand is not using any herbicides. Based on total dry matter, weeds + alfalfa is the cheapest. But over the long run, the following should be taken into account; percent protein, kinds of weeds present (poison), dairy nutrition, and palatability.

Subject 3. Summer Annual Weed Control in Alfalfa, R. F. Norris. The problem weeds in California's Central Valley alfalfa are: barnyardgrass, yellow foxtail, livegrass, sandbur, nightshade, and pigweed. Of these, yellow foxtail is the most serious. EPTC water runs have been looking good, but growers are having problems because they are applying too late. The yellow foxtail has already germinated and is in the one to two leaf stage of growth.

The following herbicides were tested and resulted in poor summer annual weed control because of their short soil residual properties: HOE 23408, H 26910, Herc 22234, ethofumesate (severe alfalfa injury), napropamid, paraquat, weed oil, and glyphosate.

The best treatments to date are: (1) terbacil granules applied between cuttings, and (2) DPX 3674 granules after the second and third cuttings at .5 to 1.0 lb/A. This treatment looks very good.

Subject 4. Dodder Control in Alfalfa, B. Fischer. Early June applications of H 26905 to attached dodder at 1, 2, and 4 lb/A gave good to excellent control. Combinations with 2,4-DB ester and bromoxynil look good in controlling weeds and dodder at the same time. However, Hercules Chemical Company has recently stopped all research with H 26905. Hopefully some other company will pick up this compound for future development.

J. O. Evans and Amchem personnel have shown some good dodder control with applications of butralin to attached dodder.

PROJECT 6 REPORT: Aquatic and Ditchbank Weeds, Obren Keckemet, Chairman

R. W. Schumacher was elected as Chairman for Project 6 Section for the 1978 meeting and D. E. Seaman as Chairman-Elect.

The program for Project 6 consisted primarily of questions-answers and discussions with the main emphasis on the following topics:

1. Application Methods which would result in placing less chemicals in the environment as well as financial savings, such as inverts, slow-release formulations, bottom applications, and similar. These types of application have been used widely in Florida during recent years but not to any significant degree in the Western United States due to different conditions and practices.

2. Factors Affecting Efficiency of Control, such as water movement, temperature and thermal layers, pH and hardness of water, suspended solids, turbidity, stage of weed growth, and similar.

3. Need for Products to do a Better Job, new formulations of existing products, mixtures of existing products, and new products.

4. New Weeds occurring in waters of the Western United States. Les Sonders, of the California Department of Agriculture, discussed discovery of *Hydrilla* in a lake near Marysville, California, the significance of this infestation and the approaches California are taking to erradicate the weed and keep it from spreading.

   R. D. Comes reported on the infestation of Eurasian milfoil in the Okanogan Valley of British Columbia, Canada, the rapid spread of this weed in Canada, and concern for the establishment and spread of the weed in the Columbia and Snake river systems of the Northwest.

5. Weed Control in Rice - D. E. Seaman discussed the problems with weed control in rice and its effect on rice yield as well as testing of various compounds for control. At the present time the only commercially available material for control of certain submersed weeds in flooded rice is Hydrothol 191 Rice Herbicide.

6. Glyphosate - R. W. Schumacher discussed briefly the disappearance and efficacy data for use of glyphosate for control of weeds in static waters as well as on ditchbanks in irrigation canals.

   R. D. Comes discussed some of the factors that affect the efficacy of glyphosate for the control and management of reed canarygrass on irrigation systems. Creeping red fescue, proposed as a replacement vegetation on ditchbanks infested with reed canarygrass, was shown to be quite tolerant of glyphosate at 1 lb/A in the seedling stage (5 to 10 weeks after seedling emergence). However, much of the tolerance was lost when 1-year-old creeping red fescue plants were treated with glyphosate.

7. E. J. Bowles, Pennwalt Corporation, discussed briefly results obtained with Hydrothol 191 Aquatic Weed Killer in 1976 treatments of irrigation canals in Idaho, California, and Arizona under an EPA Experimental Use Permit.

PROJECT 7 REPORT: Chemical and Physiological Studies, Floyd Colbert and Coburn Williams, Chairmen.

Chairman for 1978 will be M. C. Williams and Chairman-Elect for 1979 is Howard Morton.

F. O. Colbert, chairman of the project this year, was in Brazil so the Chairman-Elect, M. C. Williams, chaired the session. The subject for discussion was "Environmental Fate of Herbicides" moderated by D. G. Crosby, Environmental Toxicology, University of California, Davis. The speakers were K. W. Moilanen, Environmental Toxicology, University of California, Davis, who spoke on "Prediction of the Environmental Fate of Pesticides"; I. P. Kapoor, American Cyanamid Co., who spoke on "Metabolism and Degradation of Difenzoquat in Plant, Animals and the Environment", and B. J. Eaton, Lilly Research Laboratories, who spoke on "Tebuthiuron Research".

The speakers discussed the toxicity of trifluralin, difenzoquat, and tebuthiuron to plants and animals, their decomposition in the biosphere, and the effect of the chemicals and their metabolites on the environment. Considerable discussion was devoted to the need to inform the public better on the safety of pesticides, their minimal impact on the environment, and the consequences to our health and food supply should the use of agricultural chemicals be restricted or prohibited. The speakers devoted some time to discussing the decomposition of these chemicals. They were all subject to photodecomposition. The toxicity of metabolites was discussed and the relative futility of trying to test each and every metabolite for toxicity and other effects on the biosphere. The speakers were well prepared and lead interesting discussions on their topics.

Art Lange reported on a meeting which he attended concerning herbicide cancellation. He suggested that the President appoint a committee to draw together guidelines on the importance and benefits of weed control in Western crops. A discussion followed concerning what crops should be included, their priorities and the possibility of cooperation with other societies. No final decision was reached concerning this proposal.

President Elmore thanked the officers and members of the Society who worked diligently to insure the success of the meeting and of the Society. He then turned the meeting over to incoming President Lowell Jordan. Lowell expressed his appreciation to Clyde Elmore for the fine job he did.

The meeting was adjourned at 11:45 a.m.

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