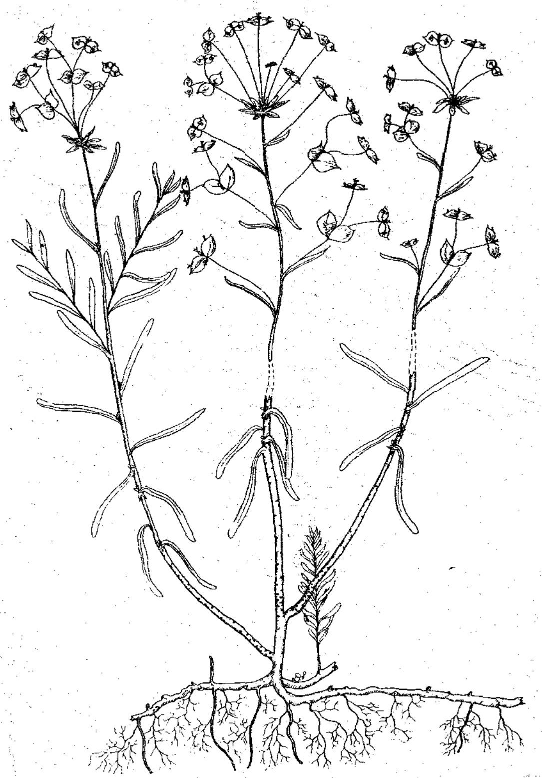
Howard L. Morton

1976

PROCEEDINGS

of

THE WESTERN SOCIETY OF WEED SCIENCE



Volume 29

March 16, 17, 18, 1976

Portland, Oregon

WESTERN SOCIETY OF WEED SCIENCE

1975 – 1976

Officers and Executive Committee

President – W. L. Anliker, CIBA-GEIGY Corporation, Vancouver, WA

President-Elect – C. L. Elmore, Botany Department, University of California, Davis, CA

Secretary – R. D. Comes, USDA-ARS, Research & Extension Center, Prosser, WA

Treasurer-Business Manager – J. LaMar Anderson, Plant Science Department, UMC 48, Utah State University, Logan, UT

Chairman Research Section – Robert Zimdahl, Department of Botany and Plant Pathology, Colorado State University, Fort Collins, CO

Chairman-Elect Research Section – L. Burrill, Oregon State University, Corvallis, OR

Chairman Education and Regulatory Section – Ronald J. Burr, Rhodia Inc., Corvallis, OR

Chairman-Elect Education and Regulatory Section – Alvin F. Gale, Agricultural Extension Service, Laramie, WY

Immediate Past President – Gary A. Lee, Idaho State University, Moscow, ID

WSSA Representative – David E. Bayer, Department of Botany, University of California, Davis, CA

Member-At-Large – Harry S. Agamalian, Cooperative Extension, University of California, Salinas, CA

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MINUTES OF THE BUSINESS MEETING

March 18, 1976

President Anliker called the meeting to order at 10:30 AM. Minutes of the 1975 WSWS business meeting were accepted as printed in the Proceedings of WSWS, Vol. 28, by unanimous vote.

Results of the election for officers, fellows, and honorary members were announced at the luncheon and reiterated at the business meeting. They are as follows:

President-Elect	L. S. Jordan
Secretary	R. J. Burr
Chairman-Elect, Research Section	A. G. Ogg, Jr.
Chairman-Elect, Education and Regulatory Section	Harold Kempen
WSSA Representative	G. A. Lee
Fellow	Arnold P. Appleby
Honorary Member	Dick Beeler

ARNOLD P. APPLEBY

Arnold Appleby was born in Formoso, Kansas on October 24, 1935, grew up on a Kansas farm and has been closely associated with agriculture ever since. He earned his B.S. degree in Agricultural Education and M.S. degree in Agronomy from Kansas State University in 1957 and 1958. He earned his Ph.D. degree from Oregon State University in 1962. That year he received the Phi Sigma Award as the Outstanding Graduate Student in Biological Sciences at Oregon State University.

Arnold remained with Oregon State University upon graduation; first as a weed science researcher at Pendleton and later as a researcher and teacher at Corvallis. He is currently leader of the Weed Science project at Oregon State University. His contributions to the development of weed control principles and practices in wheat, barley, corn, alfalfa, pastures, peppermint, potatoes, and noncropland are well known. Arnold teaches weed science courses at both the undergraduate and graduate level. His expertise as a teacher has been recognized by his students for many years, and was acknowledged by the Weed Science Society of America in 1971, when he received the CIBA-Geigy award as Outstanding Teacher in Weed Science.

In addition to serving on a host of committees for the various societies, he has served as Associate Editor of the Agronomy Journal and on the Editorial Board of the Weed Science Society of America. He served as Vice President of the Weed Science Society of America in 1974-1975 and was named a fellow of that Society in 1976. Arnold has held nearly every position in the Western Society of Weed Science including the office of President during 1971-1972.

Arnold Appleby's clear thinking, broad experience, keen sense of humor and relentless dedication to agriculture have distinguished him as a Weed Scientist.

DICK BEELER

Dick Beeler, a native of Kansas City, Missouri, received his degree in journalism from the University of Texas. He is a member of Sigma Delta Chi honorary journalism fraternity, and has served as an officer and director in several journalism and publishing associations.

After he was released from the Army in 1945 he moved to San Francisco, and in 1948 he became the owner and publisher of Animal Nutrition and Health. In 1958 he founded Agrichemical Age. He sold both national technical magazines to the California Farm Organization in 1973. He is currently editor of both magazines and managing editor of California Farmer.

FELLOWS AND HONORARY MEMBERS OF THE WESTERN SOCIETY OF WEED SCIENCE

HONORARY MEMBERS

Robert B. Balcom, 1968
*Walter S. Ball, 1968
A. S. Crafts, 1968
F. L. Timmons, 1968
D. C. Tingey, 1968
Lambert C. Erickson, 1969
*Jesse M. Hodgsen, 1969
Lee Burge, 1970
Bruce Thornton, 1970
Virgil H. Freed, 1971
W. A. Harvey, 1971
H. Fred Arle, 1972
Boysie E. Day, 1972
Harold P. Alley, 1973
K. C. Hamilton, 1973
Dick Beeler, 1976

FELLOWS

William R. Furtick, 1974
*Oliver A. Leonard, 1974
Arnold P. Appleby, 1976
Richard A. Fosse, 1975
Clarence I. Seely, 1975

*Deceased

REPORT OF AD HOC NECROLOGY COMMITTEE

Chairman Bill Harvey reported on the death of the following weed scientists during the past year: Walt Ball, Oliver Leonard, Vic Bruns, and Stan Ichikawa. The membership observed a moment of silence in respect for the deceased individuals.

TREASURER-BUSINESS MANAGER REPORT

The following financial statement was presented by LaMar Anderson, WSWS Treasurer-Business Manager. The report covers the period from March 1, 1975 to March 1, 1976.

Income

Registration, Phoenix Meeting (224)	$1120.00
Dues, members not attending Phoenix Meeting (84)	168.00
1975 Research Progress Report	1522.00
1975 Proceedings	1565.15
Sale of old publications	225.64
Payment of outstanding accounts	50.00
Industry contributions for coffee break	165.00
Advance order payments	42.00
Interest on savings	39.00
Luncheon tickets	750.00
Total Income	5646.79
Assets, March 1, 1975	4695.89
	$10,342.68

Expenditures

Annual meeting incidental expenses	511.12
1975 Research Progress Report	1348.50
1975 Proceedings	1463.50
Office supplies	58.70
Business manager honorarium	250.00
Banquet and coffee	888.50
Postage	332.11
Refunds	17.64
Plaques	63.70
1976 Research Progress Report	213.24
	$5,147.01

Liquid Assets	$5,195.67
Savings ($2,800.00)	
Checking ($2,356.67)	
Cash on hand ($39.00)	
Accounts Receivable	15.00
Potential Net Worth	$5,210.67

FINANCE COMMITTEE REPORT

A. F. Gale, L. S. Jordan and R. H. Callihan

Chairman Al Gale 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.

SITE SELECTION COMMITTEE REPORT

The 1977 and 1978 WSWS meetings will be held in Sacramento and Reno, respectively. Boise, Idaho was announced as the site for the 1979 meeting.

PLACEMENT COMMITTEE REPORT

R. A. Fosse, A. G. Ogg, Jr., L. Senior

Chairman Dick Fosse reported that they used the WSSA list of positions available and desired at the Portland meeting. The need for an organized effort to obtain background information on undergraduate and graduate students who are seeking employment was stressed.

WSSA REPRESENTATIVE REPORT

Representative Dave Bayer reported on activities of the WSSA that are of interest to the WSWS membership. Items discussed were as follows:

1. Beginning in the fall of 1976, WSSA membership dues will be reduced to $15 and student affiliate membership dues will be reduced to $7.50.

2. WSSA has joined the Inter-Society Consortium for Plant Protection (ICPP), a non-profit organization formed to respond to issues concerning pests and pesticides.

3. The 1977 meeting of WSSA has been changed from the Jefferson Hotel to Stoffers Riverfront Inn, St. Louis, Missouri.

4. The 1982 meeting of WSSA will be held in New Orleans unless the date coincides with the Mardi Gras. In that event, the 1982 meeting will be held in Dallas.

5. Members of WSWS that received awards and honors from WSSA this year were:

   Harold Alley - Outstanding Extension Award
   Arnold Appleby - Fellow
   Jean Dawson - Editor, WSSA Newsletter
   Robert Parker and M. C. Williams - Outstanding Paper Award

REPORT OF AD HOC PUBLICATIONS COMMITTEE

R. L. Zimdahl, G. A. Lee, H. Agamalian, R. D. Comes

Chairman Bob Zimdahl briefly discussed the need for Progress Reports to conform to editorial rules. Other areas discussed were:

1. The research project chairmen should serve as editors of Progress Reports, and the Research Chairman as compiler of the report.

2. The possibility that papers published in the Proceedings could become refereed journal articles.

3. The possibility of WSWS publishing reports of symposiums, etc., as separate reports or as a part of the Proceedings.

EDUCATION AND REGULATORY SECTION REPORT

Chairman Ron Burr reported that panel disucssions of "Laboratory Studies for Teaching Weed Science" and "Training Aids for Certification of Applicators and Consultants" were held.

Larry Burrill, Oregon State University; Robert Norris, University of California, Davis; and Robert Zimdahl, Colorado State University, discussed teaching techniques, topics covered and materials utilized in teaching weed science in their respective laboratories.

Bert Bohmont, Colorado State University; Dean Swan, Washington State University; and Steve Radosevich, University of California, Davis, briefly discussed the approaches used and types of materials available as training aids for certification of applicators and consultants in their respective states. Each panel member showed examples of the types of slides which were developed for these training programs. Alvin Gale will be the next Chairman and Harold Kempen was elected Chairman-Elect.

RESEARCH SECTION REPORT

R. L. Zimdahl, Chairman

The reports were briefly summarized by the Project Chairman during the business meeting. Chairman for 1977 and Chairman-Elect for 1978 are noted in each project report.

PROJECT 1 REPORT: PERENNIAL HERBACEOUS WEEDS, D. G. Swan, Chairman

The project met for 1 1/2 hours. Sixty persons signed the roster, but approximately 100 were present for the discussion.

Control of Bermudagrass, purple nutsedge, Canada thistle, Russian knapweed, field bindweed, and field horsetail was discussed. The perennial herbaceous weed papers are published in the 1976 Research Progress Report, pp. 1-28.

Stan Heathman, University of Arizona, is the Chairman in 1977, and Steve Kimball, Monsanto Company, was elected Chairman for 1978.

PROJECT 2 REPORT: HERBACEOUS WEEDS ON RANGE AND FOREST, A. W. Cooley, Chairman

Howard Morton (USDA/ARS), Tucson) is the Chairman for 1977 and the forty participants elected Roger Rohrbough as Chairman-Elect for 1978.

W. B. McHenry presented an overview of the history of rangeland in California and the plant succession of grasses and herbaceous weeds. California rangeland is unique in the fact that the rainfall season is in the winter when the temperatures are lower; therefore, when the temperature is adequate for good growing conditions, California is having a "natural" drought.

Registration status was discussed and reviewed by several company representatives. Those compounds mentioned as having registrations and/or pursuing registration in reforestation and/or rangeland were Krenite, Dinitro, Picloram, Dowpon, Dowco 233, and Asulox.

An informal discussion was held concerning the future of chemicals in range and forest due to EPA regulations and cost of development. The phenoxies were still considered to be one of the most useful herbicides for forest management.

It was discussed, moved, seconded, and unanimously recommended that Project 2 and Project 3 be combined. Participants of both sections are generally the same and it is difficult to separate herbaceous and woody plants when discussing forest and range; it was decided the project would be more effective if combined. Project 3 agreed and both sections submitted the proposal to the Executive Committee for approval.

PROJECT 3 REPORT: UNDESIRABLE WOODY PLANTS, R. E. Steward, Chairman

Tom Johnsen, Jr. (USDA-ARS) - Chairman 1977
L. E. Warren (Dow Chemical) - Chairman-Elect 1978

Thirty-seven people attended the Project 3 meeting to hear three formal presentations and a movie concerning the 2,4,5-T controversy. The formal presentations are summarized below.

Subject 1. Brush Control on Forest Lands in the Pacific Northwest, H. Gratkowski, U.S. Forest Service, Corvallis, Ore.

A portion of a slide-tape training film, "Silvicultural Use of Herbicides in Pacific Northwest Forests," was shown to illustrate the nature of forestry weed control problems.

Subject 2. Environmental Concerns and Multiple Use of Transmission Rights-of-Way, F. Gross, Bonneville Power Administration, Vancouver, Wash.

Slides were used to illustrate changes in vegetation management practices along utility rights-of-way during the past 40 years. This period began with a philosophy of complete mechanical eradication of vegetation, then a philosophy of "clean and green" using broadcast aerial sprays of herbicides, and has evolved the present practice of selective weed control and multiple use of rights-of-way.

Subject 3. The Role of Cut Surface and Other Individual Tree Treatments in Brush Control, L. E. Warren, Dow Chemical Company, Davis, Calif.

The use of injection, cut stump, and basal spray treatments on conifers and weed trees was discussed. Phenoxy herbicides, picloram, and Dowco 233 are effective on many important western tree species. Granular formulations of picloram also appear promising for controlling resprouting bigleaf maple on forest lands.

A 16 mm sound, color movie has been produced by Dow Chemical to counteract adverse publicity on use of 2,4,5-T in Arkansas. The movie is intended for non-professional audiences.

A motion to combine Projects 2 and 3, Herbaceous Weeds on Range and Forest and Undesirable Woody Plants, was unanimously passed and forwarded to the Executive Committee.

PROJECT 4 REPORT: WEEDS IN HORTICULTURAL CROPS, L. J. Senior, Chairman

The main theme of the Research Progress Reports was "difficult to control" or "resistant" weeds.

H. P. Alley explained how the weed spectrum in Scotch pine trees change from green foxtail, sunflower and Kochia to horseweed and then ends up after about five years to predominately field sandbur. Alley's field tests demonstrated that atrazine plus simazine at 0.75 plus 0.75 lbs/acre was very effective for broad spectrum weed control. GS 14254 showed promise post-emergence and leave a mulch which is advantageous.

C. L. Elmore stated that the use of trifluralin and DCPA led to a common groundsel problem in container grown ornamentals. Studies demonstrated that RH-2915 gave excellent control of common groundsel over a five-month period at 2, 4 and 6 lb/acre. Perfluidone also gave excellent control for five months. Several other herbicides were active but only gave one month residual control. It was suggested that a slow release formulation may be helpful.

J. P. Orr discussed problem weeds such as dodder, nutsedge and nightshade in canning tomatoes. Orr stated that good annual weed control usually resulted in less dodder. Napropamide plus CDED at 1 + 6 lbs/acre resulted in excellent control of annual weeds and dodder. CDED is excellent against dodder but is ineffective on other weeds. Post-emergence application of H26905 and H 22234 gave excellent control of dodder.

Napropamide plus pebulate at 2 plus 6 lbs/acre gave excellent control of nightshade, nutsedge and annual weeds. This combination gave the highest yields of all treatments. EPTC is excellent against nutgrass when applied layby and incorporated.

H. S. Agamalian reported that the main herbicide used in broccli is DCPA plus nitrofen and the problem weeds are common groundsel, sow-thistle, prickly lettuce and dog fennel. Napropamide at 2 lbs/acre preemergence surface under sprinklers gave excellent control of the problem weeds with excellent yields. RH-2512 resulted in good weed control but injured broccoli.

A. H. Lange pointed out that the main problem weeds in horticultural crops are nutsedge, cocklebur, common groundsel, henbit, nightshade and groundcherry. Lange's main point was that extremely active broad spectrum herbicides that have short residual could control these weeds prior to planting the crop. Compounds tried that showed promise but need more research are chloramben and prometryne. Soil fumigants such as methyl bromide and telone shanked into large beds and then the soil removed to near the injection point prior to planting show promise. Lange feels the industry may have overlooked certain compounds because they were "too" active but new compounds may be difficult for industry to justify registering due to market size.

Chairman for 1977 is Robert Callihan (U. of Idaho, Aberdeen) and Ron Oliver (FMC, Fresno) was elected Chairman for 1978.

PROJECT 5 REPORT: WEEDS IN AGRONOMIC CROPS, J. P. Orr, Chairman

Don Colbert (American Cyanomid, Lodi, Calif.) is the Chairman for 1977 and Paul E. Keeley (USDA/ARS, Shafter, Calif.) was elected Chairman for 1978.

Subject 1. Control of grass post emergence in sugarbeets, R. Norris.

1. Cycloate PPI 4 lb/A is the standard treatment.

2. Dalapon post is giving only fair to poor control. At 7 gal/A activity is good; over 20 gal/A half of the activity is lost.

3. Dichlofop-methyl at 2-4 lb/A post has good selectivity. Best control is obtained from sequential treatments. Higher rates are required for control than in Northwest.

4. Betanex + dichlofop-methyl 1.5 + 2.0 lb/A is giving close to complete weed control post emergence.

5. Things to look at in the future: 1) Rate, 2) Temperature, 3) Gallonage, 4) Growth stage, 5) Soil moisture.

Subject 2. Weed competition in field corn, S. Radosevich

1. It takes a substantial number of Johnsongrass and watergrass plants to affect corn yields.

2. Glyphosate and MSMA more effective when grasses are disked and allowed to regrow before application is made.

3. Do we need chemical control in corn? Moisture and nutrients play an important role in the degree of reduction.

Subject 3. Grass control in wheat with dichlofop-methol, Arnold Appleby.

1. Annual ryegrass is the biggest problem, wild oats second.

2. One lb/A early or late post gives control of both species with a twofold increase in yield.

3. Barley is more sensitive than wheat. No surfactant is needed.

4. Control is lessened when mixed with other herbicides post.

Subject 4. Field corn injury with herbicides in relation to date of planting, Jack Orr.

1. Eradicane (EPTC + R-25788) is giving severe injury to field corn planted in May and June, compared to no injury before these dates.

2. This could be related to soil temperature.

Subject 5. Herbicide interaction with bean varieties, H. Agamalian

1. Combination of EPTC + alachlor 3 + 3 lb/A is giving good hairy nightshade and yellow nutsedge control.

2. Alachlor + tribluralin 3.0 + 0.75 lb/A is giving good hairy nightshade control in lima beans.

3. Alachlor + dinitramine has a shorter residual and should be a good tool.

4. EL-161 (ethalfluralin) is giving good hairy nightshade control and has a shorter residual than trifluralin.

5. Bentazon postemergence is giving good nightshade control. Sequential treatments are best.

6. A varietal response is obtained from beans to bentazon at rates of 1 and 2 lb/A. Kidney and blackeye beans are showing injury.

7. EPTC injected in sprinklers. Some possible variety response at higher rates.

Subject 6. Soil persistence of herbicides, J. Miller.

1. Should have a standard technique of sampling.

2. Rates used are important.

3. When doing persistence studies:

    1) select correct test species
    2) standard sample technique
    3) should standardize the method of study

PROJECT 6 REPORT: AQUATIC AND DITCHBANK WEEDS, Jim McHenry, Chairman

The program of Project 6 was directed toward the registration status and label interpretation of herbicides used for canalbank weed control.

Mr. Joseph C. Cummings, Chief, Chemistry Branch, E.P.A., initially discussed the history of regulating the use of pesticides in water. The early Federal Committee on Pest Control requested the Food and Drug Administration to review aquatic uses of herbicides. Tolerances later became required under Federal food additive statutes of the Food and Drug Act. When E.P.A. assumed registration jurisdiction the requirements for water tolerances for any pesticide were required where a residue would occur in water, or crops, meat, milk, eggs, or shellfish or fish.

A protocol for establishing water tolerances has developed and continues to be developed by the pesticide registrants and E.P.A. The original 2,4-D tolerance (dimethylamine) cannot be used as an unbrella coverage for the uses of all 2,4-D forms; each use must be reviewed. The label restrictions for posticide uses must be enforceable (have practical restrictions, e.g. disallowing fishing for three days following application of herbicide).

Mr. H. Eugene Otto, U.S. Bureau of Reclamation, Denver, discussed his agency's projects in gaining the registration of herbicides for canalbank weed control. The principal effort is to develop data necessary for water tolerances thus making canalbank uses more clearly practicable. With 2,4-D dimethylamine registered, the Bureau project is now pursuing glyphosate, dalapon, simazine, and dicamba (to supplement 2,4-D for woody plants and deep rooted broadleaved species).

He noted that mechanical control measures are not particularly acceptable because of the clippings that are carried in the water.

Dr. Richard W. Schumacher, USDA-ARS, Denver, described his research on the dissipation characteristics of glyphosate in water. The herbicide diminished generally to less than 2 ppb approximately 8 km downstream in two canal studies. The application rates were 1.9 and 2.2 kg/ha on the study sites.

In small pond studies the water surface was treated with glyphosate at 9 kg/ha and water samples taken at 10 intervals over 118 days. The half-life of glyphosate was determined to be 11.5 days. Bottom sediments remained essentially unchanged at 200 ppb. No changes were observed in the invertebrates and algae during the study.

At the Project 6 business meeting a chairman and a chairman-elect were elected for 1977. The nominations committee was composed of Drs. R. D. Comes and P. A. Frank. The new officers are the following:

Chairman, Obren Keckemett, Pennwalt Chemical Company;
Chairman-Elect, Richard W. Schumacher, formerly USDA-ARS, now Monsanto Company

PROJECT 7 REPORT: CHEMICAL AND PHYSIOLOGICAL STUDIES, G. M. Booth, Chairman

The theme of this year's discussion was a free exchange of ideas on methods and techniques in metabolism.

Dr. Gerald Still, research biochemist, from the metabolism and radiation Research Laboratory in Fargo, North Dakota, was the guest speaker. He discussed the use of high performance liquid and gas liquid chromatography in purifying and identifying plant and animal metabolites. Specifically, chloropropham (isopropyl-3-chlorocarbanilate) was used as a model chemical for demonstrating these techniques. Polar conjugates (glycosides, glucuronides, sulfate esters, etc.) of the metabolites of chloropropham were identified with the above methods. The selective adsorption and nearly quantitative recovery of the conjugated polar metabolites was demonstrated using XAS-2 and Porapak-Q column packing materials.

Excellent discussions were also conducted on the utility of model eco-systems as screening tools in pesticide metabolism and residue methodology.

Several copies of reprints were available after the symposium to demonstrate the model ecosystem methodology.

The feed-back from the people present would suggest that more symposia and special workshops are needed on methodology and techniques.

Chairman for 1977 is Floyd Colbert, and Colburn Williams was elected Chairman for 1978.

The recommendation that Projects 2 and 3 be combined into one project will require a change in the constitution. Such a change requires approval by the membership and will be attempted prior to our next annual meeting. Chairman and Chairman-Elect for the combined section would be selected from the current chairmen and chairmen-elect for the two sections by the flip of a coin.

RESOLUTIONS COMMITTEE REPORT

S. R. Radosevich, R. Schirman, and J. L. Reed

Chairman Radosevich presented three resolutions to the membership for consideration. The two following resolutions were adopted unanimously by the membership.

Resolution 1:

WHEREAS: the Western Society of Weed Science has had the privilege of having their 1976 meetings at the Portland Sheraton Hotel, and

WHEREAS: the services provided by personnel of the hotel were exceptional,

THEREFORE: be it resolved that the Western Society of Weed Science express its appreciation to those who made our stay so pleasant.

Resolution 2.:

WHEREAS: the Journal of Weed Science has distinguished itself as a standard for publication of research findings relating to weeds and their control, and

WHEREAS: the need for publication of studies of applied nature is important to the implementation of these findings in agriculture

Be it resolved that the WSWS commend the Editorial Committee of WSSA for the quality of publications and the apparent increase in recent issues of papers dealing with applied aspects.

Be it further resolved that WSWS encourage periodic review of policies and procedures of the WSSA Editorial Committee to insure that publication of papers dealing with applied aspects of Weed Science is encouraged.

Resolution 1 was to be sent to the manager of the Portland Sheraton Hotel, and Resolution 2 was to be sent to the Editor of Weed Science and to members of the WSSA Executive Committee.

The third proposed resolution encouraged administrators of public research and regulatory agencies and of industry to encourage and permit employees to attend and participate in Society meetings. After considerable discussion, it was moved, seconded and approved to send the resolution back to the Committee.

R. L. Zimdahl moved that the Society send a letter to Dr. Ralph Ross of the EPA to compliment and thank him for his participation in our meeting. The motion was seconded and approved.

There was considerable discussion concerning the manner in which the site for our meeting is selected. It was finally decided to include a list of all committees and their membership with the first call for papers. Thus, persons desiring to communicate with members of a committee prior to the annual meeting will know whom to contact.

President Anliker thanked the officers and other members of the Society who worked diligently to insure the success of the meeting and of the organization. He then relinquished his office to incoming President, Clyde Elmore. Clyde expressed the gratitude of the Society to Mr. Anliker for his dedication and accomplishments during the past year.

The meeting was adjourned at 11:30 AM.

PRESIDENTIAL ADDRESS

WSWS - WHERE TO FROM HERE?

W. L. Anliker[1]

In reviewing the presidential addresses over the past several years, I found they discussed the past, present and future of this Society in considerable detail. If they had a common theme, it was the need for more involvement of the Society in major regulatory policy making. My remarks will be no exception since this is a matter of paramount concern to our industry. However, I would like to be a little more specific about the Society's capabilities to deal effectively with today's problems.

The President of this Society has the problem of not really knowing much about its operation until he has completed his term, and by that time, it is too late to do much about it. Therefore, I want to discuss what I consider to be the major problems confronting our industry and offer some suggestions as to how the WSWS can meet these challenges.

Status of the Society

The WSWS has been in existence for 38 years and is the oldest weed science society in the United States. In comparison to the other three regional weed societies, the Western serves the largest area with the fewest weed scientists per square inch. Our region has the greatest

[1]CIBA - Geigy Corp., Vancouver, WA

variety of commercial crops grown under the widest range of cultural and climatic conditions, It is also possible we have more complex weed problems than the other regions. The other regional conferences have a higher percentage of formal papers, whereas the Western conference is characterized by much more informal discussion and freer exchange of ideas.

Other comparisons can also be made. Our Society has the smallest membership, generally does a poorer job of graduate student involvement and operates on a smaller budget. We, in the Western, seem to be able to put on a good conference by having fewer people work harder and are the only one that attempts to handle the Society's affairs with one business meeting and one Executive Committee meeting each year.

These comparisons with the other regional societies are not intended to be derogatory. The point I'm trying to make is that a self-analysis is due once in a while and if we see that change is necessary, we should do something about it. We need to ask ourselves if the Society is answering the needs of the region and functioning according to our constitutional mandate.

Society Growth Rate

I suspect the rate of growth of our membership is not keeping up with the increased number of people involved in weed science. There are many qualified weed scientists working for corporate farms, agricultural chemical distributors, processors, and private consultants that have little or no association with our Society.

Graduate student participation in our meetings has been low in recent years. An attempt has been made this year to turn the trend around, but this is only a start.

Many of us agree the WSWS is not interested in playing the numbers game as far as membership is concerned, however, if we are not reaching all weed scientists in the Western Region, we need to alter our present approach.

The establishment of a membership committee should be considered to:

A. Contact prospective members,

B. Encourage graduate student participation,

C. Publicize our conference,

D. Promote wider distribution of our publications.

Responsiveness to Needs of our Industry

We have a constitutional mandate "to aid and support commercial, private and public agencies in solution of weed problems", and "to foster cooperation among state, federal and private agencies in matters of weed science".

The major dilemma weed science faces right now is the loss of our herbicide tools. Herbicide treatments are being lost at a rate faster than new ones are being developed and there are indications the loss rate will accelerate. Some of these herbicide losses are not readily apparent:

A. Losses due to cancelled registrations.

B. Losses due to withdrawn labels.

C. Losses of herbicide uses that will not be reregistered.

D. Losses of herbicide uses that will never be developed.

Three major factors determine the fate of our herbicides: inflation, regulation and liability. We can do little about inflation, so I will discuss our involvement with the regulatory and liability aspects.

Regulation

Professional societies, such as ours, have tended to maintain a posture of scientific aloofness, based on the assumption that being right is all that is necessary. By now, we should all know this approach will not work. There is a recent trend toward the opposite extreme. Some individuals are now becoming quite vocal against the proponents of pesticide regulation, advocating an adversary position against EPA and any anti-pesticide interests. The extremes in reaction to the EPA now range all the way from rolling over and playing dead, to fighting them from the street corners and rooftops.

It seems essential for our Society, which represents most of the weed science expertise in the western states, to take a position somewhere between these two extremes. Hopefully, our policy will be one of active cooperation in the pesticide regulatory processes which are consistent with the objectives of our Society and one of firm, direct opposition to those that are not.

If the membership of this Society wants a change in our approach to regulatory matters, a committee can be established for the purpose of bringing about specific changes in our position.

Liability

Pesticide labeling laws have evolved to the point where the herbicide developer is forced to virtually guarantee the successful use of their product irregardless of the circumstances of use. As a result of this, herbicide development is being drastically curtailed particularly on low acreage, high value crops.

The main reason for bringing this up now, is because it is one of this industry's major problems and it is generally being ignored:

A. EPA has done nothing more than acknowledge existence of the problem.

B. Herbicide developers tend to approach it from a short-term, problem solving standpoint. The possibility of litigation causes a great deal of concern; however, after a case is settled, there seems to be little effort to deal with the general herbicide liability problem. A company's position in these matters is often dictated by its insurance carrier, rather than its good judgment.

C. Public agency research people generally spend more energy trying to avoid legal entanglement on these issues than trying to find long term solutions.

D. The NACA does not seem to show much interest and the WSSA with its 90 odd committees, does not seem to have one which gives consideration to the legal aspects of our business.

E. Commodity groups and grower organizations tend to be too self centered to be very effective in dealing with the problem.

F. The legal profession is not likely to instigate any changes in the herbicide product liability situation, any more than they are in favor of no-fault insurance, do-it-yourself divorce or changes in the medical malpractice situation.

As far as the herbicide liability problem is concerned, there appears to be two possible approaches:

1. Change the basic law to permit the establishment of a low-liability labeling category, making it possible for the user to legally accept the liability for specific, pre-determined herbicide treatments.

2. Development by the herbicide producer of a legal mechanism such as a Hold-Harmless Indemnity, which would stand up in court. This would, in effect, permit the product to be made available to the user providing he agrees to accept the liability concerned with possible non-performance or crop injury.

How can the WSWS become involved in this problem? We can provide technical information and guidance to commodity groups, regulatory agencies, herbicide producers and legislators to encourage a coordinated effort to solve the liability problem.

We can use our Resolutions to focus attention on the problem and our broad-based representation in all areas of weed science to promote a workable solution and to prevent domination by special interest groups.

Someone needs to assume a leadership role in coordinating efforts to solve the liability dilemma and none would seem as qualified as the regional weed science societies.

In conclusion, you as members of the WSWS represent a vast resource of expertise in all areas of weed science. The objectives of any organization need to be reevaluated periodically to confirm their status or to reestablish priorities. The responsibility for this reevaluation rests with the membership of the Society. You alone can determine where we go from here.

We have to keep in mind, if the WSWS does not take an active role in determining the destiny of our science, someone is going to do it for us; and the outcome won't be the same as if we did it ourselves.

HERBICIDES IN AN AGRICULTURAL SOCIETY

V. H. Freed[1]

It is a pleasure for me to be here this morning, to have the opportunity to share this time with you, and to renew some old acquaintances. I am indebted to your program chairman for this privilege and I only hope that I can warrant a little of the confidence that he expressed in inviting me. It has been some years since I have attended one of these meetings, having become far less active in herbicide research and much more involved in other and perhaps less interesting pursuits.

Though the program chairman was very nice in inviting me to the meeting, he did exact his pound of flesh with the topic that he assigned to be discussed. There is a real challenge in the title "Herbicides in an Agricultural Society." One could assume at least two quite different postures in addressing the subject. On the one hand, one could defend the practice of herbicide use in agriculture and call for a vigorous program to increase the number and quantity of herbicides. This, despite the fact that herbicides now represent the largest class of pesticides being used. On the other hand, it would be possible to assert with equal vigor that the use of herbicides in agriculture constitutes chemical pollution of our environment and should be reduced

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as expeditiously as possible. Either of these postures however, would tend to be simplistic and certainly not do justice to the problem.

Public Concerns

To one who has seen the tremendous growth in use of herbicides since the late 1940's the fact that a group of herbicides specialists would take time to hear a talk of this title is significant. Not too many years ago, such a group would have been so busy demonstrating the unrefutable value of herbidices in increasing agricultural production that they would have considered it an unconscionable waste of time to reflect on possible negative values of herbicides. That is not true today, when some pest control biologists seem to take almost masochistic delight in being flagellated for their association with pesticide use. To be sure, popular concern today results in holding suspect anyone who advocates the use of chemicals. However, it is a respect for this concern that leads not just to the present topic but the whole of this morning's program.

It is appropriate, I think, in discussing herbicides in an agricultural society to take just a moment to examine the general concern about chemicals in the environment. It is not that this is a new phenomenon that needs to be examined. Indeed, I recall vividly some of the questions that arose in the minds of those of us doing research on pesticides in the late 1940's and early 1950's as the use of chemicals began to build up. There are others of you in the room that can remember also some of the lively discussions that this group has had from time to time about the possible consequence of using herbicides.

The concern of a substantial and highly vocal group of people disturbed over the use of chemicals falls into three categories relating to health effects, environmental effects, and possible economic effects. I should like to elaborate a little bit on these three different categories of concern after remarking that they have been stimulated in part, by what we have seen with such things as vinyl chloride, unrestrained use of chlorinated hydrocarbons, and the careless contamination of the environment with heavy metals, ALA, the Minamata Bay tragedy in Japan.

Inquiry as to the basis for the concern of the lay public about chemicals provides some sobering answers. The first and perhaps the most serious of these is the general appalling lack of knowledge about the nature of the world around about us and specifically about the action of chemicals. Though we live in a chemical world, and particularly in developed countries, utilize a myriad of synthetic chemicals, there is little understanding or appreciation for the elementary principles of toxicology. By that I don't mean to imply the public should know about the latest esoteric metabolite of some model compound used in only one laboratory, or have a full understanding of the arguments of the advantages of the multi-compartment pharmacodynamic model versus the two compartment approach. Rather what I am talking about is simple common sense knowledge and understanding of the action of chemicals well within the grasp of an average ten year old. These are such simple concepts as the dose-response relationship, which among other things would tell us that any chemical in sufficient dose can be dangerous. Another is the distinction between hazard and intrinsic toxicity which recognizes that it is the manner of handling and use, among other things, that would make a chemical dangerous.

However, there are other bases for the concern felt by the public over chemicals. One has to do with the fact that conquest of malnutrition and infectious disease has increased life-span such that carcinogenic and mutagenic effects now come into play. Moreover, we have developed highly sophisticated and sensitive techniques to detect rather small effects in test organisms. There is a tendency to extrapolate these effects to man whether or not routes and methods of exposure of the dosage regimen anywhere near approximates the exposure that a human might receive. Finally, there is the historical fact of gross misuse of chemicals in times past and even today as witness the kepone incident in Virginia. Unfortunately, the tendency is not to deal with the abuse of chemicals within the context of the specific problem but to generalize from that to a blanket indictment against all uses.

The second category of concern has to do with possible environmental effects, particularly those on non-target species. It is not easy in this instance to document the quantitative aspects of the problem but nonetheless feelings run high. There is no blinking the fact that certain of the pesticides, notably the insecticides, have caused fish kill, possible harm to localized bird populations, and show up as residues in other species. Unfortunately, some of this problem can be laid to the doorstep of pesticide researchers who neglected to give sufficiently thorough consideration to the possible behavior, transport, and fate of chemicals in the environment.

The third category of concern, that of economic consequences, is not so lively an issue in this country as it is to some overseas. We do give some thought to economic impact in terms of increased yield versus environmental effects, but I am afraid with our affluence, we don't take such considerations that seriously. On the other hand, in less well developed countries with abundant labor supply, possible dislocation of workers by introduction of chemical technology becomes a very lively issue. The rhetoric often ignores the substantial benefit in terms of increased yield or health protection deriving from chemical technology and focuses almost entirely on the transitory displacement of the labor.

The concerns cited above derive mainly from use of industrial chemicals and insecticides rather than herbicides. Generally, the herbicides having lower mammalian toxicity and being more recent to wide scale use have not received that much attention. The exception is 2,4,5-T which has become a cause celebre with some whose interest began more in the arena of politics than in science. Nonetheless, the use of herbicides is not without some attendant problems. These include problems of residue in crops, carry over in soil with injury to subsequent crops, drift and volatility with accompanying injury to non-target plants, development of resistance, modification of ecosystem, and possible effects on animals. This latter instance has been detected by some of the sophisticated and sensitive techniques, but it appears at this time not to be an imminent threat. Nonetheless, it must be kept in mind, for certainly a point will be made of it by those feeling a disquitetude about the use of chemicals.

The Need for Herbicides

Having laid a background, let me turn to the task that I set for myself in accepting this assigment, namely arguing the case for herbicides in our present society. To start, let us take the proposition that "agriculture is an activity of primary and fundamental importance to the economic and physical well-being of man." Specifically, it is a wealth generating activity based on renewable resources and has an enornous economic multiplyer effect. Any country, which for any reason neglects their agriculture, finds itself in a desperate race to maintain a healthy economy and to feed its population. Beyond that, however, the development of agriculture, and specifically, the highly productive agriculture that we have come to enjoy, represents one of the greatest steps that mankind ever has taken to improve his physical health, to insure opportunity for intellectual development and all that it implies, and the growth of other wealth producing activities.

Having postulated the importance of agriculture to the well-being of mankind, we may now enquire as to the state of affairs around the world today. In so doing, we discover an exploding population, particularly in countries with less well developed agriculture, a consequent wide-spread malnutrition and in some areas, starvation.

This may be due in part to maldistribution but no small portion of it is attributable to low agricultural production. You may be of the school of thought that holds that the potential of this planet is great enough to produce an adequate supply of food for an even larger population than we have today. However, it must be pointed out that there is a great gulf between potential and what we actually find. It is all very well and good to say that countries like Bangladesh, India, Central America, have the climatic and edaphic resources to produce an abundance of food and fiber for their people. The plain truth of the matter is that they are not. Moreover, even some of the more developed countries, for a lack of scientific and economic know how are forced to turn to the United States, Canada, and Australia, as a source of food stuffs.

Others talk about potential in terms of increasing the amount of land under cultivation and point to the fact that there is something in excess of three billion hectares of land area that could be cultivated in contrast to the 1.1 billion hectares now being utilized. However, much of this land poses special problems to bring under cultivation. The point here is that if this wealth generating activity, agriculture, is to yield enough food and fiber for the present population, let alone the future, it will require the development and application of the tools of technology. Herbicides are one such of those tools that must be used.

Most of you know far better than I the biology of plants, the life cycle of weeds, and the various methods that have been developed for the control of weeds. Bear with me however, as I restate some of the obvious and well known facts. By the term weed, we imply a plant growing in such a place or such a profusion as to limit the production of a desirable crop, plant or animal, or cause human discomfort. It may be closely related to the plant with which it is in competition, or it may be of a widely different genera. However, what makes the plant undesirable is its ability to reproduce, vigor of growth, wide adaptation, and other attributes which enable it to resist efforts at its control. Therefore, weeds, or undesirable plants if you please, pose a peculiar and difficult problem. As everyone in this room is well aware, weeds have posed a problem to the agriculturist and the gardener from time immemorial. It was with good reason that many different attempts have been made to develop control measures for plants. In ancient time, it was the tools of cultivation and crop rotation that could be used. With the rise of science some 200 years ago, more sophisticated techniques, based on better cultural implements, improved competitive crops and timing of operations were developed for the control of weeds. Many techniques for control of weeds have been tried and developed over the centuries, ranging from such things as stomping the plant into the mud, to flooding, to cultural methods based on physiological studies, and finally of course, herbicides. That certain chemicals would control plants, of course had been known for millenia as witness the use of salt during the obliteration of the city of Carthage. It has only been within the last 80 years or so that systematic attempts have been made to discover chemicals that would specifically control these pests of agriculture. Within the last 25 years the major advances in chemical weed control have been witnessed.

The benefits in terms of increased crop yeild through the use of herbicides is well documented. In fact, perusal of the literature quickly convinces all but the most irrational skeptic that there are some of our weed problems that can be controlled satisfactorily in no other way than by the use of herbicides. Moreover, in a highly complex and technical agriculture such as found in the United States and Western Europe, it is inconceivable on the basis of the evidence that we could dispense with these valuable tools. That is not to say that they are to be used with reckless abandon in every and all situations. Instead it presumes that there will be responsible, restrained use in an appropriate system of crop culture. But the importance of herbicides is not confined just to the type of agriculture found in the U. S. and Western Europe. They are becoming equally important in the agriculture of some of the less well developed countries despite the manpower pool available. In these instances, the nature of the weed and crop is such that cultural control by human labor does not ensure the level of production that is essential. This can be illustrated by the problems of the cash crop plantations of the tropics, in rice growing, and in the production of many of the other cereals.

Responsibility for Safe Use

Having, as I hope that I did, demonstrated the essentiality of herbicides in today's world, let me conclude with a few remarks to the herbicide specialists in the audience. I would remind you that into your hands has been placed the responsibilities for these technological tools and their proper use. Unless you see to this as an important matter, it is possible that unthinking chemophobes will attempt to restrict their use. To meet this responsibility I submit that you must accept the burden of demonstrating how they may be used safely and to insure the appropriate protection for man and the environment. This will presume therefore, that herbicide specialists will develop a mastery of the essential knowledge of toxicology and chemodynamics of these compounds. In addition, there is the obligation for a more thorough job of research on compounds and integrating the knowledge gained thereby into a broad picture of the role of this compound and its proper use by society. Such a responsibility may require foregoing the pursuit of the identification of some obscure and relatively minor metabolite in order to do a better material balance of the herbicide in the crop and environment. It calls forth, also, a conscientious effort to fully document the benefits and cost of the use of such a compound.

Judging by the literature reports on research, the herbicide researcher is taking these responsibilities seriously. I am encouraged to believe that the weed scientist will continue to play a significant role in development of an essential technology to improve the agriculture, not only of this nation, but of the whole world. Thank you.

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THE AXIOLOGY OF PEST CONTROL

Boysie E. Day[1]

My report is completely at odds with the scientific nature of this conference. Far from the presentation and interpretation of experimental evidence, I propose to consider with you ideas that have no basis in observation, are beyond all possibility of being proved true or false, and exist only within the realm of speculation. My subject is the axiology of pest control. By axiology is meant that branch of philosophy dealing with matters of value as in morals, esthetics, and metaphysics.

It is generally believed that there are two distinct categories of ideas, ones based on observation, such as our scientific reports at this conference, and others relating to assessments of value such as whether something is good or bad, right or wrong, proper or improper, beautiful or ugly, moral or immoral, beneficial or harmful, and the like. These are expressions of ethical judgments reflecting varying degrees of "goodness" or "badness." They do not describe events in nature and thus are not subject to experimental proof.

That a particular plant is present at a particular place is as ascertainable fact that can be verified empirically. Whether or not this is a desirable state of affairs is strictly a matter of

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opinion which in a scientific sense is neither true nor false. In pest control the very classification of an organism as a pest is a value judgment. Whether or not a control measure is good or bad, or proper or improper is likewise in the same category of opinion. All of us have our likes and dislikes and since none of us can prove that our values are better or worse than anyone else's it follows that in such matters we all speak with equal authority.

Pest control makes heavy demands upon our value assessments. It involves killing organisms that everyone does not agree ought to be killed, and by methods that seem to some unfair, cruel, morally reprehensible or needlessly destructive. Powerful qualms are raised, public emotions run high, and these ultimately become reflected in laws and regulations governing what one can or can not do in pest abatement. Thus our actions in pest control are governed in part by science but perhaps to a greater extent by values -- our own values as scientists and technicians as well as prevailing public values. On the one hand we have a vast body of research supporting our technology and on the other virtually no organized or systematic expression or appraisal of public values on pest control. Indeed, the occasional views on pest control that we see in the press or hear in conversation are rarely taken seriously by the experts, and like as not are discounted as ignorance or aimless nonsense.

In the absence of better information on opinion about pest control I am left to the device of listing the fragmentary views that I see or hear either expressed or implied, but without information on how widely the views might be held. These are but examples and in each instance we can assume that the opposite opinion is also held to some extent.

1. It is worse to kill organisms closely related to man those distantly related; for example, monkeys as opposed to snails or pigweeds.

2. It is worse to kill large organisms than small ones. Whales or redwood trees are favored over bacteria and crabgrass.

3. It is more acceptable to kill organisms that threaten us greatly as opposed to those causing little harm. To a degree it is proper for the punishment to fit the crime. There is little sympathy for mad dogs or mosquitos bearing malaria, or bacteria in one's bloodstream.

4. "Natural" methods of control are better than "artificial" ones. Botanical pesticides such as rotenone are better than purely synthetic ones such as parathion.

5. Biological control is better than chemical control.

6. Mechanical methods such as plowing are better than chemical methods such as herbicides.

7. There are "good methods" and "bad methods" dependent upon the perceived virtue of the agencies and persons involved in pest control. Traditional or folk methods are better than newly invented techniques. Methods associated with "agribusiness" are less acceptable than ones throught to prevail on the individual farmer's farm. Methods devised and marketed by large corporations are more suspect than ones developed by individuals or public agencies.

8. An extreme view is that there is no need for pest control at all. If people were to give up synthetic pesticides, fertilizers and other artificial methods, the balance of nature would be restored and the need for such materials would vanish.

9. There is to some extent a view that all pest control is immoral. The coyote, coddling moth and crabgrass plant are thought to have as much right to live on earth as you or I.

We could add to this list endlessly by reading the popular press and, for that matter, the Congressional Record and the Federal Register. Values are not always overtly stated but are more often made known obliquely through the use of value-charged adjectives and descriptive expressions. The redundancy chemical pesticide is used in a reproachful sense. Instead of writing about application of pesticides one uses the term indiscriminate application of pesticides, and the term highly toxic is often appended regardless of toxicological properties. Ecosystems are always termed fragile. Spraying may be called "a rain of death." Anything that happens may be called environmental or ecological insult, the current elegant value expression. The adjectives catastrophe, disaster, obscene, and outrage often appear. A person's views of pest control appear to be related to his view of science generally. An extreme view is that the methods of science can be applied to the solution of all problems and all we need is to get on with the job. The opposite view is that science creates problems rather than solving them. Most persons holding this view have little confidence in technology and may look upon scientists as unprincipled, irresponsible cranks who love to dabble with danger. To some the methods of science and the presumed character and morality of scientiest are sources of concern and fear. Indeed, we can but wonder what the view of the modern world must be for an otherwise educated humanist, lawyer or politician who has never studied science and is not familiar with its principles and vocabulary. He is a creature from the past placed in a strange world with nothing to guide his opinion except blind trust and the superstitions of the ages.

Our values about pest control are also governed by our individual views about the relationship of man to the other living things on earth and to inanimate nature as well. There are two general ways of looking at nature that may well serve as the basis for a unifying classification of opinions about pest control. These view points are called anthropocentric and anthropomorphic. Anthropocentrism values all actions in terms of the welfare of man. Anthropomorphism assigns human values or at least intrinsic values or rights to other living creatures including such collective surrogates as "nature," "the ecology," or "ecosystem."

Both categories are themselves value judgments and thus can not be proven or disproven. However, if either viewpoint were agreed upon as a proper basis for the relationship between man and organic nature many arguments could be settled upon the basis of the facts in each case.

Pest control is most often undertaken in pursuit of economic or health objectives. Values are based primarily on the most benefit for the least cost or effort. To the extent that we agree on this, decision can be made on the basis of the assessment of problems and the comparative efficiency of methods. This modern anthropocentric view recognizes not only economic values but comprehends also social and esthetic considerations. However, it stops short of assigning human or, indeed, superhuman values to nature.

Much of contemporary opinion is anthropomorphic in outlook. Its usual expression is a kind of "nature knows best" outlook. We see this in our "wild-wisdom" type of television program in which animals are depicted as striving toward cooperative aims and ecosystem stability. Moral virtues, if not assigned to organisms individually, are implied in terms of the natural system as a whole. The anthropomorphic evaluation of natural systems suggest a kind of natural justice and deliberate cooperation in a unified effort and glasses over predation, parasitism and interspecies conflict.

When the snake swallows the frog, the coyote kills the rabbit, a beaver fells a tree and lightning strikes a person we ask the question, are these acts moral, immoral, or amoral? When stated so clearly most persons would agree that these are the workings of non-ethicizing creatures and inanimate nature and have no ethical content at all. But it is all a matter of opinion. And seemingly one man's judgment is as good as another's.

The anthoropomorphic view has penetrated into government. The term environment has replaced mother nature as the personification of natural values. Law and policy speak of protecting the environment as an anthropomorphic entity. We have in the EPA a governmental bureau serving a virtual environmental diety. Its priestcraft is based not on the scientist and his tables and graphs but on the lawyer and his disputatiousness.

CAST -- AN ORGANIZATION REPRESENTING WEED SCIENCE: THEIR ACTIVITIES

J. Richie Cowan[1]

Now that the whole earth has been explored and occupied, the problem is to manage its resources efficiently and effectively. Careful management need not mean stagnation. In many places the interplay between man and nature results in a creative symbiotic relationship that facilitates revolutionary changes. Man continuously tried to derive from nature new satisfactions that go beyond his elementary biological needs, and he thereby gives expression to some of nature's potentialities that would remain unrecognized without his efforts. Therefore, we can consider man as an asset, not a liability to our environment. Of the 70 to 100 billion people who have walked the surface of the earth since man acquired his biological identity, by far the largest percentage have lived on the man-made lands that have been created since the time of the agricultural revolution.

The concept of the value of food just as in the case of a good environment, is largely a matter of opinion. It is primarily a subjective rather than an objective criterion. In the case of food, it depends on how hungry you are and how long you have been without food. By his own skill and persistance man has generated an astonishing diversity of man-made environments which have constituted

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the settings for most of human life. A typical landscape consists of forest and mountains and hills serving as backdrops for pastures and ariable lands, villages with their green, their dwellings, their houses of worship and their public buildings. People now refer to such a landscape as "nature". Even though most of its vegetation has been introduced by man, its environmental quality can be maintained by the individualized ecological environment.

Just as nature has not been capable by itself of giving full expression to the potential diversity of our globe, likewise it is not capable of maintaining man-made environments in a healthy state. Now that so much of the world has been settled by man, environmental health depends to a large extent upon human care. Forests must be managed, swampy areas which are under cultivation must be continually drained, the productivity of farm lands must be maintained by the control of weeds, crop rotation, irrigation, fertilization, etc.

In the late 1930's, the number of acres of harvested crops in the United States which had been declining since 1930, intersected with our population increase. Since then, our population has continued to increase on almost a straight line while our crop acres harvested has declined to a point below that of 1910. In spite of this reverse relationship, we are now producing more agricultural products than ever recorded in our history. In fact, we have exported some 23 billion dollars worth of agricultural goods above and beyond our own domestic needs on an annual basis during the last 2 years. How has this been possible? Effective use of our agricultural technology and incentives for our farmers and ranchers to perform in the most efficient and proficient manner possible. One of the prime ingredients in this formula has been WEED CONTROL. Our previous speaker has very ably articulated the problems which we have facing us. This is why CAST came into existence.

May I digress a moment from this general point of view to trace a little history which I think is extremely important at this point. During President Lincoln's administration there was established an institution known as the National Academy of Sciences. This prestigious scientific organization had as a prime responsibility to provide counsel, guidance, and information on matters of a scientific nature which were needed in making public policy decisions. In those days our country was primarily rural in nature. As a result, those persons in the legislative halls of the nation, were mainly of the rural walk of life. Because of their knowledge of agriculture, it was not necessary for them to turn to such an organization as the National Academy of Sciences for information and direction relative to policy decisions involving agriculture. Agriculture at that time was not considered to be a science, but fell into the realm of an art. As the years passed, our agriculture became more sophisticated and efficient. It released people from the rural areas to go to urban areas and aided in the development of our urbanized industry. As a result, it became necessary to have representation for agriculture in the National Academy of Sciences. An Agricultural Board was set up for this purpose. It dealt over the years with national matters pertaining to agriculture. However, there was never any direct representation from the agriculture sector on the governing board of the National Academy of Sciences. As a result, agriculture's need and contributions by virtue of interpretation and knowledge did not play much of a role in the decisions for which the counsel and guidance of the National Academy were sought. In 1951, as an adjunct of the Agriculture Board there was established an Agricultural Research Institute. This was a function of the Academy of Sciences and hence, certain restrictions and constraints were placed upon it in the way in which it could operate. In 1973, ARI, (Agricultural Research Institute) was organized to serve national research needs of both the public and private sector of agriculture. Its primary goal is to provide a forum whereby agricultural research might be improved and expedited.

During the mid 60's the Deans of Agriculture of the Land Grant Colleges in an effort to provide some credibility for agriculture, explored carefully and in considerable depth, the feasibility of setting up an agriculture academy of sciences. In the late 60's representatives of several agricultural professional societies began exploring the possibility of bringing together the expertise of the various agricultural professional societies into an organization which could provde counsel and guidance on decisions being made relative to the future welfare of agriculture. This philosophy was encouraged by the Agriculture Board. The Agriculture Board provided assistance in setting up one of the initial meetings to consider the feasibility of such an approach. There are some 35 agriculturally oriented professional societies. A good representative group attended, and a decision was made to proceed with exploring the possibility of organizing such a body. The Weed Science Society of America was one of the professional societies among this charter group. This was the beginning of what eventually was identified as CAST (Council for Agricultural Science and Technology). An organizational meeting was held in early December of 1970. An iterim Board of Directors was established, by-laws were developed and the general organization was established and the first interim Board of Directors met in Chicago in March of 1972.

In June of 1973, Congressman Jerry Litton of Missouri convened a meeting of representatives of all the agricultural organizations throughout the country in Washington, D. C. The purpose of this meeting was to examine how agriculture might do a better job in its public relations. This was followed by a second meeting in September of '73 and the ACA, (Agriculture Council of America) was organized. Thus, we have ARI which devotes its primary thrust to encouraging high quality research, ACA which is devoted to public relations and CAST whose objective is to advance the understanding and the use of agricultural science and technology in the public interest. Thus, these three organizations all working in the interest of agriculture as an industry as the survival of mankind compliment one another most effectively. The Board of Directors and officers of these three organizations have diligently worked at keeping one another advised of their programs and progress.

The Council for Agricultural Science and Technology, CAST, is a consortium of agricultural scientific societies created to increase the effectiveness of agricultural scientists as sources of objective and factual information for the government and the public. CAST is an educational organization not a scientific society. It is incorporated as a non-profit organization for which a 501 (c) 3 internal revenue service classification has been obtained. Membership dues and contributions to CAST are tax deductable.

Member societies of CAST currently include: The American College of Veterinary Toxicologists, American Dairy Science Association, American Forage and Grassland Council, American Meteorological Society, American Society for Horticultural Science, American Society of Agricultural Engineers, American Society of Agronomy, American Society of Animal Science, Association of Official Seed Analysts, Council for Soil Testing and Plant Analysis, Crop Science Society of America, Poultry Science Association, Rural Sociological Society, Society of Nematologists, Soil Science Society of America, the Southern Weed Science Society and the Weed Science Society of America. Each member professional society is entitled of representation on the Board of Directors. The number of representatives is based on the size of the membership of the professional society. The only way in which a person may be elected to the Board of Directors is through his or her professional society or as a member representing members at-large. Thus, the policy of CAST is exclusively the function of professional people. At the present time as I have just indicated, there are 17 professional societies, over 1,000 individual members; 40 supporting, 39 sustaining, and 13 subscriber members.

All member societies pay dues in relationship to the number of members, and membership fees are used to support the activities of the organization. In some instances grants have been made to assist on special projects. Most of the money is used to pay travel expenses of

Task Force participants except for an Assistant Executive Vice President, a Secretary and some part-time secretarial help. The Headquarters Office is at Ames, Iowa. Dr. C. A. Black is Executive Vice President. Currently, Dr. Bart Cardon is President of CAST, representing the Animal Sciences and your own Dr. Fred Warren of Purdue is President-Elect. There has been a great deal of unselfish voluntary effort made on the part of many sincerely dedicated scientists to bring us to the point where we are today.

CAST affairs are guided by a Board of Directors composed of scientists, representing member societies and others elected from the roster of individual members. Officers are elected by the Board. CAST projects are carried out by Task Forces of scientists selected with the aid of members of the CAST Board of Directors. The presidents of the relevant scientific societies, and the Task Force chairman. Most projects are of necessity undertaken and completed quickly because of the short time available. Most Task Forces meet at a central location to discuss their assignment and to prepare a draft of their report. All participants serve as scientists and not as representatives of their respective employers.

CAST was initially inaugurated in late January of 1973 in Moline, Illinois. The first Board of Directors met at that time. A second Board of Directors meeting was held in early March, 1973. The first Task Force report was released in May of 1973. Since that time, there have been some 55 Task Force reports released. In order to accomplish this, there have been several thousand scientists involved who have contributed willingly of their time and talent so that the facts might be avilable. In a local publication here in Portland last week, March 2, 1976, Commercial Review had an article "CAST Refutes Misleading Charges." This article went on to report the work of a Task Force assigned to study the role of the "Phenoxy Herbicides, etc." This report was developed by a Task Force under the very capable leadership of the previous speaker, Dr. Boysie Day. At the height of the energy crisis of 1973, an extremely excellent Task Force report entitled, "Energy and Agriculture" was submitted to Congress, November 26, 1973. As you recall in late 1973, particularly there developed a great deal of misunderstanding and much publicity relative to livestock production and the role of grain for the maintenance of this facet of agriculture. A publication was prepared and released in March of 1975 entitled "Ruminants as Food Producers -- Now and for the Future." This was in the early stages of preparation in October of 1974. A preliminary draft was made available to all delegates attending the Food Conference held in Rome in early November, 1974. A classic publication was the Task Force report in August of 1974 entitled, "Zero Concepts in Air, Water and Food Quality Legislation". This was addressed to the basic concept of the Delaney Clause with which you are most familiar. These are some examples of efforts that have been the result of these many Task Forces over the last three years.

In addition to the Task Force program, in October of '73, we held a symposium in Chicago entitled, "Pesticide Report to the Nation." This brought together many representatives of the media and was very successful. In addition to this symposium, we had a telephone dialogue if you will, a dial free opportunity for anyone to phone anywhere in the continental

United States to seek answers of questions relative to pesticides. A battery of some dozen phones was manned by a group of extension specialists knowledgeable in the area of herbicides, insecticides, fungicides and toxicology. This was extremely well received. Subsequently in St. Louis on April 19, 1975, another such telephone dialogue was conducted on the topic of Food Production directed to high school science students. A larger number of phones was used and this, too, was very successful. A third one is being planned for mid April of this year. Also, arrangements are being made for a special seminar or workshop in Washington, D. C. to which administrators of Congressmen can be invited so that they might have a better understanding of agriculture.

Of recent months a great deal of time has been spent on endeavoring to support the retention of many important pesticides. As you well know, the basis of their abandonment has been the possibility of of their carcinogenic properties. It is interesting to note in a recent release from the American Society of Agronomy that Dr. Russell S. Adams, Soil Science Department, University of Minnesota, has identified and made known many of the serious cancer causing agents to be found natural in the soils. He indicates that in many instances, it might be that some of the pesticides which we have been using have tended to suppress the impact of these natural occurring carcinogens. A CAST Task Force was successful in prompting EPA to give up on the so called "Nine Principles of Carcinogenicity" and go back to the drawing board again.

Farmers are responsible citizens and hard workers who are entitled to an economic return. If we in society insist on implementation of laws which bring about unnecessary duress on them in order to carry out their programs and production then we must expect to pay for these extras which we require. For those who wish to return to the "Good old Days" when we didn't have dirty industries and automobiles to pollute air, we'll consider what life in America was really like before the Civil War. For one thing, life was very brief. The life expectancy for males was less than forty years. Those forty years were exhausting, backbreaking years. The work week was 72 hours. The average pay was $300 per year. The life of woman was far from "women's lib." They worked 98 hours per week scrubbing floors, making and washing clothes by hand, bringing in firewood, cooking in heavy iron pots and fighting off insects without screens or pesticides. Most of the clothes were very inferior by present day standards. There were no fresh vegetables in the winter. Vitamin deficiency diseases were prevalent. Homes were cold in the winter and sweltering in the summer. Every year an epidemic could be expected and chances were high that someone in your immediate family could be effected. Water pollution may be bad now, but it was even more deadly then. In 1793, one person in every five in the city of Philadelphia died in a single epidemic of typhoid fever as a result of polluted water. Well informed people certainly would not want to return to the "paradise" of the good antebellum days. Perhaps the simple life is not so simple.

Many are alarmed by the dire announcements made by technically untrained people and scientists who have not bothered to check their assumptions against the evidence. These alarms have made many decision makers go off with half-cocked expensive measures, in some cases to solve problems that are more imaginary than real.

From what we read and hear, it would seem that we are on the brink of pending doom. Scientific evaluation of the evidence does not support this conclusion. We clearly have some undesirable problems attributed to technological activities. The solution of these problems will require a technical understanding of their nature. The problems cannot be solved unless they are properly identified. This will require more technically trained people not less. These problems cannot be solved by legislation unless the legislators understand the technical nature of the problems. This of course, is what CAST is all about. We provide facts, not recommendations. I have great confidence in the ingenuity of the citizens of this country. The public has not been getting all the scientific facts on many matters relating to ecology. As Thomas Jefferson so aptly said, "If the public is properly informed, the people will make wise decisions."

Agriculture is America's number one natural resource. It is this nation's largest industry with assets of better than 370 billion dollars. Farming in the U.S. employs 4.4 million workers, almost as many as the combined work force in the manufacture of automobiles and other transportation equipment plus the entire steel industry. The American farmer is also a consumer. Farmers spend about 43 billion dollars every year for goods and services just to produce their crops and livestock, plus another 13 billion dollars for things we will use such as good, clothes, medicines, furniture and appliances.

Agriculture is the nation's and the world's only industry that absolutely affects every living person in some way. It is the one thing the millionnaire has in common with the most primative tribesman. Regardless of our walk of life, we all have a responsibility to promote a strong and productive agriculture. This can be done and still maintain a quality of environment. We all must take time to understand the other person's concerns. Legislative decisions must be based on factual evidence not emotions. We cannot afford to lose all of the tools for a productive agriculture such as those which you as scientists have developed because of the emotional concern of the uninformed few. If this is to be done, it will take the united effort of everyone including each of you. A ten dollar membership is a small contribution for you to make to help this worthy cause. Your society should be a professional member so that you might have a part in guiding the destiny of this significant effort.

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CHEMICAL WEED CONTROL WITH DRIP IRRIGATION

A. Lange, H. Kempen, B. Fischer and J. Schlesselman[1]

Introduction

Controlled emission irrigation by more or less continuous trickle or drip irrigation is increasing throughout the world and particularly in California. Many of the hillsides formerly difficult for the culture of row crops are now being developed with drip irrigation. With most of the plastic distribution systems above ground, mechanical cultivation for weed control particularly in both directions as in perennial crops is impossible.

University studies of preemergence herbicides with drip irrigation began about 1971. It was soon clear that while the overall annual weed control problem was often less with drip irrigation, the weed problem in the continuously wet area of the emitter was greater. Most of the preemergence herbicides tested did not hold up in this wet area. Annual weed control in orchards and vineyards often broke in early summer. Those few annual weeds escaping the preemergence herbicide with a continuous supply of water in the area of the emitter grew larger when their roots grew below the herbicide and were more difficult to control than when growing with other less continuous irrigation. In addition, perennial weeds appeared more difficult to control, perhaps again because of more favorable conditions for recovery. As a result of several years of work, there is now good evidence that annual and perennial weed problems

[1]University of California Cooperative Extension Service, Parlier, California.

in drip irrigation will find their solutions in several areas of chemical weed control. One is the use of preemergence herbicides for annual weeds which persist longer in the soil than the presently used herbicides, particularly under continuous moisture. Another is the use of contact herbicides on the emerged weeds in the wet spot or persistent herbicides with contact activity. A third approach is the use of herbicides through the drip system, i.e., the use of herbicides capable of killing weeds as they germinate. With all three approaches it is essential that perennial weeds be eliminated before going into drip irrigation. Once perennial weeds are present they must be eliminated as soon as possible by the best method available. The use of effective foliar applied translocated herbicides have been effective.

Research Results

Single annual applications of a number of promising herbicide combinations in the fall, winter and spring have been made for 4 consecutive years starting in a newly planted orchard (OM 0.1%, sand 72%, silt 10% and clay 8%). With drip irrigation. excellent safety and weed control was obtained. An evaluation of the total sprayed plot area vs. the wet spot immediately under the emitter showed a combination of simazine and oxadiazon to be consistently better than other treatments. Another combination of note was simazine and oryzalin. In this sandy soil (sand 72%, silt 22%, clay 6%, OM 0.13%) and with the irrigation and rainfall regime, most of the herbicides tended to lose control of summer grasses and lambsquarter in the moist area of the emitter in early June each year.

A second field trial initiated 1/23/74 and retreated 11/13/74 showed the loss of control in the moist area of the emitter with some herbicides particularly napropamide and oryzalin. In a number of other trials, combinations were quite effective well into June. Any treatment that had 1 to 2 lb/A of simazine was much more effective than with the herbicide alone in orchard trials. Very little phytotoxicity symptoms on trees and vines were observed except with nonflurazon on pistachios and grapes.

Contact Herbicides

A second area of research has been to evaluate contact herbicides with short term residual activity. A great many herbicides are sufficiently effective on young weed seedlings in the moist zone. In a corn experiment under drip irrigation, young 6-inch corn plants heavily infested with crabgrass (*Digitaria sanguinalia* L.), cupgrass (*Eriochloa gracilis* Hitchc.), pigweed (*Amaranthus* sp.) and lambsquarter (*Chenopodium album*) 3-4 inches high were sprayed 5/28/74. The evaluation on 6/8/74 showed that all herbicides gave control of these weeds with little or no significant damage to the young corn. The algae control evaluated 6/30/74 appeared best with ametryne.

Injection

The use of herbicides through the drip system offers still another answer to some of the annual weed problems under drip irrigation. A series of greenhouse experiments to evaluate the effect of trifluralin and several other herbicides in suspension on plant growth were conducted. The activity was measured by means of plant response of six crops. The results of this and three other greenhouse tests showed that most herbicides are active in the 1-10 ppm range.

Armed with the greenhouse data injection of herbicides in the range of 1 to 10 ppm were made in field trials. It was soon apparent that the key to control of weeds in the area of the emitter is the distance moved by the herbicide in an active concentration at a distance from the point of emission. The herbicides in an active state that move are usually those that are fairly soluble and do not adsorb readily to soil particles. If adsorbtion were not involved, the amount of control would depend on the amount of total herbicide delivered by the emitter. The amount delivered would depend on the concentration of injected herbicide, the dilution during injection and the length of time of the injection. Since many herbicides are active in the neighborhood of 1 ppm in the soil solution, this rate was used for different lengths of time in one of the first injection experiments. The sphere of trifluralin activity was greater for an 8 hour injection period than 1 and 2 hours. The undisturbed zone displayed generally good grass control but had little or no effect on subsequent algae growth when evaluated 8 weeks after application.

In another field trial when a number of herbicides were injected into the drip irrigation line it was obvious that different herbicide moved differently in a Delhi sandy loam. Herbicides like EPTC and perfluridone being quite soluble moved the greatest distances from the emitter. Napropamide may have moved in lower amounts since napropamide is very toxic to barley. Nitrofen, oxadiazon and trifluralin usually relatively immobile herbicides moved least from the emitter in this field trial.

In still another field test the total distance moved from the emitter at 1, 10 and 100 ppm was not too different for each individual herbicide. The emulsifiable concentrate formulation of napropamide appeared to move slightly further than the wettable powder formulation. The higher concentrations of EPTC and oxadiazon appeared to move slightly further than the lower concentrations. In this trial and others it appeared that herbicides did not move as far as the water. In other field trials in a Delhi loamy sand herbicides moved about half as far as the water, i.e., 42 to 61%. The diameter of the circle of control around the emitter was in the neighborhood of 3 cm. In this study the sphere of weed control was greatest with napropamide.

Under commercial orchard conditions 6 herbicides were injected for 1/2 hour at 20 ppm. The soil was a Panoche clay loam low in organic matter. Of the herbicides in this study oxadiazon was most effective on the 3 species present. Napropamide also gave excellent weed control near the emitter. Barley and sugar beets seeded in this zone showed the oryzalin to be as active as napropamide early in the season.

In another field test where 4 and 12 lb/A were applied preemergence to soil in January and napropamide injected through the drip irrigation system at 12 and 120 ppm, good weed control in the area of the emitter was obtained in some treatments. The best was where napropamide was applied preemergence and followed by injections of napropamide through the irrigation system. Oxadiazon preemergence was next most active and oryzalin was least active.

Irrigation through biwall emitter was surprisingly good with three herbicides - pronamide, RH-2915 and norflurazon. Very little work has been done with this type of emitter.

Conclusion

Although a number of methods of chemical weed control have been included in the testing thus far none has given 100% control in all soils under all kinds of irrigation programs. Napropamide has been quite effective through the irrigation system. Oxadiazon has been effective applied preemergency prior to winter rainfall and has stood up quite well in the most area around the emitter. Many herbicides can be successfully applied through the drip system. All seem to move a shorter distance than the water thus leaving a fringe of weeds around each emitter. The more soluble, less adsorbed ones would be expected to move further and give better control in the area of the emitter. Most herbicides with contact activity were effective at killing standing weeds in the emitter area.

APPLICATION OF HERBICIDES THROUGH SPRINKLERS[1]

Alex G. Off, Jr.[2]

Introduction

In 1975 there were 54.3 million acres of irrigated farmland in the United States (Irr. Journal, 1975) (Table 1). About 13.3 million acres (23%) were irrigated by sprinkler systems and over 83% of the sprinkler-irrigated farmland was located in the 17 western states. Texas, Nebraska, California, and Idaho each had over one million acres under sprinkler irrigation.

The greatest interest in applying herbicides through sprinkler irrigation equipment has focused on center-pivot sprinklers. In the 17 western states, there are about 3.5 million acres irrigated by center-pivot sprinklers. Properly designed and operated systems have excellent uniformity of water application and there is no run-off water to contaminate streams and rivers. Because the sprinklers are already being used to apply water and often fertilizers, very little additional equipment is required to apply herbicides. Numerous herbicides are currently registered for application through sprinklers (Table 2). At the present time,

[1]This is a progress report on research on the use of certain chemicals that require registration under the Federal Insecticide, Fungicide, and Rodenticide Act. It does not set forth recommendations for the use of such chemicals, nor does it imply that the uses discussed have been registered. All uses of these chemicals must be registered by the appropriate State and Federal agencies before they can be recommended.

[2]Plant Physiol., Agr. Res. Serv., U. S. Dep. of Agr., Irrigated Agr. Res. and Ext. Center, Prosser, WA 99350.

Table 1. 1975 survey of irrigated acreage in the 17 western states

State	Total irrigated (acres)	Sprinkler irrigated (acres)	Center-pivot sprinklers (acres)
1. Texas	8,618,000	1,918,000	400,000
2. Nebraska	5,614.970	1,641,856	1,188.256
3. California	8,759,000	1,559,000	3,000
4. Idaho	4,038,700	1,290,200	169,670
5. Oregon	1,938,000	818,000	110,000
6. Washington	1,593,000	791,000	117,000
7. Kansas	2,591,000	641,000	540,000
8. Colorado	3,120,000	520,000	460,000
9. Montana	3,400,000	500,000	- - - -
10. Utah	1,887,650	369,050	22,760
11. Oklahoma	758,040	312,040	75,000
12. South Dakota	247,000	189,000	102,000
13. New Mexico	1,069,600	159,800	150,000
14. Wyoming	1,826,500	159,600	74,400
15. Arizona	1,150,000	51,000	14,000
16. North Dakota	91,910	48,589	42,324
17. Nevada	1,317,000	27,000	3,000
17 western stated	48,019,770	10,995,135	3,471,410
Other states	6,316,164	2,259,788	392,060
U.S. Total	54,335,934	13,254,923	3,863,470

Table 2. Herbicides registered or pending for use through sprinklers

Herbicide	Crop
EPTC + safener	corn (midwest)
EPTC	alfalfa, clover, almonds, potatoes, sugarbeets, walnuts. beans (pending).
Cycloate	sugarbeets (pending)
Metham	weed seed (preplant)
Atrazine	corn and sorghum (pending) (midwest)
Alachlor and Alachlor tank mixes	corn (pending)
Butylate and Butylate/atrazine	corn (midwest) corn (midwest)
Napropamide	trees and vines, alfalfa, ornamentals (all pending)

Table 3. Comparison of three methods of applying herbicides on the yield of weeds and corn

Method of application	Treatment		Weeds (lb/acre)	Corn (bu/acre)
Ground	Atrazine	3 lb/a	0	119
	Alachlor	2.5 lb/a	0	116
Aircraft	Atrazine	3 lb/a	11	123
	Alachlor	2.5 lb/a	11	124
Sprinkler	Atrazine	3 lb/a	<1	122
	Alachlor	2.5 lb/a	<1	118
Untreated control			1044	44

Ref: Robinson and Mulliner, 1972.

research on applying herbicides through center-pivot sprinklers is being conducted in Nebraska, Colorado, Idaho, Wisconsin, and Washington. Crops under investigation include corn, potatoes, beans, sugarbeets, and alfalfa. Results from tests conducted by the University of Nebraska indicate that the practice of applying herbicides in the water by center-pivot sprinklers is safe and effective for weed control in corn (Robinson and Mulliner, 1972) (Table 3).

Uniformity of Application

Herbicides applied through sprinkler systems will never be distributed more evenly than the water. Therefore, the problem of obtaining a uniform herbicide application is basically one of obtaining uniform water application. Uniformity of water application through a sprinkler system is usually expressed as the coefficient of uniformity (C.U.) Pair, 1975).

$$C.U. = 100 \quad 1 - \frac{\Sigma \text{ deviations from the mean}}{\text{mean x No. of observations}}$$

For center-pivot systems, the C. U. is determined by the formula by first measuring the volume of water (catchment) caught in cans as the system passes over the cans, and then calculating the mean and the deviation of each catchment from the mean. An ideal pattern in which the application is perfectly uniform would have no variation and the coefficient of uniformity would be 100%. As the variation increases, the uniformity will decrease. A C.U. of 80% is the minimum accepted standard for performance (Figure 1).

When properly designed and operated, sprinkler systems can apply pesticides as uniformly as ground or aerial equipment (Table 4). Tests

Table 4. Coefficients of uniformity for different methods of applying herbicides

Method of application	C.U.[a]
Ground	70-90
Aircraft	60-90
Sprinklers	
(a) Solid-set	70-85
(b) Side-roll	75-85
(c) Center-pivot	85-92

[a]Wind velocity less than 10 mph.

by Bode, et al. (1968) show that uniformity of low volume fan spray nozzles on ground equipment can vary from 70 to 90%, depending on pressure. Yates (1962) indicates that the coefficient of uniformity for aircraft applications varies between 60 and 90%. Modern design center-pivot sprinklers are giving coefficients of uniformity in excess of 90%.

Many variables affect the distribution of water onto the soil or crop from a sprinkler system (Pair, 1967). These variables can be grouped as follows:

1) Climatic variables--windspeed and direction.

2) Sprinkler head variables--nozzle size, nozzle angle, rotation speed, pressure at nozzle, number and type of nozzles.

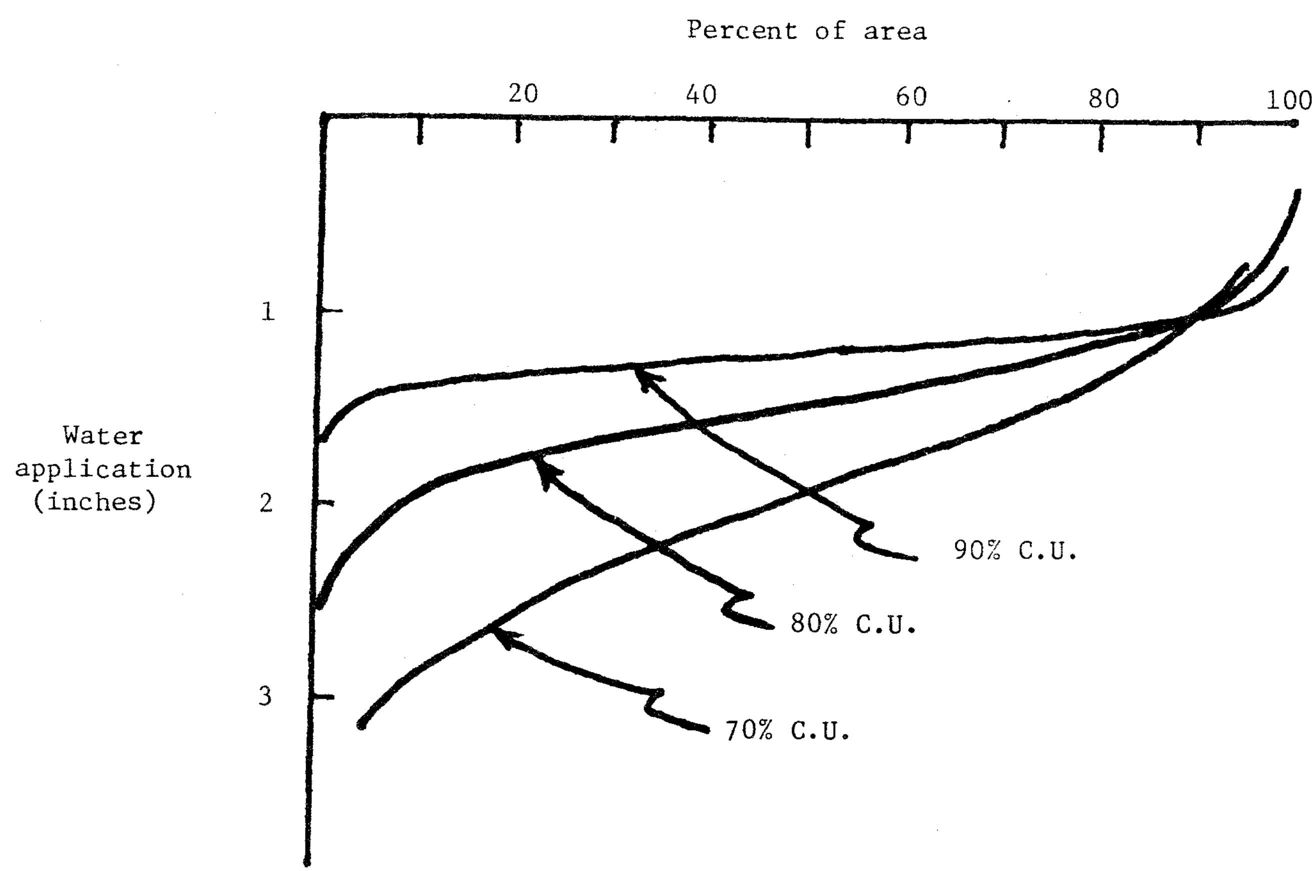

Figure 1. Comparison of water distribution at 70, 80, and 90% coefficient of uniformity.

3) Distribution system variables--sprinkler head spacing on the lateral, spacing of laterals along the main pipeline, height of sprinkler above the soil or crop, stability of the sprinkler riser, and pressure variation in the sprinkler system.

4) Management variables--duration of system operation, velocity of lateral or sprinkler movement over the ground in self-propelled laterals and sprinkler machines, alignment of sprinkler risers with the vertical.

Wolfe (1967) studied solid-set sprinkler systems and reported that windspeed was the most important factor affecting uniformity (Figure 2). Pressure was less important than nozzle size or spacing. Shearer (1966) studied a sprinkler lateral that moved continuously in a linear direction, and reported uniformities of 92% in winds from 4 to 16 mph. In a later study, Shearer (1971) found that reducing pressure, increasing speed, or reducing water application rate reduced the uniformity of water distribution with moving systems. Our results with center-pivot sprinklers also show that moderate wind velocities do not greatly affect the uniformity of water distribution (Table 5).

Experiments in Washington

Our research in Washington has been conducted in potatoes grown under center-pivot sprinklers. Our initial experiments were in 1972 on the coarse-textured soils of the Columbia River Basin in southern Washington. These soils often contain 90% sand and less than 1% organic matter.

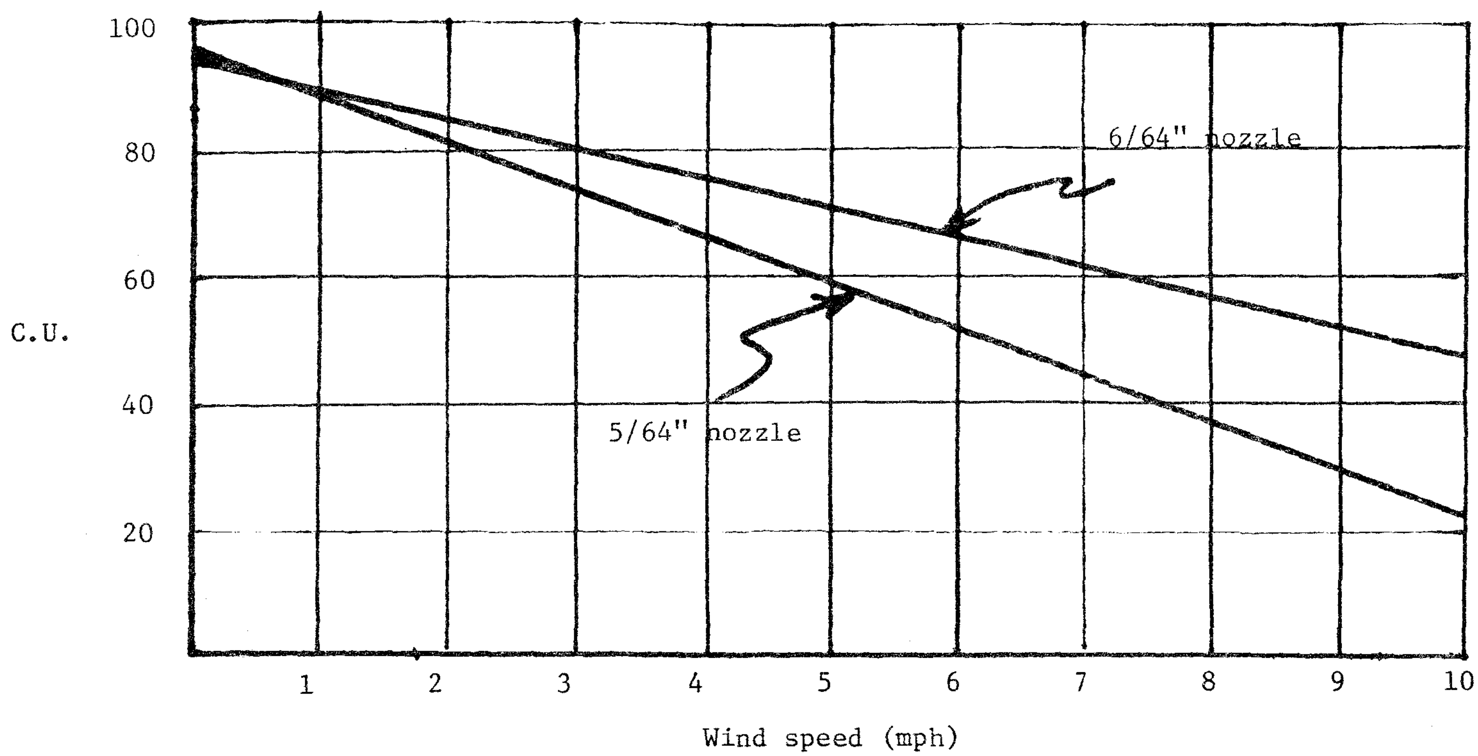

Figure 2. Effect of wind speed and nozzle size on the coefficient of uniformity for a solid-set sprinkler.

Table 5. Coefficients of uniformity of a center-pivot system as influenced by windspeed and water application rate

Operating conditions	C.U.
0.25 inches of water applied	
Wind: 7-10 mph in line with sprinkler	87
Wind: 3-5 mph across sprinkler	86
0.50 inches of water applied	
Wind: 6-10 mph in line with sprinkler	85
Wind: 4-6 mph across sprinkler	92

Russet Burbank potatoes were planted on March 20. EPTC and EPTC plus trifluralin were injected into a center-pivot sprinkler and applied with 0.5 inch of water on March 30. Metribuzin was applied on April 27 in 0.25 inch of water. Plots were wedge-shaped portions of the 130 acre irrigated circle. Each chemically treated plot was 5 acres, and each nontreated plot was 1.7 acres. All treatments were replicated three times.

Dense populations of Russian thistle, pigweed, barnyardgrass, common lambsquarters, and nightshade developed in the nontreated plots. EPTC and EPTC plus trifluralin were not effective in controlling any of the weeds in this experiment. On the other hand, metribuzin applied soon after the weeds emerged, controlled all of the weeds for about six weeks.

None of the herbicides injured the potatoes noticeably. However, some general yellowing within plots treated with metribuzin was noted from aerial observation in July.

Analyses of nonaerated water samples taken at the center of the pivot system indicated that EPTC was thoroughly mixed with water and that the actual concentration was very close to the calculated concentration (Table 6).

Table 6. Analyses of nonaerated water samples during the application of EPTC

Sample	EPTC (ppm)
1	20.0
2	22.0
3	22.1
4	20.1
5	20.9
Average	21.0
Calculated concentration = 22.7 ppm	

Data from the University of Nebraska show that herbicides formulated as liquids (alachlor) remain uniformly mixed with water in the sprinkler (Table 7). On the other hand, atrazine, a wettable powder, may be dropping out midway along the sprinkler. Our results with metribuzin, formulated as a wettable powder, also indicate lower concentrations midway along the sprinkler (Figure 3). In our studies, large quantities of the volatile herbicide, EPTC, (21-44%) were lost to the atmosphere during the application. The percentage of loss decreased as the distance from the

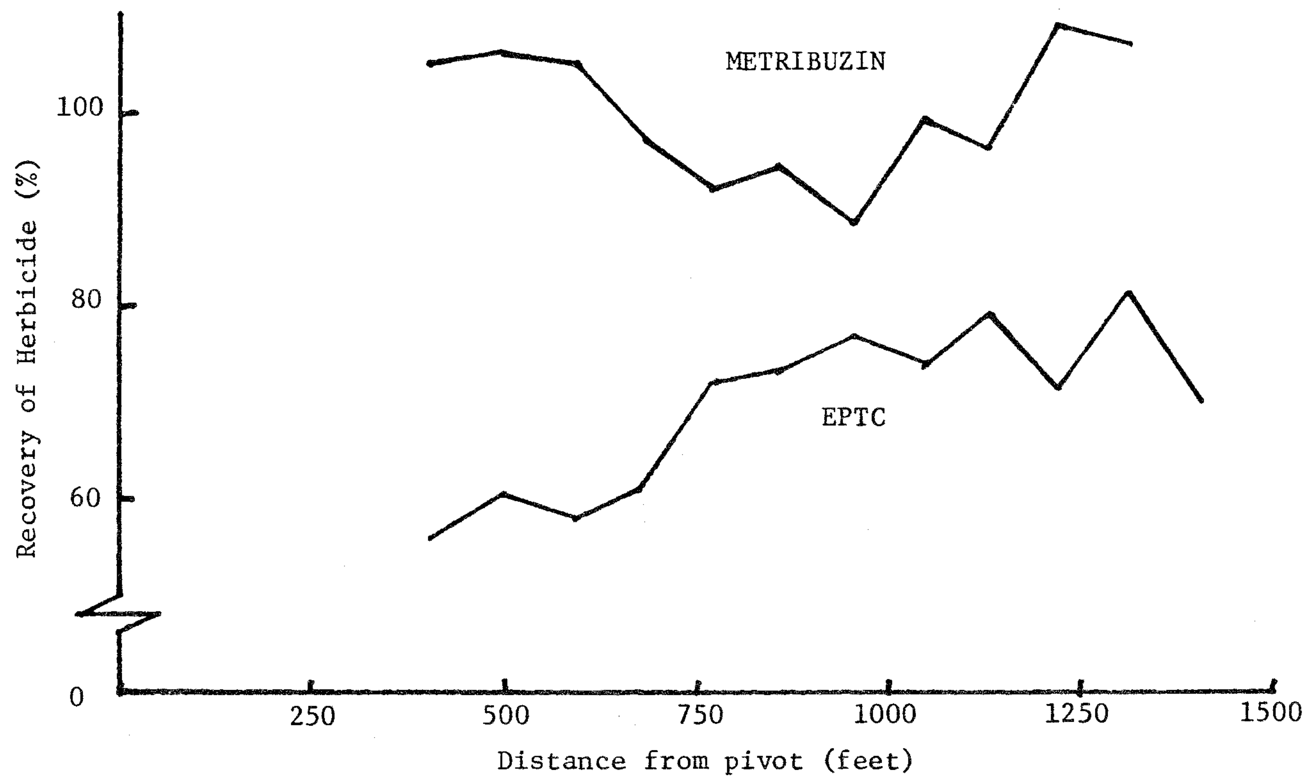

Figure 3. Analysis of water samples for herbicides at various distances from the pivot.

pivot increased. These findings indicate that large quantities of EPTC evaporated during the time the herbicide-water droplets left the sprinkler nozzle and before they reached the ground.

Table 7. The effect of distance from the pivot of a center-pivot sprinkler on the concentration of herbicide in the water of collecting cans

Sprinkler head position on center-pivot	Atrazine (ppm)	Alachlor (ppm)
First	28	23
Midway	20	22
End	30	21

Ref: Robinson and Mulliner, 1972.

Although the amount of water in the collecting cans varied considerably, coefficients of uniformity calculated from the data were 85-92% (Figure 4).

The greatest variation in water application occurred at the outer-end of the pivot. High water application rates at the end of the system were caused by a large nozzle at this location that was supposed to aid in applying water during high wind periods. During the period of pesticide application, this large nozzle should be plugged to prevent excessive rates from being applied along the outer perimeter of the field.

Although EPTC did not control weeds in our tests, similar types of applications in Colorado, Nebraska, and Wisconsin have been effective for the control of weeds in corn and beans.

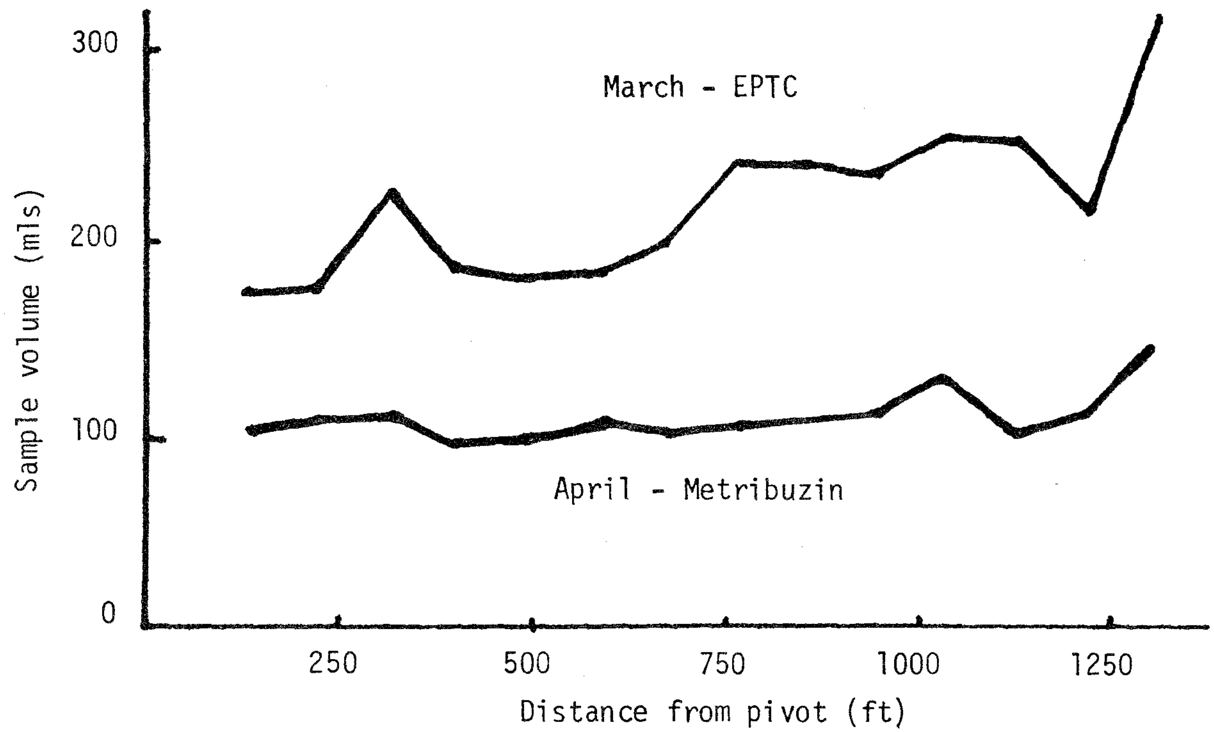

Figure 4. Volume of water in collecting cans at various distances from the pivot.

Metribuzin was highly effective in our early studies. In 1975, we conducted a large field test with this herbicide to further evaluate its effect on potatoes and weeds.

Russet Burbank potatoes, planted on April 9, were just emerging when the first application was made on May 13. There was a dense population of lambsquarters, barnyardgrass, and nightshade in the field. Scattered Russian thistle and annual bursage were also present. The metribuzin was injected into the sprinkler at the pivot over a 10 hour period. The sprinkler covered 64 acres or one-half of the circle and applied 0.25 lb of metribuzin per acre in 0.25 inch of water. Large sheets of plastic (12 x 30 feet) were placed on the ground in several locations ahead of the sprinkler to intercept the treated water. These areas served as untreated controls so that weed control and crop tolerance could be assessed accurately. A second application of metribuzin at the same rate was made on June 18, after the final hilling of the potatoes. Method and rate of application and location of untreated controls were the same as described earlier.

Within one week of the first application, many of the weeds were dead. Except for a few large Russian thistle and nightshade plants, all weeds were controlled effectively two weeks after treatment. The only injury symptom observed on potatoes was some slight veinal chlorosis 10 to 16 days after the first application. Potatoes recovered rapidly and no differences in foliage growth or color were visible 3 weeks after treatment. More weeds emerged after the final hilling operation, but they were controlled by the second application of metribuzin. The field was virtually weed-free the remainder of the growing season.

In conclusion, application of herbicides through properly designed and carefully operated sprinklers appears to be a safe and effective method for controlling weeds in potatoes, corn, and several other crops. Wind velocity, nozzle size, and water application rate appear to be three of the most important factors that affect uniformity of application. Many other conditions related to soil type, soil moisture content, water infiltration rates, and water application volumes need to be investigated before sound recommendations can be made.

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HERBICIDES APPLIED IN FURROW IRRIGATION WATER

Paul J. Carey[1]

Today there are approximately 53 million acres of irrigated land in the United States. Using moderate estimates this should expand to 65 million acres by 1979. Most land being brought into production today is irrigated and it is expected that by the year 2000, 100 million acres or one third of our crop acreage will be irrigated. With the ever increasing energy costs and the decreasing supply or absence of farm labor, many farmers are now using irrigation water to apply (and incorporate) herbicides.

Applications of fertilizers in surface irrigation water often times gave more response at the head of the furrow or check than at the end giving rise to the belief that surface irrigation applications of chemicals are uneven and unsuitable. While this is possible due to poor irrigation practices it has also been demonstrated that positive ammoniun ions are attracted to negative soil clay particles and that this ion capture removes some of the ammonium near the head of the furrow. In addition ammonia leaves the water as a gas as it moves down the furrow the net effect of this is less nitrogen at the end of the furrow. This would be apparent in crop response when low levels of nitrogen are available to the plant. This same affect does not seem to take place with our thiocarbonates.

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[1]Stauffer Chemical Company, Fresno, California.

For purposes of discussion let's look at how evenly surface systems irrigate. Uniformity of application is defined by taking a statistical average and measuring the variation. This variation is called the coefficient of variation. This subtracted from 100 will give the coefficient of uniformity. A completely uniform application would be 100%. If there were 10% variation the uniformity would only be 90%.

Properly designed basin and border systems operate at uniformities above 90%. Furrow systems are now being designed to operate at efficiencies above 90%. This requires proper grading and reuse systems. Uniformity in most furrow systems is in the 75% range. This uniformity is equal to the best alternative methods of herbicide application.

Irrigation applications have some additional advantages over conventional spray and incorporation methods.

There is a tremendous savings in application costs. In most surface irrigation systems there is virtually no cost for application. A simple pipe assembly for metering the herbicide into the irrigation water can be made for 5-6 dollars.

Because of a canopy affect on established row crops it is difficult to place the herbicide on the soil under the plant and incorporation in the row is difficult using mechanical methods. In contrast where the herbicide is applied in the irrigation water it either penetrates the plant canopy in the case of sprinkler applied herbicides or in the case of furrow irrigation is subbed up under the plant from the furrow by capillary action.

Using volatile herbicides such as Eptam on established crops, no foliage residues result even from sprinkler applications. The herbicide is incorporated into the soil by the water and that which hits the foliage volatilizes. This is especially important in treating alfalfa. Herbicides which are not volatile may leave residues on foliage. If the compounds are quite soluble additional applications of water may wash the compound off the foliage.

Often granular products are formulated to overcome residue problems that sift on through the foliage and land on the ground. Subsequent rainfall or irrigation incorporates them.

If the compound is water soluble and will work in irrigation applications, it may be applied in surface irrigation water which will minimize foliage residues.

A calibration chart is used to determine the proper orifice size used in the metering pipe assembly. This chart appears on the Eptam label and on a supplemental fact sheet. Flow rates are calibrated in pounds per hour and are calculated by multiplying the acres treated by the pounds applied per acre and then dividing by the irrigation time. Once calculated, the proper orifice is selected and placed in the holder. The assembly is attached to a drum, which has been fitted with a 3/4 inch bung and inverted over the water supply. After a few minutes of running, a check should be made to see that the proper flow has been achieved.

As an update on surface applications--Eptam is registered for irrigation application in furrows and flood on almonds, citrus, walnuts, sugar beets, potatoes, and alfalfa. Ordram is registered for flood applications on rice in the Southwest and will be registered in California.

We at Stauffer call this Herbigation Weed Control Service. We are supporting programs to further its technology both within our company and with University Extension specialists.

A MODEL OF THE SUSCEPTIBILITY OF PURPLE NUTSEDGE TO GLYPHOSATE

Ben Y. Mason and J. Wayne Whitworth[1]

Abstract. The literature reports a wide range in the dosage rate of glyphosate (*N*-phosphonomethyl glycine) required to control purple nutsedge (*Cyperus rotundus* *L*.). The present study assumed that almost all such variability would arise from growth-stage and environmental factors which could be described in terms of planting date, plant age, treatment date, and sunshade regime, and that a susceptibility model could be constructed in those terms. An outdoor pot test was designed to obtain a "kill" or "no kill" response after glyphosate treatment of plants drawn from the feasible combinations of four planting dates, four treatment dates, four chronological ages, and five sun-shade regimes. Since blooming, a manifestation of maturity, and fresh foliar weight, a measure of herbicide interception, would be factors in the causation of susceptibility, those responses were also recorded. The susceptibility model accounted for 76% of the variability of the kill response over the range of the experimental conditions. The bloom and topgrowth models, although derived from the same data matrix, were unrelated to herbicidal treatment. As physiological models of untreated plants, they accounted for 75% of the variability in bloom incidence and 92% of the variability in topgrowth mass over the period between

[1]Department of Agronomy, New Mexico State University, Las Cruces.

the summer solstice and the autumnal equinox. The latter models were utilized to clarify the causation inferred from the susceptibility model.

The susceptibility model predicts high resistance prior to the initiation of tuberization, high resistance in plants exposed to a season-long full-sun regime, and susceptibility in circumstances related to lush foliar display. Predictions from the model indicate that the traditional practice of sprouting nutsedge by tillage and then treating the shoots before the onset of tuberization cannot be an acceptable strategy when glyphosate is used.

Chronological age of the treated plant was not significant in the probability of kill, but the optimum combination of planting date and treatment date would result in treatment of 12-week-old plants late enough in the season for tuberization to be well under way.

STUDIES ON THE MECHANISM OF S-TRIAZINE RESISTANCE IN SEVERAL PLANT SPECIES

S. R. Radosevich[1]

Abstract. The distribution of simazine in whole plants and the effect of atrizine on isolated leaf cells and chloroplasts of two biotypes of common grounsel (Senecio vulgaris L.) were studied. No differences in ^{14}C-simazine distribution between the two biotypes was observed. Atrazine inhibited photosynthesis, RNA synthesis and lipid synthesis is isolated susceptible (S) cells but not resistant (R) cells. Photochemical activity of R-chloroplasts was not inhibited by atrazine but S-chloroplasts were severely inhibited.

Additional ^{14}C-atrazine uptake and metabolism studies were conducted on susceptible and resistant biotypes of redroot pigweed (Amaranthus retroflexus L.) and lambsquarters (Chenopodium album L.).

[1]Botany Department, University of California, Davis.

SITE OF UPTAKE AND SOIL MOVEMENT OF PERFLUIDONE

Lucinda Jackson and D. E. Bayer[1]

Abstract. Perfluidone is a relatively new herbicide that has shown some problems in providing consistent weed control in the field. It is used for the control of certain grass and broadleaf weeds and of yellow and purple nutsedge, and is recommended for use as a preemergence, soil-applied herbicide. The selective action of many soil-applied herbicides depends on the depth of placement in the soil and the herbicide uptake by the emerging roots and shoots of germinating seedlings.

To determine the site of uptake of perfluidone by several plant species, a charcoal-plastic barrier technique modified from Gray and Weierich, 1969 was utilized. This technique allowed the selective exposure of the shoots and the roots of the emerging seedlings. Wheat and rice exhibited stronger root uptake, while barnyardgrass, oats, and milo showed predominently shoot uptake. A morphological similarity between the three shoot-sensitive species is the elongation and exposure of the first internode (mesocotyl) region. This region does not elongate and the emerging shoot is sheathed by the coleoptile in wheat and rice.

The behavior of perfluidone in the soil was also investigated. Soil thin-layer chromatography, coil columns, and a slurry technique were used to study the adsorption, desorption, and leaching of

[1]Botany Department, University of California, Davis.

perfluidone in 3 soil types. Perfluidone was found to move readily in all soil types with weak adsorption and rapid desorption. Rf values of the soil thin-layer plates and the soil solumns were similar, regardless of the amount of water applied, indicating that the herbicide moved with the water front.

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FACTORS MODIFYING POSTEMERGENCE SEEDLING GRASS CONTROL

WITH DALAPON OR HOE-23408

Robert F. Norris[1]

Abstract. Control of barnyardgrass (*Echinochloa crus-galli* (L.) Beauv.) following field applications of dalapon of Hoe-23408 (methyl-2-[4-(2,4-dichlorophenoxy)]phenoxy(propanoate)) has varied from 90% or better to less than 50% from experiment to experiment. Greenhouse testing was initiated to try to elucidate which environmental variables might be contributing to this variation in activity.

Differences in soil moisture caused large differences in the activity of Hoe-23408. When barnyardgrass seedlings were grown in soil maintained at 30% moisture (on a weight/weight basis) the control was 99% following application of 0.5 lb/A of Hoe-23408. When the soil moisture was kept at 20% the control was reduced to 86%; at 10% soil moisture control decreased to 20%. Dalapon at 4.0 lb/A did not show a consistent change in response in relation to these soil moisture regimes.

Applications of Hoe-23408 at 0.5 lb/A resulted in only 26% control when the barnyardgrass seedlings had 4 to 5 leaves when sprayed; this increased to 49% control when the seedlings had 2 to 3 leaves, and to 67% when seedlings had only one leaf when sprayed. Control was 69%, 81% and 92% respectively when 2.9 lb/A of herbicide was used. Control following application of 4.0 lb/A of dalapon was 25%, 51% and 59% respectively at the three stages of growth.

[1]Botany Department, University of California, Davis.

Dalapon showed a large differential in response in relation to spray volume. Dry weight increase following application of 4.0 lb/A of dalapon was 170 mg of barnyardgrass per pot when 5 gal/A of water was used. The increase in dry weight was 730 mg per pot when 80 gal/A of water was employed; the controls gained 1600 mg during the same time period. Hoe-23408 showed a similar, but reduced differential in activity in relation to spray volume. Experiments utilizing wild oats (*Avena sativa* L.) have shown that surfactants only enhance the activity of the Hoe-23408 when the rate of herbicide was marginal.

These results suggest that soil moisture may be the single most important variable in determining relative activity of Hoe-23408. The size of the weeds at spraying is also important, and spray volume may be more critical than had been previously considered, especially when using dalapon.

INFLUENCE OF SURFACTANTS ON THE PHYTOTOXICITY OF HOE-23408

G. A. Lee and Dick D. Englert[1]

Abstract. Greenhouse investigations were conducted to determine the influence of six surfactants on the phytotoxicity of HOE-23408 on wild oat (*Avena fatva* L.), barley (*Hordium vulgare*, 'Steptoe') and spring wheat (*Triticum aestivum*, 'Fielder'). HOE-23408 at .375, .5, .75, 1.0 and 1.5 lb/A was applied in 69 gpa of water carrier with a constant rate of each surfactant at .5% v/v. The herbicide was applied 18 days after seedling emergence. The wild oat, barley, and wheat plants were in the 3-leaf stage, 4-leaf stage and 4-leaf stage, respectively, at the time of herbicide application. The plants were visually evaluated at weekly intervals during a four week period. Plants were harvested 26 days after treatment and the dry weights for the above-ground portion recorded for comparison of herbicidal effects.

Results of the study indicate that surfactants increased the phytotoxic effect of HOE-23408 on wild oat plants compared to applications with water alone. The time interval from application until visual symptoms occurred was reduced with treatments containing surfactants. There were, however, significant differences between the six surfactants as indicated by visual ratings of phytotoxicity and dry weight of harvested plants. Data indicates that Triton CS-7 and Triton-XA enhanced the absorption of HOE-23408 more than the other surfactants studied. As the rate of herbicide increased, the differential response due to surfactants decreased.

[1]Plant Science Department, University of Idaho, Moscow.

The addition of the various surfactants did not substantially increase the phytotoxicity of HOE-23408 toward barley and wheat at rates herbicidally active toward wild oat.

Surfactants enhanced both the rate of induced phytotoxic symptoms as well as greater herbicidal activity of HOE-23408 on wild oat. Steptoe barley appeared to have greater tolerance to the herbicide with the addition of the six surfactants than Fielder spring wheat. HOE-23408 at .5 lb/A + Triton CS-7 at .5% v/v and Triton XA at .5% v/v was euqally active as HOE-23408 at 1.5 lb/A without surfactant. This was a three fold increase in herbicidal activity on wild oat without significant phytotoxic damage to Steptoe barley or Fielder spring wheat.

FACTORS DETERMINING THE RESPONSE OF WHEAT VARIETIES TO IPC AND PCMC

Richard F. Ludt and John O. Evans[1]

Introduction

The carbanilate herbicides are primarily used for the control of emerging and established annual grasses and select broadleaf weeds in soybeans, alfalfa and sugarbeets. Lowered rates of propham show promise for the control of *Bromus tectorum* and annual rye in established stands of wheat.

In the northwest where sugarbeets are commonly planted in seedling small grain to prevent erosion, IPC is used to control the cover crop after the beets emerge. Reports from growers in this area indicate differing tolerances in wheat varieties to IPC. Wheat varieties of Mexican origin have been reported as requiring a considerable increase of propham for their control.

Where wheat plays a duality of roles, both as a crop and as a weed, a differential susceptibility of wheat varieties would present a unique situation. Tolerant varieties would be favorable where IPC was used to control *Bromus tectorum*, however, these varieties would be unfavorable when grown as a cover crop preceding sugarbeets or as volunteer in alfalfa. Labeling or registration for annual grass control in wheat might require specific varietal designations if such differential responses exist.

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

This study examined the validity of the reports of differing tolerances of wheat varieties to carbanilate herbicides in the field, as well as investigating factors commonly associated with differential varietal responses.

Materials and Methods

Two common winter varieties in the Intermountain area, Nugaines and Bridger, were compared in their response to the carbanilate herbicides, and to the response of two spring varieties, Fremont and Inia 66.

A sandy loam soil in 7.5 by 11cm pots was used in all greenhouse and growth chamber trials. At emergence, seedlings were thinned to six healthy plants per pot. All studies were replicated four times.

Trials with propham and chloropropham in the presence and absence of the carbanilate extender para-chloromethyl carbamate (PCMC) in field and greenhouse failed to show that PCMC altered the activity of the herbicides lending support to the findings of others. For this reason and ease of terminology, the terms IPC and CIPC will designate corresponding carbanilate herbicides with PCMC in a 4:1 ratio of herbicide to microbial inhibitor.

A shielding technique was employed to evaluate the herbicides being applied to the foliage-only versus applying them to the foliage and the soil surface. The soil surface of one group of greenhouse grown plants was covered with vermiculite prior to treatment, thus allowing only the foliage to be sprayed. The other group was treated normally allowing for herbicide coverage on both the foliage and the soil surface.

One hour after treatment the vermiculite was poured off and the pots were watered. Plants were treated at the 2 leaf stage and harvested 6 weeks later.

Nugaines and Fremont were subjected to two temperatures, 10° and 25°C, prior to and after treatment with IPC. Five days acclimation time was allowed prior to treatment; and the plants were harvested 10 days later.

Results and Discussion

Plant growth stage at the time of treatment was determined to be an important factor in expression of injury of all varieties to IPC. The 2 leaf stage was significantly more sensitive to the herbicides than was the 3 leaf stage. The dry weight yields of foliage harvested 6 weeks after treatment failed to demonstrate any significant varietal differences in response. Yields of plants treated in the 2 leaf stage were reduced 80% or more as compated to untreated controls at either the 2 or 4 lb/A rates (Figure 1).

When wheat was treated during the 3 leaf stage yeild reductions of 60 to 68% were recorded. A growth differential did not occur between the varieties or at either growth stage when compared at the 2 and 4 lb/A rates (Table 1).

Another factor investigated was a method of applying the herbicide to wheat. All varieties treated with IPC on the foliage plus the soil surface demonstrated reductions in dry weight yields typical of previous findings observed when treated at the 2 leaf stage. Yield reductions when compared to the check plants were 83% or more for this

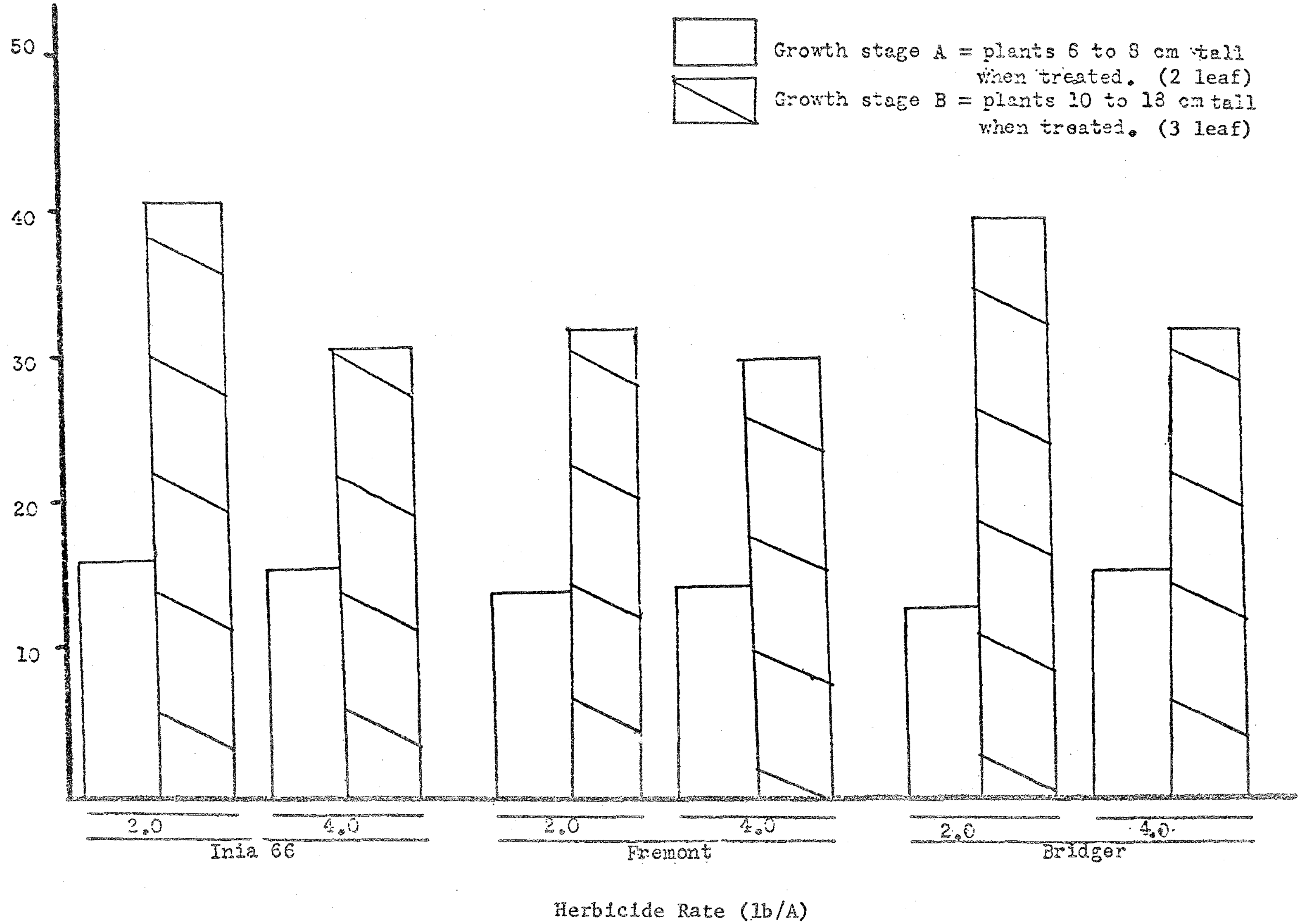

Figure 1. Growth stage responses of wheat varieties to two dosages of IPC.

Table 1. Influence of growth stage and herbicide treatment on dry weight yield of wheat varieties

Variety	Rate (lb/A)	Growth* stage	Yield (Percent of control)
Bridger	2	A	12.9b
		B	38.8a
	4	A	15.2b
		B	31.5a
Fremont	2	A	14.5b
		B	31.7a
	4	A	13.9b
		B	28.8a
Inia 66	2	A	15.1b
		B	40.6a
	4	A	16.0b
		B	30.5a

Values between the dotten lines followed by the same letter are not significantly different at the 5% level according to DMR test.

*Growth stages

A = plants 6 to 8 cm tall when treated (2 leaf)

B = plants 10 to 18 cm tall when treated (3 leaf)

method of treatment for both the 2 and 4 lb/A rates; with no significan differences in response between the rates (Figure 2).

The application of IPC to the foliage alone resulted in varietal differences between the two types of wheat; winter versus spring

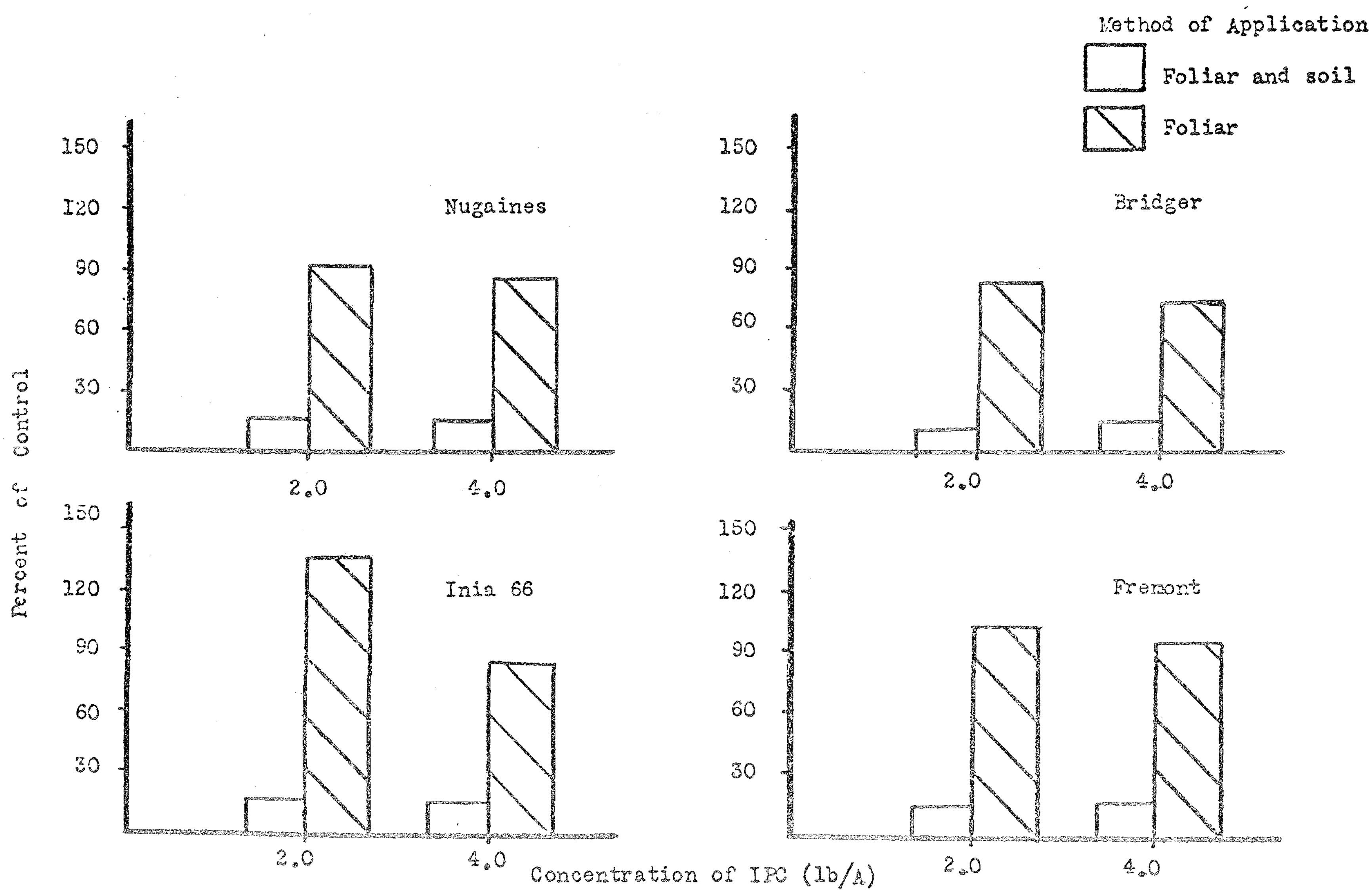

Figure 2. Influence of application methods of IPC on shoot growth response of wheat varieties.

varieties. The growth of the spring varieties, Fremont and Inia 66, treated with the lower dosage showed a significant enhancement over the controls (Table 2). The higher dosages applied to the foliage reduced growth of all varieties studied. The winter types exhibited growth reductions at both levels of treatment; the 4 lb/A rate being more active than the 2 lb/A rate.

In the temperature study only the 1 lb/A rate or more at the elevated temperature showed a reduction in growth of Nugaines wheat (Tables 3 and 4). A similar observation was made for the spring variety. Dosages of 1 lb/A or more were required to reduce the growth of Fremont wheat and then, only at the elevated temperature. In this case the significance is not as obvious as with the winter variety adding some credibility to our previous observation that the winter varieties are slightly more sensitive to IPC.

Summary

Under normal field use differential varietal response of wheat to the carbanilate herbicides, although measurable in the greenhouse and growth chamber, is not likely to be of practical importance.

All varieties were more sensitive to the herbicide treatments than the spring varieties. When the herbicide was applied to the foliage and soil surface the difference in response of the varieties was not noted; a situation that would be typical of field spraying.

Wheat sensitivity increased with increasing temperatures regardless of dosage level.

Over a two year period of study PCMC did not alter the activity of either IPC or CIPC in field and greenhouse trials.

Table 2. Influence of method of application of IPC on growth response of wheat varieties

Variety	Rate (lb/A)	Application Method*	Yield (Percent of control
Bridger	2	F	85.0a
		F & S	12.5c
	4	F	70.0b
		F & S	15.3c
Nugaines	2	F	91.0a
		F & S	16.4c
	4	F	86.0b
		F & S	13.6c
Fremont	2	F	108.7a
		F & S	13.4c
	4	F	91.2b
		F & S	14.9c
Inia 66	2	F	135.8a
		F & S	16.4c
	4	F	85.6b
		F & S	15.4c

Values between the dotted lines followed by the same letter are not significantly different at the 5% level according to the DMR test.

*Method of application

F = herbicide applied to foliage only.

F & S = herbicide applied to both foliage and the soil.

Table 3. Influence of temperature and dosage of IPC on growth response of Nugaines wheat

Temperature (°C)	Rate (lb/A)	Yield* (g/pot)	Percent of control
10	0.00	2.15a	100.0
	0.50	2.03a	94.4
	0.75	2.10a	97.7
	1.00	2.08a	96.7
	1.25	2.24a	104.8
	1.50	1.88a	87.4
25	0.00	2.50a	100.0
	0.50	2.90a	116.0
	0.75	2.26ab	90.4
	1.00	1.94b	77.6
	1.25	1.79b	71.6
	1.50	1.84b	73.6

Means between dotted lines followed by the same letter are not significantly different at the 5% level according to DMR test.

*Average dry weight of 6 plants harvested 10 days after treatment.

Table 4. Influence of temperature and rates of IPC on growth response of Fremont wheat

Temperature (°C)	Rate (lb/A)	Yield* (g/pot)	Percent of control
10	0.00	2.45b	100.0
	0.50	2.33b	95.0
	0.75	3.02a	123.2
	1.00	2.70ab	110.2
	1.25	2.32b	94.7
	1.50	2.24b	91.4
25	0.00	3.33ab	100.0
	0.50	3.60a	108.1
	0.75	3.30ab	99.0
	1.00	2.97b	89.1
	1.25	2.83b	84.9
	1.50	2.84b	85.2

Means between dotted lines followed by the same letter are not significantly different at the 5% level according to DMR test.

*Average dry weight of 6 plants harvested 10 days after treatment.

BIFENOX

RESULTS OF THE 1975 EXPERIMENTAL PERMIT

ON SMALL GRAINS AND SORGHUM

W. T. Smith, D. R. Adams, D. J. Cihacek,
R. K. Vannoy and R. H. Dreger[1]

Bifenox [Methyl 5-(2, 4-dichloraphenoxy)-2-nitrobenzoate] was field-tested by small grain and sorghum growers under EPA Experimental Permit Numbers 2224-EXP-5G and 2224-EXP-4G in 1975 in the Midwest, Southwestern and Western areas of the United States. Trials were also conducted in Canada under the supervision of Chipman Chemicals Ltd. personnel. Postemergence treatments on small grains at the recommended rates gave commercial control of such broadleaf weeds as pigweed, lambsquarters, smartweed, wild mustard and wild buckwheat. Preemergence treatments in Canada at the .75-1.00a.i. per acre rate gave control superior to the postemergence treatments.

Differences in efficacy also were noted between the liquid and wettable powder formulations. Commercial weed control was also obtained in grain sorghum when Bifenox was used at the recommended rates either alone or as a combination treatment with propachlor. A state label for the use of Bifenox on grain sorghum in Texas for the 1976 season has been obtained.

[1]Mobil Chemical Company, Crop Chemicals Group, Richmond, Virginia

SOIL DEGRADATION OF FOUR DINITROANILINES

R. L. Zimdahl and S. M. Gwynn[1]

Abstract. These studies were conducted to more precisely define the rate of degradation and the associated rate law for four dinitroaniline herbicides. The experiments were conducted under laboratory conditions in two soils at two temperatures. Rate of degradation was directly correlated with temperature. First order kinetics adequately described the rate of degradation at 15 C but the simple first order assumption was not sufficient for degradation at 30 C. The implication of our interpretation is that at 30 C there are two rate processes operative in the soil degradation of these dinitroaniline herbicides. The data show an initial rapid first order rate of degradation with a gradual change to a slower first order process.

[1] Botany Department, Colorado State University, Fort Collins.

GRAZING WITH SHEEP FOR LEAFY SPURGE MANAGEMENT

Laurence O. Baker[1]

Abstract. Leafy spurge is the fastest spreading and one of the most difficult perennial weeds to control in Montana. The infestations along streams and rivers coupled with its adaptability to water spread contribute to the rapid invasion. Inaccessability of many sites to ground treatment requires aerial applications. Such applications are undesirable because of injury to erosion controlling trees and shrubs. Other means are needed to restrict the spread and work toward effective management of this plant.

Grazing leafy spurge with sheep offer a nonchemical method of managing this difficult to control, deep rooted perennial weed. Grazing trials involving time of first grazing in the spring and grazing intensity combined with 2,4-D application has been conducted at the Montana Agricultural Experiment Station, Bozeman, for six years.

This experiment has demonstrated that leafy spurge can be successfully grazed with sheep. They had to learn to eat the plant, but did not appear to be adversely affected by leafy spurge. The best treatment has reduced spurge growth and vigor to about 10% of the check. Best spurge control, coupled with greatest grass vigor and production was obtained by an early 2,4-D spray followed by grazing spurge regrowth.

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

LIGHT COMPETITION BETWEEN SEVERAL CROPS AND YELLOW NUTSEDGE

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

Abstract. The influence of artificial shading (0, 30, 47, 70, 80, and 94% shade) on growth and reproduction of yellow nutsedge and rate of interception of light by developing canopies of several crops were investigated in field studies to estimate the potential of crops to compete with nutsedge for light.

Number of shoots and tubers and total dry matter production decreased in direct proportion to the amount of shading imposed on nutsedge plants, correlation coefficients (r = .982 to .999). Whereas total tuber weight was highly correlated with light (r = .982 and .988) weight of individual tubers was not correlated. Compared to no shading, flower production was substantially reduced by 30% shade and was essentially absent under more dense treatments.

Photosynthetically active radiation (PAR) measured at weekly intervals indicated that the rapidity of light interception by crop canopies, and therefore their ability to compete with nutsedge for light, varied for crops. As expected, light interception occurred first within the drill row of crops, then on shoulders of planting beds, and finally in furrows. The most rapidly developing canopies (corn, potatoes, and safflower) intercepted 90% or greater PAR, including illumination in furrows, within 8 to 9 weeks after planting. About 10

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to 12, 11 to 12, and 17 to 20 weeks were required for 80% interception for blackeyes, milo, and cotton, respectively. Fall-planted barley intercepted about 90% PAR by March 12, or prior to or about the time that nutsedge begins to grow. Although onions planted in December intercepted 95% of the PAR in each of the two drill rows per bed about 26 weeks after planting, only about 20 to 30% interception occurred in furrows and row middles. The only non-row crop measured, alfalfa, generally intercepted 90% or greater PAR within 2 to 3 weeks after individual cuttings.

BIOLOGICAL CONTROL OF SPOTTED KNAPWEED

J. M. Story, L. O. Baker, and

N. L. Anderson[1]

Abstract. A gall fly, *Urophora affinis* Frfld., was introduced into Western Montana in 1973 to be evaluated for its potential as a biological control agent for spotted knapweed (*Centaurea maculosa* Lam.). The insect deposits its eggs inside the young flower buds of spotted knapweed where the resulting larvae feed. The feeding of the larvae reduces achene production and causes the plant tissues to form a gall around the larvae.

The first release of 150 *U. affinis* adults was made in June 1973 into a 3.6 meter long x 1.8 meter wide x 1.8 meter high field cage placed in a heavy infestation of spotted knapweed. Additional releases totaling 2700 adults were field released during July in 1974 and 1975 at five locations in Western Montana.

Approximately 15 percent of the seed heads within the cage contained galls in May 1974. This figure increased to 71 percent after reproduction in 1975. Flies were observed in 1975 at a distance of up to 100 meters, but galls were found up to only 34 meters from the release site.

Gall flies were found in the webs of a spider, *Dictyna major* Menge, that builds its web at the top of spotted knapweed plants. Its effect on the fly population has not been determined.

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INTRODUCED RANGE PLANTS - WEEDS OR FORAGE?

M. Coburn Williams and Lynn F. James[1]

Abstract. Several plants purposefully introduced as ornamentals or for fiber, forage, and windbreaks have become pests in the United States. Marijuana, Dalmation toadflax, musk thistle, and Johnongrass are among these introductions.

The Poisonous Plant Research Laboratory at Logan, Utah, recently examined several introduced range species for toxicological properties. The plants had either been released for seeding or were scheduled for release. Sicklepod milkvetch, *Astragalus falcatus*, contained high concentrations of nitro compounds and was toxic to cattle and sheep. Fivehook bassia, *Bassia hyssopifolia*, contained 6 to 7 percent soluble oxalates, but proved to be as toxic to sheep as halogeton which contained twice that concentration of oxalates. Ruby sheepbush, *Enchylaena tomentosa*, a Chenopod from Australia, contained 6 to 7 percent soluble oxalates. *Galenia pubescens*, an African member of the Aizoaceae being studied for use in California, contained up to 7 percent soluble oxalates.

Plants are being introduced from abroad, propagated, and released without adequate safeguards that they will not become pests. Toxicological investigations on introduced species are particularly inadequate. Sicklepod milkvetch has been studied in this country for over 50 years. One week devoted to toxicological studies with cattle and sheep would have shown this plant to be poisonous. Strip mining and other disturbances associated with the current energy crisis will require

reseeding of vast areas of western rangeland. Some species used to reseed may be introduced. Since many of the purposefully introduced plants which became pests contained poisonous compounds, toxicology tests should be conducted first on any potential plant introduction.

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ANNUAL GRASS CONTROL ON NATIVE RANGELAND AND IMPROVED PASTURE

S. D. Cockreham and H. P. Alley[1]

Abstract. The introduced European annual bromes, downy brome (*Bromus tectorum* L.), and Japanese brome (*Bromus japonicus* Thunb.) are two problem grassy weeds covering much of the Western United States. Reasons these two species have become so abundant and widely distributed may include: (1) poor management of the original plant cover, (2) favorable soils and climatic conditions which enable it to compete with and to overcome native plants and grasses, (3) the natural aggressive nature of the European flora as a whole, as compared with the North American flora, (4) elaborate man-made transportation systems which allow rapid distribution of plant materials and (5) cropping systems which encourage establishment of new species.

To overcome the competitive nature of downy and Japanses brome on our native rangelands and improved pastures, selective chemical control is extensively being studied. From testing several different herbicides in a randomized complete block design, atrazine has proved reliable in selectively controlling downy brome. In Goshen County, southeastern Wyoming, the increase in production in terms of oven-dry weight of desired perennial grasses was over three times as great on study sites treated with atrazine at 1.0 lb/A, as compared to the untreated areas. On another research area at the Sheridan Experiment Station, north central Wyoming, oven-dry forage production of desired grasses was nearly double on native range plots treated with 1.0 lb/A

of atrazine and over twice on improved pasture as opposed to the check areas. In terms of total vegetative basal cover, plots treated with atrazine at 1.0 lb/A had a basal cover of 12% with 0% downy brome and .18% Japanese brome. On the untreated areas, the vegetative basal cover was 14%. Downy brome constituted 1.4% and Japanese brome 3.4% for a total of 4.8% basal cover of undesirable grass species.

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AERIAL SPRAY TESTS OF DRIFT CONTROL ADDITIVES FOR HERBICIDES IN OIL AND OIL-IN-WATER CARRIERS[1]

H. Gratkowski and R. Stewart[2]

Abstract. Early spring aerial spray tests on three National Forests in western Oregon showed that Accutrol™ and Foamspray ™ forming agents and water-soluble Lo-Drift™ reduced drift of herbicidal sprays in oil-in-water emulsion carriers. However, effective drift control also reduced brush and weed tree control with phenozy herbicides. An oil-soluble form of Lo-Drift was ineffective with diesel oil carriers.

Introduction

Drift control is an essential consideration in aerial application of herbicides on Pacific Northwest forest lands (2,4). Use of spray additives is one method to reduce drift. To be useful, however, drift control additives not only must be effective at economically acceptable rates, but also must not drastically reduce the degree of control obtained on weed species nor damage the conifers. During March and April of 1973, several drift control additives were compared

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[1]The herbicides and additives reported on and recommended here were registered for the use described at the time this manuscript was prepared. Since registration of herbicides is under constant review by State and Federal authorities, a responsible State agency should be consulted concerning the current status of these chemicals.

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to determine their effectiveness in budbreak aerial sprays to release young Douglas-firs from competition of shrubs and weed trees on the Umpqua, Siskiyou, and Siuslaw National Forests in western Oregon.[3]

More than 20 years' experience with aerial sprays has proved budbreak sprays of phenoxy herbicides most effective when applied in either an oil carrier or in an oil-in-water emulsion. Water carriers are usually far less effective for budbreak sprays, especially where deciduous shrubs and weed trees are abundant. Therefore, these trials involved only oil and oil-in-water emulsion carriers.

Study Areas and Methods

Emulsion carriers

In the Cascade Range, shrub and weed tree control with 2 lb of low volatile esters of 2,4,5-T/A in an oil-in-water emulsion carrier was compared with that obtained with similar sprays containing either Foamspray™ or water-soluble Lo-Drift™ spray additives.[4] The sprays were used to release young Douglas-firs from competition of snowbrush ceanothus and vine maple on three clearcut areas at elevations

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[3]The authors are indebted to the Forest Silviculturists of the National Forests and to Silviculturists and other personnel of Glide, Steamboat, Diamond Lake, Chetco, and Hebo Ranger Districts who cooperated and assisted in these tests.

[4]The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U. S. Department of Agriculture of any product or service to the exclusion of others which may be suitable.

between 3,200 and 4,400 ft above sea level. Each cutting unit was divided in half to provide two replications of each treatment.

In the Siskiyou Mountains near the coast, effect of oil-in-water emulsion sprays containing 3 lb ae of low volatile esters of 2,4-D/A were compared with similar sprays which also included either water-soluble Lo-Drift or Accutrol™ foaming agent drift control additives. There, the sprays were tested for release of Douglas-firs from tanoak, golden evergreenchinquapin (Castanopsis chrysophylla var. minor), and Pacific madrone at elevations of 1,900 and 2,300 ft. Six cuttings with two subdivisions per cutting provided a total of four replications per treatment.

All three drift control agents were added to the standard emulsion at rates specified by their manufacturers. Lo-Drift sprays contained 1 pt of water-soluble Lo-Drift plus 1/2 pt of X-77 surfactant per 100 gal of spray. Accutrol and Foamspray foaming agents were added at a rate of 3 qt/100 gal of spray mixture.

All herbicides were applied by helicopter in a spray volume of 10 gal/A, including 3/4 gal of diesel oil per 10 gal of spray mixture. To insure some shattering and misting of spray droplets in the standard emulsion as a basis for detecting effectiveness of the drift control additives, all nozzles were directed down and back along the airstream at an angle of 45 degrees from the horizontal.

Both the standard emulsion and Lo-Drift sprays were applied through D8 hollow cone tips without whirl plates on standard diaphragm Spraying Systems TeeJet aerial spray nozzles. Accutrol sprays were applied through Accutrol 842 aerial coarse spray nozzles; Foamspray mixtures were applied through Foamspray Chemicals, Inc. row crop/band 646 nozzles. Boom pressures were 30 psi for the normal emulsion, 35 psi with the Lo-Drift added, and 40 psi for emulsion carriers with foaming agents. Flying speed was 40 to 50 mph at an average height of approximately 40 ft above the vegetation.

Oil carriers

An oil-soluble form of Lo-Drift (Lo-Drift O.S.) in a diesel oil carrier was compared with a diesel oil carrier without drift control additives in aerial sprays to control red alder and salmonberry in three clearcut areas on the coastal slope of the Oregon Coast Ranges and on a mixture of redstem ceanothus, blueberry elder, snowbrush ceanothus, and vine maple in four clearcut areas on the west slope of the Cascade Range of western Oregon. The Coast Range cuttings were at an elevation of 900 ft; the Cascade Range cuttings between 2,400 and 4,100 ft above sea level.

The Coast Range cuttings were sprayed with 1 lb ae each of low volatile esters of 2,4-D and 2,4,5-T per acre in 10 gal of diesel oil. All Cascade Range cuttings were sprayed with 2 lb ae of low volatile esters of 2,4,5-T per acre in 10 gal of spray solution. For the drift control subdivisions, 2 qt of Lo-Drift O.S. were added to each 100 gal of oil and herbicide. In the Coast Ranges, the spray solution was applied through Spraying Systems TeeJet D8-46 hollow cone aerial spray nozzles; in the Cascade Range, the spray was applied through Teejet nozzles with D8 orifices but without whirl plates. Boom pressure was 30 psi and flying height varied between 30 and 70 ft depending on terrain.

Data were obtained on defoliation, topkill, and mortality of Douglas-firs, shrub species, and weed trees in early autumn of the first and second years after spraying. Twenty trees and shrubs of each of the most abundant species in each replication were sampled during late September 1973; 40 Douglas-firs, shrubs, and weed trees were sampled in each replication during autumn of 1974 to more accurately measure the full effect of each treatment at the end of the second growing season after spraying. Super 8 color movies were made on all areas to obtain photographic records and to supplement observations of performance of the drift control additives.

Results and Discussion

Young Douglas-firs were not damaged by presence of any of these drift control additives in the aerial spray mixture. Defoliation of Douglas-firs on areas treated with herbicides in the standard oil-in-water emulsion was so near normal and natural that it was indiscernible and of no practical significance (Table 1). Addition of drift control agents to the emulsion carrier had no adverse effects on the conifers.

Although slight defoliation was observed on conifers in all areas treated with 2,4,5-T in oil carriers (Table 2), loss of needles was no greater on subdivisions where Lo-Drift O.S. was added than on those treated with the standard oil carrier.

Shrub and weed tree control were in agreement with observation of spray patterns during aerial application and later study of the Super 8 color films taken during spraying. Sprays that produced smaller droplets (indicated by more misting and upward swirling of spray from ends of the spray boom) resulted in better coverage and improved control of the shrubs and weed trees. These results agree with effects reported by Buehring et al. (1) and McKinlay et al. (7). Both reported that smaller droplets were more phytotoxic than larger droplets for a given amount of herbicide per unit area.

Larger droplets produced by foam sprays reduced visible drift, but they also reduced defoliation and kill of the shrubs and weed trees. These results with phenoxy herbicides also agree with observations of effects of drop size on phytotoxicity of paraquat under field conditions (1). Although all areas were cross flown to provide double coverage with spray volumes of 10 gal/A, foamed sprays reduced drift and coverage and resulted in many readily evident lightly sprayed and unsprayed spots and strips in the sprayed areas.

Specific results and observations concerning effects of the various spray mixtures, performance of the drift control additives, and a discussion of factors involved are offered below.

Emulsion carriers

Emulsion carriers are especially effective on broad-leaved evergreen shrubs and weed trees, for such sprays are primarily absorbed through foliage of the weed species (3). They have also proved effective on many deciduous species. Each year, emulsion carriers are used on more than half the acreage aerially sprayed with herbicides by Pacific Northwest silviculturists.

Emulsion (no drift control agents)--Normal oil-in-water emulsions without drift control agents proved the most biologically effective carriers for aerial sprays of phenoxy herbicides in both the Cascade

Range and the Siskiyou Mountains. Shattering of spray droplets in the airstream produced large numbers of mistlike, drift-susceptible droplets. This was especially evident with the unthickened oil-in-water emulsion. Spray mist and upward swirling spray vortices from the ends of the spray boom were carried high above the helicopter. However, in the cool, damp weather of early spring, most of these small droplets did not appear to evaporate but slowly dropped onto the vegetation.

Vortices and drift of the fine droplets improved coverage and eliminated skips and unsprayed areas that were so evident later in foam-sprayed subdivisions. The smaller droplets may also have resulted in deeper penetration of spray into the shrub canopy, reaching leaves in the lower crowns as observed by Threadgill (8). These effects plus wider spray swaths were probably the primary factors responsible for the greater degree of shrub and weed tree control found in all areas sprayed with herbicides in standard unthickened oil-in-water emulsion carriers.

Lo-Drift (water soluble)--1 pt of water-soluble Lo-Drift/100 gal of spray mixture did not produce any noticeable degree of drift control in comparison with the standard oil-in-water emulsion without drift control additives. Both observations during aerial spraying and later study of the Super 8 color films confirmed this. Misting and swirling spray vortices from ends of the spray booms were almost identical to those of the standard emulsion in the tests in the Cascade Range and in the Siskiyou Mountains.

This observation was confirmed by the data for brush and weed tree control obtained with the normal oil-in-water emulsion carriers compared with that produced by the emulsion plus Lo-Drift (Table 1). Degree of weed control are areas sprayed with Lo-Drift in the emulsion was approximately the same as that obtained with the ordinary oil-in-water emulsions. Coverage was excellent, leaving almost no unsprayed patches. This also indicated that both sprays produced droplets of similar diameter with vortices and spray drift providing coverage of areas between spray swaths.

Foamed sprays--Large droplets produced by the air-induction nozzles used with both Foamspray and Accutrol reduced drift, but they also reduced biological effectiveness of the phenoxy herbicides in aerial sprays. Misting and spray whorls were minimized and spray drift was almost eliminated.

However, reduced drift and narrower spray swaths with foam sprays also had another effect. Although all areas were either cross flown or double flown, foamed sprays did not allow sufficient spray to drift and provide coverage and control on areas and strips not directly flown over. Ground flagging or marking of ends of flight lines across cuttings is not practical or economically feasible in the steep, mountainous terrain characteristic of Pacific Northwest forest land. Therefore, reduced coverage, less uniform distribution of sprays, and an increased number of unsprayed strips and small areas must be accepted as a cost of drift reduction.

Oil carriers

Diesel oil or No. 2 fuel oil has proved the most effective carrier for low volatile esters of phenoxy herbicides in budbreak sprays on areas where deciduous species are predominant. However, in comparison with a 2.8-percent oil-in-water emulsion carrier, Yates et al.(9) found that a 100-percent oil carrier deposited more than four times as much herbicidal residue 500 to 1,000 ft downwind from where aerial sprays were released. An effective drift control additive for oil carriers is urgently needed for aerial application of pesticides in oil carriers.

Lo-Drift O.S.--Lo-Drift O.S. did not produce any noticeable reduction in misting, fine droplets, or upward swirls from ends of the spray boom. Patterns of spray distribution looked almost exactly like that of the unthickened diesel oil carrier both with D8-46 hollow cone nozzles in the Coast Range and with D8 jet nozzles in the Cascade Range.

This conclusion, based on observation during spraying and later study of the Super 8 color films, was confirmed by data for brush and weed tree control at the end of the first summer after spraying (Table 2). Degree of control where Lo-Drift O.S. was added to the oil carrier was almost identical to that found on areas treated with herbicide in the standard oil carrier. Furthermore, spray coverage shown by effects on shrubs and weed trees in both areas was also similar. Apparently Lo-Drift O.S. did not reduce spray drift.

Lo-Drift O.S. at 2 qt/100 gal of spray solution was rated a failure as a drift-control additive for aerial application of phenoxy herbicides in oil carriers. Tests of this drift control agent were discontinued. Unfortunately, we reamin without a useful drift control additive for aerial application of herbicides in oil carriers.

Aerial Spray Tests With Varied Amounts of Lo-Drift

Development of practical and economical methods for aerial flagging of spray swaths (6) could minimize missed areas when foam sprays or other drift control additives are used. But a more practical, less expensive, and more biologically effective procedure is to use drift control agents only where necessary--to leave unsprayed buffer strips along streams, to insure accurate deposition of spray along ownership lines, and to protect ecologically sensitive areas. Unthickened oil-in-water emulsion carriers that provide better coverage and are more biologically effective can then be used on the remainder of all sprayed areas.

This procedure is possible with foam sprays using air-induction nozzles that produce large droplets, but would require nurse tanks with at least two entirely separate sections; one for the normal spray mixture, and one for spray containing the foaming agent. An alternative method would be to place the foaming agent in the saddle tanks when filling the tanks for application on areas where drift control is desired. However, all areas to be sprayed with foamed spray would have to be sprayed first. Then the foam nozzles should be replaced with standard aerial spray nozzles to apply herbicides in the unthickened emulsion carrier--an additional expense and a time-consuming operation, especially when flying time suitable for aerial spraying is usually limited due to rapid diurnal changes in atmospheric and weather conditions.

Water-soluble Lo-Drift seemed a more logical choice of drift control agents that might meet the considerations outlined above. It can be applied through standard D8 jet nozzles, and it can be added directly into the saddle tanks of the helicopter. This allows its use only where needed along buffer strips, ownership lines, and other places where drift control is necessary. Away from these sites, silviculturists can use the more effective standard water or oil-in-water emulsion carriers to insure better coverage and optimum brush control. No special spray mixtures would be required in the nurse tanks, and spray nozzles need not be changed for application of herbicides in unthickened water or oil-in-water emulsion carriers.

Additional aerial spray tests of Lo-Drift seemed warranted. If Lo-Drift would provide acceptable drift control even at increased rates, it would be a very convenient additive for use by silviculturists.

An unreplicated trial of Lo-Drift in application of 2 lb ae of low volatile esters of 2,4,5-T/A in a water carrier was arranged during late summer aerial spraying on the Umpqua National Forest. With continuous agitation while pumping spray into the saddle tanks of the helicopter, Lo-Drift was added directly to the spray mixture in the saddle tanks at rates of 1 pt, 1 qt, 1 1/4 qt/100 gal of spray. The test area was at an elevation of 4,500 ft in the Cascade Range.

Results and discussion

With the water carrier, 1 qt of Lo-Drift/100 gal of spray provided an acceptable degree of drift control. The spray mixture emerged as an 18-in to 2-ft stream from the D8 jet nozzles before shattering in the airstream. Fine droplets were noticeably reduced, and few whorls were observed from the ends of the spray boom.

The 1 1/2 qt/100 gal rate of Lo-Drift produced a spray so thick that relatively unbroken separate streams fell as far as 20 to 25 ft toward the vegetation below. The intermediate rate of 1 1/4 qt/100 gal of spray appeared almost as effective in drift reduction. However, even these highest rates did not eliminate all fine droplets and mist. Some misting was observed even at the 1 1/2 qt/100 gal rate when the helicopter passed between observers and the sun, where diffusion and refraction of sunlight revealed small droplets between the streams from the D8 jet nozzles.

On the basis of these trials, the authors concluded that 1 qt of Lo-Drift per 100 gal of spray will provide an acceptable degree of drift control with water carriers. With an oil-in-water emulsion, it is advisable to use 1 1/4 qt of Lo-Drift per 100 gal of spray mixture. To insure activation of the polyvinyl polymer before application, it is important that agitation of the spray mixture be continued for 5 to 10 minutes after adding Lo-Drift (5). Such sprays should be applied through standard D8 or equivalent jet aerial spray nozzles without whirl plates.

For maximum drift control, nozzles should be directed straight back along the airstream to obtain largest droplets. With nozzles directed straight back along the airstream, it may also be feasible to use only 1/4 to 1/2 qt of Lo-Drift per 100 gal of spray mixture in water or oil-in-water emulsion carriers. If some small droplets are desired to improve coverage and brush control, the nozzles may be directed back and down along the airstream at an angle no greater than 30 degrees from the horizontal.

Conclusions

Results of the tests lead us to several conclusions concerning use of drift control additives in aerial sprays. These are:

1. Silviculturists using water or oil-in-water emulsion carriers for herbicidal sprays can obtain an acceptable degree of drift control eith either foam spray additives applied through nozzles that produce large droplets or Lo-Drift sprays applied through D8 jet nozzles.
2. Foamspray provided good drift control at a rate of 3 qt/100 gal of spray with emulsion carriers applied through air-foam induction nozzles that produced large droplets. Two qt/100 gal should be adequate with water carriers. Foamspray may be applied through Foamspray Chemicals, Inc. row crop/band 646 nozzles. Boom pressure should be 40 psi, flying height 30 to 50 ft above the brush, and flying speed between 40 and 50 mph.
3. Accutrol also provided excellent drift control at a rate of 3 qt/100 gal of spray in an oil-in-water emulsion carrier. Two qt/100 gal should give satisfactory drift control with water carriers. Apply Accutrol through

Accutrol 842 aerial coarse spray nozzles that include proper flow control discs and strainers with a boom pressure of 40 psi. Flying height should be approximately 30 to 50 ft above the vegetation, and airspeed maintained as near 45 mph as possible.

4. Lo-Drift[5] will produce acceptable drift control at a rate of 1 qt/100 gal in water carriers and 1 1/4 qt/100 gal with oil-in-water emulsion carriers. Use standard diaphragm aerial spray nozzles with 1/8-inch jet orifices, no whirl plates, and nozzles oriented back along the airstream no more than 30 degrees from horizontal. If oriented straight back, 1/4 to 1/2 qt/100 gal should be sufficient with water carriers. With emulsion carriers, greater amounts of Lo-Drift must be added. Boom pressure should be maintained at 35 psi and flying speed between 40 and 50 mph. Again, a flying height of approximately 40 ft above the vegetation is most desirable. Lower flying heights can reduce spray swath width and endanger the pilot. Depending upon atmospheric conditions, greater flying heights can result in increased drift and greater loss of spray by evaporation of fine droplets.

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[5]Nalco-Trol produced by Nalco Chemical Company is a polyvinyl polymer similar to Lo-Drift. It increases viscosity of the liquid spray and should produce results similar to those obtained with Lo-Drift.

5. Spray volumes should be increased to 15 or even 20 gal/A to insure adequate coverage when using effective drift control additives. Drift control is obtained by applying spray droplets that are larger in diameter, greater in volume, and fewer in number per gal of spray. With the usual 10 gal/A spray volume, unsprayed areas and strips are almost inevitable even when areas are cross flown or double flown.

Rates of herbicide/A and amount of oil/A probably should be increased slightly (perhaps by one-fourth) over the rates and amounts used in 10 gal/A sprays. Since a greater volume of water must be added to obtain the increased spray volume/A, the increased amount of herbicide will help maintain toxic concentrations of herbicide in the larger spray droplets. The amount of drift control additive should be increased proportionately to the increase above spray volumes of 10 gal/A.

The same nozzles designated for 10 gal/A spray volumes should be used in applying the larger volume/A. This, of course, will increase flying time and number of flights across each area. As a result, flying cost/A will also increase. Where drift control is necessary, this cost is justifiable. However, the increased flying time and cost/A plus increased cost of herbicide and oil favor use of ordinary unthickened water or emulsion carriers on areas where drift control is not necessary.

6. Finally, failure of Lo-Drift O.S. still leaves us without an effective drift control additive for herbicidal sprays in oil carriers.

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Table 1. Influence of drift-control additives on effects of phenoxy herbicides in emulsion carriers at end of second summer after aerial spraying[1]

Species	Emulsion				Emulsion plus Lo-Drift				Emulsion plus Foamspray[2]			
	No. of plants	Defoliation	Top-kill	Plants dead	No. of plants	Defoliation	Top-kill	Plants dead	No. of plants	Defoliation	Top-kill	Plants dead
		Percent				Percent				Percent		
2,4,5-T in Cascade Range												
Douglas-fir	80	0	0	0	80	0	0	0	80	0	0	0
Snowbrush ceanothus	80	87	88	19	80	90	92	18	80	77	75	9
Vine maple	35	60	75	3	35	50	58	0	32	48	56	0
Golden chinquapin	26	80	81	8	20	72	72	10	6	76	69	0
2,4-D in Siskiyou Mountains												
Douglas-fir	160	0	0	0	160	0	0	0	160	1	0	0
Tanoak	160	48	50	3	160	45	42	2	160	39	38	5
Golden evergreenchinquapin	11	30	30	11	30	41	41	20	40	21	18	2

[1]Aerial spray applied April 1973; rated September-October 1974.

[2]Foamspray added to emulsion in Cascade Range; Accutrol added to emulsion in Siskiyou Mountains.

Table 2. First-year influence of Lo-Drift O.S. drift-control additive on effects of budbreak aerial sprays of phenoxy herbicides in a diesel oil carrier.[1]

Species	Diesel oil				Diesel oil plus Lo-Drift O.S.[2]			
	No. of plants	Defolia-tion	Top-kill	Plants dead	No. of plants	Defolia-tion	Top-kill	Plants dead
		Percent				Percent		
Oregon Coast Range								
Douglas-fir	120	12	1	1	120	9	1	0
Red Alder	120	97	68	23	120	100	69	24
Salmonberry	120	74	64	2	120	66	57	5
Cascade Range								
Douglas-fir	80	12	2	1	80	14	1	0
Redstem ceanothus	60	89	88	10	60	88	89	8
Vine maple	60	71	71	0	60	64	73	0
Blue elder-berry	55	35	38	0	47	46	70	0

[1]Sprayed during April 1973; rated during late September 1973.

[2]Two qt Lo-Drift O.S. added per 100 gal of spray solution.

CONTROL OF WOODY PLANTS WITH CUT SURFACE APPLICATIONS OF TRICLOPYR

L. E. Warren[1]

Undesired hardwoods have been controlled with trunk injections of 2,4-D or TORDON[2] 101 Mixture (3,4,7), and thinning of conifer stands with MSMA and TORDON 101 Mixture appears to be practical (5,8). Radosevich et al. (9) reported sizeable improvements in growth of Douglas fir 12 years after trunk injections of amine 2,4-D or TORDON 22K Weed Killer. Finnis (2) showed that TORDON 101 Mixture applied to the cambium of freshly cut bigleaf maple stumps would prevent resprouting. This system is used extensively on timber harvest sites in the Pacific Northwest to control unwanted sprouting hardwoods at the time of harvesting conifers.

Triclopyr (3,4,5-trichloro-2-pyridinyloxyacetic acid) a recently introduced systemic herbicide, is effective in control of woody plants as foliar applications (1). Early screening tests indicated that trunk injections of triethylamine salt formulation of triclopry would kill certain hardwood trees(3). Application of herbicides as trunk injections or to freshly cut stumps to control undesired woody plants is of interest to many vegetation managers; the requirements for efficient use of this system with triclopry are needed. Results of experiments to determine rates, timing and species response are reported.

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[2]Trademark of The Dow Chemical Company

Materials and Methods

M-3724 is a triethylamine salt formulation of triclopyr (3,5,6-trichloro-2-pyridinyloxyacetic acid) containing 3 lb a.e. per gallon. M-3724 was compared to TORDON 101 Mixture, TORDON 212 Mixture and TORDON 22K Weed Killer; the TORDON formulations contain 0.5, 1 and 2 lb picloram plus 2, 2 and 0 lb 2,4-D pergallon respectively. They are all water soluble salts.

In the trunk injection applications, cuts were made with a sharp hatchet through the cambium at spacings of about 4 inch centers around the trunk, and about 2 feet above the root crown. Trees varied from about 1 inch to 22 inches in diameter at 2 feet height. About 1 ml of formulation, undiluted or half strength in water, was applied to each cut. Treatments were made in the late spring and in early fall. Species that have been treated are shown in Table 1.

Cut stump applications were made after cutting the trees about 24 inches or less above the ground and applying the herbicide in a thin stream completely covering the cambium. Trees or stumps were marked with aluminum tags, paint, or both. Kill of trunk-injected trees was based on overall top kill plus crown or root sprouting within 1 to 2 feet of the stump. Kill of treated stumps was based on response of existing and new crown sprouts. A scale of 0 to 10 was used to profice a quantitative estimate of the response as indicated below:

Brush Rating Scale

0	No effect.
1	Noticeable but small lear burn or malformation.

Table 1. Species involved in research studies

Common name	Species	Location
Tanoak	*Lithocarpus densiflorus*	Sierras and Coast Range*
California black oak	*Quercus kelloggii*	Sierras*
Pacific dogwood	*Cornus nuttalli*	Sierras*
Willow	*Salix* spp.	Coast Range* and Washington
Poplar	*Populus balsamifera*	Coast Range* and Washington
Bigleaf maple	*Acer macrophyllum*	Washington
Bitter cherry	*Prunus emarginata*	Washington
Douglas fir	*Pseudotsuga menziesii*	California and Washington
Western hemlock	*Tsuga heterophylla*	Washington
Coast redwood	*Sequoia sempervirens*	Coast Range*
Western redcedar	*Thuja picata*	Washington
Ponderosa pine	*Pinus ponderosa*	California

*California

2	Less than 60% of top growth dead with normal new shoot growth.
3	60-90% of top growth dead with nearly normal new growth.
4	Less than 60% of top growth dead with noticeably reduced new shoot growth.
5	90-100% top kill with normal resprouts from trunk or root collar.
6	60-90% of top growth dead and very restricted or abnormal new shoot growth.
7	60-90% top kill with very restricted or grossly abnormal resprouting from root collar or trunk only.
8	90-100% top kill with some abnormal and/or reduced resprouting from trunk or root collar.
9	90-100% top kill with very little resprouting.
10	Complete kill (no resprouting).

These ratings were averaged and converted to percent control compared to untreated adjacent trees.

The term "flashback" is used to denote effects of easily translocated herbicides on adjacent untreated trees from trunk injections to trees located within a few feet of the untreated crop trees. This can occur from root grafts or pick-up of root exudates from treated trees. Response ratings of these crop trees were made on the same 0 to 10 scale.

Trunk Injection Treatments

An experiment was established at the University of California Blodgett Forest, Georgetown, CA, in September 1973 using trunk injection treatments to control tanoak, Pacific dogwood and California black oak. Blodgett Forest is on the west slope of the Sierras at about 4000 feet elevation. The tanoak was 4 to 7 inches in diameter at 2 feet height, the black oak was 10 to 18 inches in diameter and the dogwood was 5 to 6 inches. Plots were individual trees or clumps and included five trees or clumps of tanoak, five black oak and three dogwood trees. Several large ponderosa pine and Douglas fir trees were intermixed at infrequent intervals.

Tanoak and black oak were treated at the same location in May 1974 to compare seasonal effects. Ten to 11 trees or clumps were used per treatment. The tanoak varied from 1.5 to 18 inches in diameter and the black oak was 12 to 18 inches in diameter. Both species were breaking the bud stage when treated.

Another experiment was established on Masonite Corp. property near Boonville, CA, in the Coast Range at about 2000 feet elevation, to compare M-3724, TORDON 101 Mixture and TORDON 22K Weed Killer as trunk injection treatments to tanoak. There were five to six trees, 10 to 22 inches in diameter, per treatment and they were mised with large Douglas fir and a few coast redwoods. Applications were made in October 1973 after fall rains has provided some soil moisture for plant growth. This experiment was compared with one treated in May 1974 on nearby property. Tanoak was breaking but in the latter experiment. About 10 trees, 1 to 10 inches in diameter, were injected per treatment. There was a mixture of coast redwood and Douglas fir with the tanoak.

The final injection trial was established east of Castle Rock, WA to compare M-3724 with TORDON 101 Mixture at both full and half strength as trunk injection applications to thin conifers and control hardwoods. Treatments were applied in May and December 1974. Plots were 0.25 acre each and duplicated. Trees included Douglas fir, western hemlock, western redcedar, bigleaf maple, bitter cherry, willows and poplar. The kill of treated trees and any side effects on the crop (leave) trees were evaluated in October 1975.

Cut Stump Experiments

Tanoak stumps at the Blodgett Forest were treated with M-3724 or TORDON 101 Mixture at full and half strength at times as indicated in Table 5. Application, after cutting, of TORDON 101 Mixture undiluted was delayed 2 to 4 hours. The stumps varied from 2 inches to 14 inches in diameter and five to six stumps of various sizes were included in each treatment. The stumps were marked with numbered metal tags and painted in color code.

An experiment comparing M-3724, TORDON 101 Mixture and TORDON 212 Mixture as cut stump treatments to control tanoak was established in October 1973 on Masonite Corp. property, Boonville, Ca. The trees were 6 to 16 inches in diameter and there were five trees per treatment. Observations of stump kill were made in August 1975 (Table 5).

Results and Discussion

Trunk Injection Treatments

The experiments to control black oak, tanoak and dogwood at Blodgett Forest were observed in August 1975. Dogwood was treated only with M-3724 and control was about 75%. Results on black oak and tanoak are presented in Table 2.

Table 2. Control of Tanoak and Black Oak by Trunk Injections of TORDON 101 Mixture and Triclopyr, Blodgett Forest, Georgetown, CA

Treatment	Percent Control*			
	Tanoak		Black oak	
Date appl.	10/73	5/74	10/73	5/74
TORDON 101 Mixture	70 (4-8)†	90 (1-12)†	96 (7-11)†	
TORDON 101 Mixture, diluted 1:1 in water		95 (1-12)		
TORDON 22K, diluted 1:1 in water		87 (1-12)		
M-3724	97 (3-10)	96 (1-12)	98 (7-14)	93 (11-16)
M-3724, diluted 1:1 in water		97 (1-12)		

*Evaluation August 1975

†Trunk diameters in parentheses.

The results from trunk injection treatments on Masonite Corp. sites are shown in Table 3.

Table 3. Control of Tanoak with trunk injections of Triclopyr and TORDON 101 Mixture, Masonite Corp., Boonville, CA

Treatment	Percent control†			
	Treated: October 1973††		May 1974*	
	Tanoak	Conifer	Tanoak	Conifer**
TORDON 101 Mixture	66	1-2	93	1-2
TORDON 212 Mixture	86	1-2	--	--
TORDON 22K Weed Killer	89	1-2	--	--
TORDON 22K, diluted 1:1 in water	--	--	87	
M-3724	97	0	94	0
M-3724, diluted 1:1 in water	--	0	92	0
Cuts only	10	0	0	0

†Evaluation August 1975.

††Five trees per treatment, diameter 6-22 inches at 4 feet height.

*Ten trees or clumps per treatment, diameter 1-11 inches at 2 feet height.

**Douglas fir or coast redwood - "flashback" on untreated trees.

Trunk injections in October of TORDON 101 Mixture on tanoak seemed to be less effective than with May treatment at both locations. M-3724 was effective at both times, although it was not diluted to half strength at the fall application.

In the plots with TORDON 101 Mixture at both the Blodgett and Masonite locations, some effects on needles of untreated adjacent large Douglas firs and redwoods from root pick-up was noted. These symptoms were not extensive and they were confined to trees that were within a few feet of treated trees.

Results of treatments at Castle Rock, WA are presented in Table 4. Control of deciduous hardwoods was very good with both TORDON 101 Mixture and M-3724 at both full and half strength. Some cuts on conifers were made too high and too far apart. However, control was generally good with TORDON 101 Mixture at full or half strength on the three conifer crop trees at either spring or fall application. M-3724 provided very good control of Douglas fir and hemlock with May application, but was not quite as effective with December treatment. A second season may be required for full response. M-3724 was ineffective on western redcedar.

"Flashback" with TORDON 101 Mixture on crop trees was very noticeable with both May and December applications. By contrast, these symptoms were almost absent with M-3724. The few conifers that expressed a slight reaction to M-3724 were very close to several treated trees.

Cut Stump Treatments

Results from treating cut stumps of tanoak at both Blodgett Forest and Masonite Corp. locations are presented in Table 5. Fall cut stump treatments were very effective with both TORDON 101 Mixture and M-3724 at Blodgett Forest when the stumps were treated in less than 20 minutes after cutting. At Masonite, stump kill with M-3724 was less than with TORDON 101 Mixture and both were less effective than at Blodgett.

Table 4. Control of hardwoods and conifers with trunk injections of TORDON 101 Mixture and Triclopyr, Castle Rock, WA

Treatment	Month appl.	Percent control*							Flashback		
		Maple	Cherry	Alder	Willow	Doug. Fir	Hem-lock	Red Cedar	Doug. Fir	Hem-lock	Cedar
TORDON 101 Mixture	May	100	100	100	96	83†	--	85†	20	--	10
M-3724	May	96†	100	100	100	99	90†	43	3	3	0
M-3724, dil. 1:1 in water	May	86†	100	100	100	99	--	48	5	1	0
TORDON 101 Mixture	Dec.	96	100	100	--	94	94†	92	30	20	18
TORDON 101 Mixture, dil. 11:1 in water	Dec.	100	98†	98	--	95†	94†	88	18	17	15
M-3724	Dec.	100	93†	98	--	93†	89	58†	3	3	0
M-3724, dil. 1:1 in water	Dec.	100	97†	100	--	74†	--	40†	1	1	0

*Average of duplicate plots, except TORDON 101 Mixture, May application. Ratings made September 1975.

†Insufficient cuts or cuts made too high on some trees.

Table 5. Control of Tanoak by applications of TORDON 101 mixture and Triclopyr to cut stumps, Blodgett Forest and Masonite locations, CA.

Treatments	Application time after cutting	Percent control* October 1973 Blodgett	Masonite	May 2† Blodgett
TORDON 101 Mixture	10 min.			87 (1972)
TORDON 101 Mixture, 1:1 dil. in water	10 min			81 (1972)
TORDON 101 Mixture	4-5 hrs.			60 (1972)
Untreated	--			2-4' sprouts (1972)
TORDON 101 Mixture	10 min.	98	91	90 (1973)
TORDON 101 Mixture, 1:1 dil. in water	10 min.	--	--	91 (1973)
TORDON 101 Mixture	2 hrs.	96	81	--
TORDON 22K Weed Killer, 1:1 dil. in water	10 min	--	--	97 (1973)
TORDON 212 Mixture	10 min.	100	93	--
M-3724	10 min.	98	84	82 (1973)
M-3724, 1:1 dil. in water	10 min.	96	82	47 (1973)
Untreated	--	0	0	0

*Evaluation August 1975.

†Year of application shown in parentheses.

Delaying application for 2 to 4 hours after cutting also reduced control, apparently because suberization impeded absorption of the herbicide. This effect was reported by Geronimo (3) on live oak stumps as well.

Spring trunk injection applications were generally less effective than those in the fall, but TORDON 22K Weed Killer as a 1:1 dilution in water provided good control in the experiment where it was used. It seems possible that movement of foods in the phloem would be upward during spring before growth begins and that there is less opportunity for the herbicides to move down into the crown and roots. The more mobile picloram may move down better in this situation, which could account for better kill with TORDON 22K Weed Killer at half strength than with TORDON 101 Mixture.

A report from the U. S. Forest Service at Alturas, CA (Modoc National Forest) (6) indicated that all ponderosa pine trees treated with M-3724 or TORDON 101 Mixture at full or half strength in May 1975 were dead by late October. Geronimo (3) reported only fair kill of Aleppo pine with July application of either compound; perhaps summer dormancy reduced effectiveness.

It will be desirable to develop a satisfactory treatment to kill western red- or incense cedar which are somewhat tolerant to M-3724. These trees are usually third or fourth choices in a mixed conifer stand. It is possible that treated trees will respond further next season, but their present condition discourages such a hope. Perhaps a more intensive injection would suffice to obtain adequate kill. A mixture of picloram and triclopyr may be desirable.

Further studies on other species and locations using both trunk injection and cut stump treatments with M-3724 are in progress.

Conclusions

Trunk Injection Treatments

1. Spaced trunk injections of M-3724 at 1 ml per injection at full or half strength, applied in fall or spring to hardwoods and conifers, were effective on all species tested at either timing, except western redcedar.

2. TORDON 101 Mixture gave good control of tanoak with spring treatment but was poor in fall treatments. Other hardwoods seemed to be susceptible at both times.

3. "Flashback" (effects on untreated crop trees) was sometimes noticeable with TORDON 101 Mixture. With M-3724 it was almost nonexistent.

4. Conifer thinning with both TORDON 101 Mixture and M-3724 at full or half strength was very effective on ponderosa pine, Douglas fir and western hemlock; western redcedar was susceptible to TORDON 101 Mixture but only moderately susceptible to M-3724.

Cut Stump Treatments

1. M-3724, applied to freshly cut stumps of tanoak, gave good kill with the fall (October) treatments but was less effective with the spring (May) timing, especially when diluted 1:1 with water.

2. Control with TORDON 101 Mixture was good to fair with both timings.

3. Delay of 2 to 4 hours in treating stumps with TORDON 101 Mixture after cutting reduced control.

Triclopyr as M-3724 shows promise for use in cut stump and trunk injection treatments to control hardwoods and conifers on rights-of-way and in forestry site preparation and conifer thinning operations. Further research is needed to assess the most economical rates and proper timing and conditions for treatment.

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CONTROL OF CALIFORNIA SCRUB OAK WITH HERBICIDE PELLETS

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

Abstract. Two tests were conducted on a chaparral site in southern California to determine the effect of herbicide pellets on sprouting California scrub oak plants. Results from the first test 3 years after treatment show that an average plant kill of 70% or better was obtained with 30 lbs a.i./acre of fenuron (1,1-dimethyl-3-phenylurea), 8 and 12 lbs a.i./acre of picloram (4-amino-3,5,6-trichloropicolinic acid), and 8, 16, and 24 lbs a.i./acre of karbutilate [tert-butylcarbamic acid ester with 3-(m-hydroxyphenyl)-1,1-dimethylurea]. Little additional kill was obtained by increasing the rate of picloram from 8 to 12 lbs (75 vs 78% kill), but 100% plant kill was obtained with 16 and 24 lbs of karbutilate.

Grass establishment was greatly influenced by the different herbicide formulations. Eleven months after treatment, an average of 850 to 900 lbs/acre (dry weight) of grass was present on plots receiving all rates of picloram while no grass was present on any of the karbutilate plots. Fenuron did not inhibit grass establishment as completely as karbutilate and some grass was present at all rates. Two and one-half years after treatment there was still no grass on plots receiving 24 lbs of karbutilate, but there was now as much grass on the 8-pound karbutilate plots as on those treated with picloram. Within

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5 1/2 years after treatment, there was as much grass on plots receiving 24 lbs of karbutilate as on the picloram plots.

In the second test, good oak control was obtained with a 2 1/2 ft. grid pattern of both the 8 and 16 lb a.i./acre rate of karbutilate and with the 16 lb rate of 5 1/2 ft. spacing. All three treatments were more effective than a 16 lb broadcast rate of karbutilate. The soil was still sterile in the treated spots 5 years later.

K2XHSB: A HERBICIDE TEST PLOT DESIGN TO REMEMBER

Harold M. Kempen[1]

Because a weed scientist will test many herbicides in each weed management trial, it becomes difficult for him to apply them all and more importantly, to evaluate and remember the results. A herbicide test plot design that I have found useful in overcoming the above problems is one which I call the K2XHSB design. Unlike sporty foreign car model notation, it has meaning.

Essentially it is a split-block randomized design, with blocks (1X and 2X rates) randomized and herbicides as subplots also randomized (Figure 1). The K2X relates that the ratio of herbicide to diluent remains constant in both X and 2X applications. The H refers to herbicides, but inasmuch as this technique can and is often used when applying other pesticides it could be dropped.

K2XHSB

Rep	1	2	3	. . . .	10	<—— 1X rate
						<—— 2X rate
Rep II	11	12	13	. . . .	20	<—— 2X rate
						<—— 1X rate
Rep III	21	22	23	. . . .	30	<—— 1X rate
						<—— 2X rate

Figure 1

Using such a technique, a scientist can mix up a gallon of a herbicide solution, spray the X rate once and the 2X rate by spraying twice (Figure 2). Thus only half as many calculations and measurements need be made during application.

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[1]Cooperative Extension Service, University of California, Bakersfield.

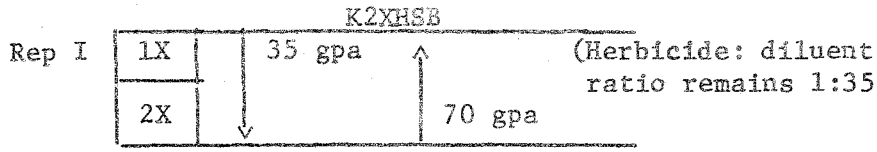

Figure 2

More important, after an evaluation without knowledge of which are the 2X blocks, a scientist can study the X and 2X rates of each herbicide, each in close proximity, to see if the 2X rate has injured the test plants.

Some researchers might object to the doubling of diluent to get a 2X rate. With soil active herbicides, they might assent to such a technique but with foliar herbicides, they would not. Yet many trials conducted this way have not shown anomalous results when doubling the diluent. In fact the herbicide linuron, when applied through sprinklers, will show contact activity comparable in ground sprays at 50 gpa. In sprinklers, it would be applied in 5000 gpa during a 2 hour set.

One also can argue for maintaining a constant herbicide: diluent ratio when herbicides such as glyphosate are formulated with adjuvant. Growers or weed management specialists would be more comfortable knowing an overlap (2X rate) is safer on their crop than a double rate applied at equal volumes per acre. Scientists in regulation, it seems to me, should also accept such data willingly. But all must agree that the differences are not sufficiently profound to be worth a lot of discussion.

Another good argument for the K2X approach is that researchers are more likely to include the 2X rate. With so many herbicides being tested, the ability to learn the relative tolerance of crops to 2X rates of related compounds gives added insight into their relative differences.

The split-block design permits more precision in the statistical measurement of differences. If they aren't safe at 2X rates, they aren't safe to use, I would say.

Many combinations are being tested. With conventionable plot designs, the 2X rates often aren't tested, but the K2X design permits that testing.

I can relate some disadvantages to the K2XHSB design. For one, a researcher may unintentionally memorize which block is the 2X block and be biased as a result. Also, should one plot show serious injury at the 2X rate but not the X rate, then the design might be obvious to the evaluator.

Secondly, the design limits rate increments less than 100%. This is objectionable to many companies because EPA mandates what rate protocols shall be used. Data on rates other than those requested on labels are qoute, "Interesting but of little value for registration purposes." This hopefully could be changed.

Finally, some might object to a new design which because it is new, upsets the status quo.

In total I have found the K2XHSB design to be very useful to me in application and evaluation of herbicides. It aids me greatly in recalling the safety of herbicides to some of the 80 crops we grow in Kern County, and gives me added insight into the effects higher than use rates has on weeds. I recommend that other weed scientists evaluate the design for their weed research trials.

HERBICIDES FOR CONTROL OF BARNYARDGRASS AND REDROOT PIGWEED IN ORNAMENTAL NURSERIES

G. F. Ryan[1]

Abstract. Herbicides applied in the spring often are ineffective against barnyardgrass [*Echinochloa crus-galli* (L.) Beauv.] and redroot pigweed (*Amaranthus retroflexus* L.) by the time they germinate in midsummer in western Washington nurseries. Several herbicides currently or potentially available for use in ornamental nurseries were evaluated for control of the two weeds. In 1973, weed emergence occurred within a month after herbicide application on May 7. Butralin at 4 lb/A and a combination of simazine at 3.2 lb/A plus alachlor at 3 lb/A controlled barnyardgrass 99.5%. Dichlobenil at 3 or 4 lb/A, oxadiazon at 3 or 6 lb/A, and simazine at 3.2 lb/A plus chlorpropham at 6 lb/A controlled redroot pigweed 97 to 100%. In 1974, control of barnyardgrass after 109 days was 98 to 100% from simazine at 3.2 lb/A, oxadiazon at 6 lb/A, and dichlobenil at 4 lb/A plus alachlor at 3 lb/A or dichlobenil at 4 lb/A plus a delayed application of nitralin at 6 lb/A. Control of redroot pigweed was 94 to 100% from the same treatments, and also from dichlobenil at 4 lb/A plus diphenamid at 3 or 6 lb/A and from dichlobenil plus chlorpropham at 6 lb/A.

Introduction

A number of herbicides are available for control of annual grasses (1, 2) and *Amaranthus* species (3), depending on the crop in which they occur.

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Dichlobenil and simazine have been suggested for use in nurseries in western Washington for several years because of their tolerance by many woody ornamental plants and their broad spectrum of weed control. When applied in the spring, these herbicides often are not effective against barnyardgrass and redroot pigweed by the time germination occurs in early summer.

In 1973 and 1974, dichlobenil, simazine, and several other herbicides currently or potentially available for use in ornamental nurseries were evaluated separately, in combination, or in delayed sequence, for control of the two weed species. Data on control of ladysthumb (*Polygonum persicaria* L.) was obtained also the first year.

Materials and Methods

Plots 4 ft by 30 ft in a randomized block design with 3 replications were established in Puyallup loam soil. Spray applications were made with a power sprayer, in water at 100 gpa. Granular herbicides, except dichlobenil, were applied by hand with a shaker. Dichlobenil was applied with a power spreader.

1973 Experiment. Ten herbicides or combinations were applied May 7. Rainfall on the following 3 days was 0.9 inch. The plots were sprinkler irrigated the following week, and another inch of rainfall occurred the second week. Barnyardgrass seed was broadcast over the plots before herbicide application, and there was a heavy natural stand of redroot pigweed and ladysthumb. Weed counts were made June 19 on part of each plot and expressed as percent control compared with untreated plots.

1974 Experiment. Simazine at 3.2 lb/A and dichlobenil at 3, 4 or 6 lb/A were applied April 19. Supplemental treatments with simazine, dichlobenil, alachlor, nitralin, diphenamid, and chlorpropham were applied May 31 or June 6. Rainfall on April 20 was 0.1 inch, and April 22 to 27, 1.4 inches. The plots were sprinkler irrigated on June 10 and periodically as needed thereafter. Weed counts made August 6 and 20 were for the entire plot area.

Results and Discussion

1973 Experiment. Emergency of barnyardgrass and redroot pigweed was apparent by the end of May. This was earlier than normal in western Washington, and did not permit the use of supplemental treatments intended for application 6 weeks after the initial treatments. Apparently a warm period in mid-May was responsible for the early germination. Maximum daily air temperatures on May 12 to 17 were 79 to 88°F. In contrast, no temperatures above 70°F were recorded in May 1974.

With the short period between herbicide application and weed emergence, several treatments were highly effective (Table 1). Butralin at 4 lb/A and the combination of simazine plus alachlor (ratios of 3.2 to 3 or 2 to 8 lb/A) gave 99.5 to 99.8% control of barnyard grass. The simazine plus alachlor combinations also controlled redroot pigweed 99 to 100%. Dichlobenil at 3 or 4 lb/A, oxadiazon at 3 or 6 lb/A, and simazine at 3.2 plus chlorpropham at 6 lb/A controlled redroot pigweed 97 to 100% and ladysthumb 98 to 100%

1974 Experiment. Dichlobenil plus a delayed application of nitralin, diphenamid, chlorpropham, or simazine gave 94 to 100% control of redroot pigweed (Table 2). Control of both redroot pigweed and barnyardgrass was 98% or higher from dichlobenil plus alachlor applied in April, but when the alachlor application was delayed until May 31, control of both species was not significantly better than from dichlobenil alone. A delayed application of nitralin at 6 lb/A was the only other supplemental treatment that significantly increased barnyardgrass control, compared with dichlobenil alone. Dichlobenil followed after 7 weeks by simazine gave 98% control.

Simazine applied in April controlled barnyardgrass nearly as well as the dichlobenil plus alachlor and dichlobenil plus nitralin combinations (Table 3). Control of redroot pigweed was increased by application of alachlor with simazine in April. Oxadiazon at 6 lb/A controlled both species 99.5 to 100%.

Weed control from simazine was much better in 1974 than in 1973. With not more than 3 weeks between herbicide application and weed seed germination, there may not have been enough rainfall or irrigation in 1973 to move the simazine far enough into the soil to control barnyardgrass and ladysthumb seedlings.

Not all of the herbicides used in this study are available for use in ornamental nurseries. The combinations of dichlobenil and simazine, either one applied April 19 and followed by the other on May 31 or June 6 were among the best treatments in the 1974 experiment, and these are herbicides currently available for nursery use.

Table 1. Control of barnyardgrass, redroot pigweed and ladysthumb, 1973

Herbicide	Rate (lb/A)	Percent control after 6 weeks* Barnyard-grass	Redroot pigweed	Ladysthumb
Dichlobenil 4G	3	74.5 bcdef†	98.8 ab	98.8 ab
Dichlobenil 4G + simazine 80W	3 + 2.4	88.9 abcde	99.8 ab	99.9 ab
Dichlobenil 4G	4	92.0 abcd	99.9 a	98.8 ab
Dichlobenil 4G + chlorpropham 4EC**	4 + 6	95.2 ab	99.6 ab	100.0 a
Simazine 80W	2.4	39.9 g	80.9 cd	64.8 cdef
Simazine 80W	3.2	59.2 fg	97.3 abc	62.1 def
Simazine 80W + chlorpropham 4EC**	3.2 + 6	71.5 def	97.4 ab	100.0 a
Simazine 80W + alachlor 4EC	3.2 + 3	99.5 a	100.0 a	85.1 abcd
Simazine + alachlor 10G	2 + 8	99.8 a	99.9 a	95.5 abc
Oxadiazon 2G	3	69.8 def	100.0 a	99.0 ab
Oxadiazon 2G	6	94.3 abc	100.0 a	100.0 a
Norflurazon 5G	2	70.8 def	67.9 a	20.9 gh
Norflurazon 5G	4	71.7 cdef	84.1 bcd	12.3 h
Butralin 4EC	2	87.0 abcde	26.7 e	45.0 ef
Butralin 4EC	4	99.5 a	92.3 abc	79.4 bcde
Untreated check	--	(440)††	(275)	(343)

* Control determined by weed count in 3 areas, each 4.5 sq ft in each plot, expressed as % of untreated plots.

** Chlorpropham, 4 bl/gal, plus PPG 124, 0.75 lb/gal.

† Mean separation within columns by Duncan's multiple range test at 5% level.

†† Figures in parenthesis are numbers of seedlings in the 13.5 sq ft area counted in untreated plots.

Table 2. Control of barnyardgrass and redroot pigweed with dichlobenil and supplemental treatments, 1974

Dichlobenil applied 4/19 (lb/A)	Supplemental treatments			Percent control			
				Barnyardgrass		Redroot pigweed	
	Herbicide	Rate (lb/A)	Date applied	8/6	8/29	8/6	8/29
3				87.8 cd*	89.7 d	66.9 b	78.5 defg
3	Dichlobenil 4G	3	6/6	89.3 de	90.1 d	49.0 c	55.7 g
4				93.2 cdef	93.6 cd	64.5 bc	68.6 efg
4	Dichlobenil 4G	2	6/6	95.8 bcde	95.2 cd	90.6 a	89.1 cde
6				90.0 de	90.9 cd	88.8 a	90.7 bcd
4	Alachlor 4EC	3	4/20	99.9 ab	99.9 ab	98.9 a	98.0 ab
4	Alachlor 4EC	3	5/31	98.8 def	94.3 cd	61.7 bc	65.7 fg
4	Nitralin 4WDL	6	5/31	100.0 a	100.0 a	100.0 a	100.0 a
4	Diphenamid 80W	3	6/6	95.6 bcde	95.5 bcd	98.9 a	99.8 a
4	Diphenamid 80W	6	6/6	82.6 e	85.8 d	99.8 a	99.2 ab
4	Chlorpropham 4EC	6	6/6	95.3 abcd	95.0 abcd	99.4 a	94.5 abc
4	Simazine 4G	3.2	6/6	99.2 abc	98.4 abc	99.5 a	96.1 abc
—	Untreated check	—	—	(441)**	(461)	(95)	(125)

*Mean separation within columns by Duncan's multiple range test at 5% level.

**Figures in parenthesis are mean numbers of seedlings in untreated plots.

Table 3. Control of barnyardgrass and redroot pigweed with dichlobenil, simazine, oxadiazon and alachlor, 1974

Herbicide	Rate (lb/A)	Date applied	Percent control: Barnyardgrass 8/6	Barnyardgrass 9/29	Redroot pigweed 8/6	Redroot pigweed 9/29
Dichlobenil 4G	4	4/19	93.2 b*	93.6 b	64.5 b	68.6 c
Dichlobenil 4G	4	4/19	99.9 a	99.9 a	98.9 a	98.0 ab
+ alachlor 4EC	3	4/20				
Dichlobenil 4G	4	4/19	100.0 a	100.0 a	100.0 a	100.0 a
+ nitralin 4WDL	6	5/31				
Simazine 80W	3.2	4/19	98.9 ab	98.2 a	95.9 a	94.6 b
Simazine 80W	3.2	4/19	99.9 a	99.8 a	100.0 a	100.0 a
+ alachlor 4EC	3	4/20				
Simazine 80W	3.2	4/19	99.0 a	98.9 a	98.2 a	96.8 ab
+ alachlor 4EC	3	5/31				
Simazine 80W	3.2	4/19	99.7 a	99.8 a	96.3 a	97.1 ab
+ dichlobenil 4G	3	5/31				
Oxadiazon 2G	6	4/19	99.5 a	99.6 a	100.0 a	100.0 a

*Mean separation within columns by Duncan's multiple range test at 5% level.

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TELESCOPING NURSERY WEED CONTROL RESEARCH

Michael Newton[1]

Abstract. Forest nursery weeds contribute substantially to the total cost of reforestation. A combination of high fertility, irrigation and slow crop development place conifers in a very inferior position relative to weeds, and sensitivity of new germinants combined with high crop value create risks in the use of chemicals. Yet the losses from lack of control are immense.

Research is described that produced useful (if not registered) prescriptions in one year. Winter greenhouse screening was used to determine the sensitivity of seedlings to various herbicides during early development. Douglas-fir seeds were sown in flats of nursery soil. Six sowing dates were used in each flat to demonstrate at which stage of seedling development the herbicides could be used with a range of dosages. The herbicides were applied before the fourth sowing emerged and when the first displayed a half inch of secondary growth.

Herbicides to which seedlings were tolerant were applied in repeated dosages to determine the existence of chronic exposure problems. The flats also provided some data regarding weed control. Six months screening in the greenhouse produced a set of trial prescriptions for testing in the field.

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Field testing was begun after drilling in operational nursery seedbeds. According to greenhouse tests, applications were made pre-cracking, and at the 30-day post-emergence time. These times of application avoided the sensitive cotyledon stage of seedling development, and reached weeds before they were totally dominant.

Seedbeds treated at the pre-cracking stage were also treated again with the most promising herbicide at the 30-day post timing. After two weeks of examination for injury, the best post-emergence herbicide was tested on some whole seedbeds.

In one year, an effort involving ten total man-days succeeded in selecting a series of treatments that were effective on coniferous seedlings at several stages of development with a reasonable margin of safety, and with promise for control of a wide variety of troublesome weeds.

CONTROL OF BITTERCRESS, COMMON GROUNDSEL, AND BARNYARDGRASS IN TWO NURSERY CONTAINER MEDIA

G. F. Ryan[1]

Abstract. Control of bittercress (Cardamine oligosperma Nutt.), common grounsel (Senecio vulgaris L.), and barnyardgrass [Echinochloa crus-galli (L.) Link] in 1 gal nursery containers was studied using two growing media, one of 70% sawdust and the other of 75% bark. In most cases weeds were controlled for 14 weeks or longer in both media by napropamide at 12 lb/A, or napropamide at 3 lb/A plus dichlobenil at 3 lb/A. Napropamide at 6 lb/A controlled grounsel in the sawdust mix and barnyard grass in both media. Alachlor at 6 lb/A controlled the three species for 6 weeks in both media, and barnyardgrass for 14 weeks in the bark mix. Oxadiazon at 3 lb/A controlled bittercress and barnyardgrass for 14 weeks in both media, and dichlobenil at 3 lb/A controlled groundsel. Most of the treatments had no effect on growth of nursery stock, as measured by fresh weight of the tops at the end of the season. Weight of 'Rosebud' azalea was reduced 16 to 21% by two combinations of napropamide plus simazine.

Introduction

Weeds compete severely with nursery stock in containers (3), and control of weeds is expensive (1, 4). Herbicides that are successful in field nurseries may be ineffective or phytotoxic in containers because of differences between the field and container environment,

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and their effects on weed, plant and herbicide interactions. Bittercress is one of the serious weed problems in containers (2). Common groundsel is a problem in field nurseries, particularly when the triazine resistant form is prevalent. Barnyardgrass also is a problem in field nurseries (5). These two weeds were included with bittercress in a study of container weed control to obtain information on their response to certain herbicides and combinations that we had not previously investigated at Puyallup.

Materials and Methods

Separate experiments were conducted to determine control of the three weed species by the herbicides separately and in combination, and effects of the treatments on growth of nursery stock. Two growing media were used, one that will be referred to as the sawdust mix and the other as the bark mix. The sawdust mix consisted of 7 parts sawdust (Douglas fir and cedar, 1:1), 1.5 parts hop waste, and 1.5 parts sand. The bark mix was 6 parts bark (Douglas fir and hemlock), 1 part sphagnum peat, and 1 part sand. A 10-6-4 fertilizer (90% of N as ureaformaldehyde) was included at 10 lb/cu yd in both mixes, and supplemental N was supplied during the growing season in the form of ammonium sulfate in water. Not all treatments were included in both mixes because of limitations on plant material and working space.

All experiments were outdoors, using tapered metal 1 gal cans. Treatments were replicated four times, with five containers as an experimental unit. Granular herbicides were applied on a measured area with a shaker, and sprays with a compressed air back pack sprayer in water at 50 gpa. The area was sprinkler irrigated immediately after herbicide application and at 1 to 4 day intervals as needed throughout the duration of the experiments.

Experiment 1. The following plants were transplanted June 4 into the sawdust mix: Japanese holly (Ilex crenata Thunb. 'Convexa'), rhododendron (Rhododendron X 'Royal Pink'), azalea (Rhododendron X 'Rosebud'), juniper (Juniperus sabina L. 'Tamariscifolia'), and yew (Taxus baccata L. 'Repandens'). The first three were propagated during summer 1974 and were in styrofoam blocks, flats, and plastic pots, respectively, before transplanting to the 1 gal cans. The junipers and yews were propagated in January or February, 1974, and were in plastic pots. Plants of yew and 'Rosebud' azalea from the same source were transplanted into the bark mix June 9 or 12. Herbicides were applied July 3.

Some weed seeds were present in the sawdust mix, and some were carried into the cans with the root balls of the transplants. All weeds were removed before herbicide application, and any that emerged later were periodically recorded and removed to avoid competition that would affect growth of the nursery plants.

The plant tops were cut at the surface of the growing medium and weighed in December. Fresh weight was expressed as percent of the weight of untreated plants.

Experiment 2. The same herbicides as in Experiment 1 were applied on the same data (July 3) to two sets of containers of each mix without nursery plants. Second and third applications were made on some treatments after 6 and 14 weeks.

Bittercress seed was broadcast on one set of each mix the day before the initial herbicide application, and common groundsel and barnyardgrass on the other set. Bittercress was reseeded August 14 (6 weeks) and October 7 (14 weeks), and common groundsel and barnyardgrass were reseeded August 14. Weed counts were made after 4, 6, 8, 14 and 22 weeks, and recorded as percent control compared with untreated containers.

Experiment 3. The following plants were transplanted June 4 into the sawdust mix: Mediterranean heather (*Erica purpurascens* 'Darleyensis'), broom (*Cytisus praecox* Bean 'Moonlight'), and cotoneaster (*Cotoneaster dammeri* Schneid. 'Lowfast'); and June 10 to 20 into the bark mix: 'Blue Diamond' rhododendron, 'Caroline Gable' azalea, and 'Lowfast' cotoneaster. The rhododendrons and azaleas were from 2 inch plastic pots and the others from 2 inch peat pots. All were propagated the previous summer. Herbicides were applied July 8 and again on August 21 in some treatments. Any weeds observed were removed prior to herbicide application and periodically during the season as in Experiment 1. The plant tops were cut and weighed in November.

Experiment 4. The same treatments as in Experiment 3 were applied on the same date (July 8) on two sets of containers of each mix seeded with bittercress, common groundsel and barnyardgrass as in Experiment 2. Most of the treatments were reseeded August 19 or 20 (6 weeks) and several received a second herbicide application at that time.

Results and Discussion

Experiment 1. Fresh weight of 'Rosebud' azalea plants in the bark mix was significantly reduced by the combination of napropamide at

6 lb/A plus simazine at 1 lb/A (Table 1). In the sawdust mix it was reduced by napropamide at 3 lb/A plus simazine at 1 lb/A, followed after 6 weeks by 1.8 and 0.6 lb/A, respectively. Weights of the other treated plants did not differ significantly from un-reated plants. There were no significant differences among treatments of Japanese holly (data not shown).

Experiment 2. Bittercress was controlled for 22 weeks by napropamide in the sawdust mix at 5 or 6 lb/A, and in both mixes at 12 lb/A (Table 2). Control the first 6 weeks was not as good from granular napropamide as from wettable powder. Alachlor controlled bittercress better than napropamide during the first 6 weeks in bark, and in sawdust during that period it controlled all three weeds as well as napropamide.

Napropamide controlled common groundsel 14 weeks in the sawdust mix (5, 6 and 12 lb/A), and barnyardgrass in both mixes (6 and 12 lb/A in the bark mix). Alachlor at 6 lb/A controlled barnyardgrass 14 weeks in the bark mix. Napropamide at 12 lb/A was the one treatment that controlled the three weed species 96 to 100% for 14 weeks in both media, except for groundsel in the bark mix (82% control).

Bittercress was controlled in the sawdust mix after the first 6 weeks by a second application of napropamide at 1.8 or 3 lb/A, or simazine at 1.6 lb/A (Table 3). Common groundsel and barnyardgrass were controlled for a total of 14 weeks where a second application of napropamide was made after the first 6 weeks. Alachlor treatments were not repeated after the initial application.

Experiments 3 and 4. Fresh weight of plant tops was not significantly affected by any of the treatments (Table 4).

The three weed species were controlled 93 to 100% for 14 weeks in both media by napropamide at 12 lb/A, and the combination of napropamide at 3 lb/A plus dichlobenil at 3 lb/A (Table 5). The control of bittercress by napropamide at 12 lb/A did not appear to be good in the bark mix at the end of 6 weeks, but most of the seedlings present at that time made no growth beyond the 2 to 4 leaf stage or died before the end of 14 weeks. Bittercress was controlled also in both media by oxadiazon at 3 lb/A, alone or in combination with napropamide or simazine.

Groundsel was controlled 14 weeks by napropamide at 6 lb/A in sawdust (Table 5). It was controlled in both media by dichlobenil at 3 lb/A, separately or in combination with napropamide.

Barnyardgrass was controlled 14 weeks in both media by napropamide at 6 lb/A, napropamide at 3 lb/A plus dichlobenil at 3 lb/A, and oxadiazon at 3 lb/A separately or in combination with napropamide or simazine (Table 5). It was controlled also by napropamide at 3 lb/A repeated after 6 weeks, and bittercress was controlled after the first 6 weeks by a second application of simazine at 1.2 lb/A, or of napropamide at 3 lb/A (Table 6).

Napropamide gave better weed control in the sawdust mix than in the bark mix, and it controlled weeds for a longer period than alachlor in the sawdust mix. Granular alachlor gave better control than granular napropamide during the first 6 weeks in the bark mix, but not by the end of 14 weeks. Differences in physical structure and chemical composition between the two growing media and their effects on adsorption and leaching, along with inherent differences between the two herbicides, could account for these differences in herbicidal activity.

Results with simazine in controlling bittercress, and dichlobenil in controlling common groundsel are in agreement with previous data (6).

The reduction in fresh weight of 'Rosebud' azaleas by the combination of napropamide plus simazine, but not by either herbicide separately, suggests a synergistic action of the two applied together. 'Rosebud' azalea has shown growth reduction from higher rates of simazine and from other herbicides or combinations in other studies (6).

Acknowledgments

Appreciation is expressed to Briggs Nursery for supplying plants and other materials for this research, and to Mallinckrodt, Inc., for financial support.

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Table 1. Effects of napropamide, alachlor, and simazine on growth of nursery stock in two container growing media, Experiment 1

	Dates and rates of application (lb/A)			Fresh weight of plant tops as percent of untreated checks					
				Bark mix		Sawdust mix			
Herbicide	7/3	8/15	10/8	Azalea	Yew	Azalea	Yew	Rhodo-dendron	Juniper
Untreated check				100 ab*	100 ab	100 ab	100 a	100 abc	100 ab
Napropamide 8G	3	3	3	101 ab	111 a	111 ab	90 a	78 c	106 ab
Napropamide 8G	6	6		109 a	101 ab	104 ab	89 a	104 ab	93 ab
Napropamide 8G	12			102 a	101 ab	106 ab	103 a	110 a	110 ab
Napropamide 50W	3	1.8		—	—	79 c**	96 a	100 abc	106 ab
+ simazine 80W	1	0.6							
Napropamide 50W	5			—	—	102 ab	95 a	105 ab	112 ab
+ simazine 80W	1								
Napropamide 50W	6			84 c	97 ab	96 abc	98 a	93 abc	97 ab
+ simazine 80W	1								
Napropamide 50W	3	1.8		—	—	103 ab	97 a	87 abc	94 ab
Napropamide 50W	5			—	—	109 ab	99 a	108 a	94 ab
Napropamide 50W	6			—	—	116 a	101 a	93 abc	94 ab
Alachlor 8-1/3 G	6		6	96 abc	83 b	114 ab	102 a	88 abc	114 a
Alachlor 8-1/3 G	4					113 ag	95 a	101 ab	108 ab
+ simazine 1-2/3 G	0.8								
Alachlor 8-1/3 G	6		6	89 bc	86 b	103 ab	92 a	82 bc	104 ab
+ simazine 1-2/3 G	1.2		1.2						
Alachlor 8-1/3 G	8			—	—	108 ab	90 a	86 abc	103 ab
+ simazine 1-2/3 G	1.6								
Simazine 4G	1.6	1.6	1.6	99 ab	93 ab	94 bc	101 a	98 abc	88 b

*Mean separation within columns by Duncan's multiple range tests at 5% level.
**Two plants died in the fourth replication. Data is based on fresh weight of live plants.

Table 2. Control of bittercress, groundsel, and barnyard grass with napropamide, alachlor, and simazine in two nursery container growing media, Experiment 2

Herbicide	Rate (lb/A)	Percent control (weeks after treatment) Bittercress 6	Bittercress 14	Bittercress 22	Groundsel 6	Groundsel 14	Barnyardgrass 6	Barnyardgrass 14
Sawdust mix								
Napropamide 50W	5	99.6 ab*	99 a	98.7 ab	93 ab	93 a	100 a	100.0 a
Napropamide 50W	6	99.7 ab	99 a	98.3 ab	92 ab**	92 a	100 a	99.7 a
Napropamide 8G	6	93.9 cd	98 a	96.9 b	86 ab	88 a	99 a	98.7 a
Napropamide 8G	12	92.6 d	98 a	98.1 ab	97 ab	96 a	100 a	100.0 a
Napropamide 50W + simazine 80W	6 + 1	94.7 cd	99 a	99.4 a	97 ab	94 a	100 a	99.3 a
Alachlor 8-1/3 G	6	100.0 a	54 d	---	92 b**	42 b	99 a	90.6 b
Alachlor 8-1/3 G + simazine 1-2/3 G	4 + 0.8	97.2 bc	54 d	---	96 ab	25 c	100 a	85.5 c
Alachlor 8-1/3 G + simazine 1-2/3 G	6 + 1.2	99.9 a	64 c	---	97 ab	52 b	100 a	91.3 b
Alachlor 8-1/3 G + simazine 1-2/3 G	8 + 1.6	99.1 ab	84 b	---	100 a	53 b	100 a	93.7 b
Untreated check		(132)†	(472)	(504)	(29)	(226)	(54)	(70)
Bark mix								
Napropamide 8G	6	65 c	87 ab	---	---††	67 ab	98 a	99.3 a
Napropamide 8G	12	83 abc	98 a	97.6	---	82 a	100 a	99.8 a
Napropamide 50W + simazine 80W	6 + 1	69 bc	92 a	---	---	84 a	100 a	99.3 a
Alachlor 8-1/3 G	6	100 a	69 b	---	---	45 bc	100 a	96.3 ab
Alachlor 8-1/3 G + simazine 1-2/3 G	6 + 1.2	98 ab	71 b	---	---	26 c	99 a	95.0 b
Untreated check		(41)†	(366)	(404)	(5)	(146)	(51)	(71)

*Mean separation within columns and within mixes by Duncan's multiple range test at 5% level.

**The apparent discrepancy in letters following these means resulted from arcsine transformation of percentages for analysis of variance.

†Figures in parenthesis are numbers of seedlings in 5 cans.

††There were not enough seedlings in the untreated containers for meaningful data.

Table 3. Control of bittercress, common groundsel, and barnyardgrass with repeat applications of napropamide and simazine in sawdust mix, Experiment 2

Herbicide	Dates and rates of application (lb/A) 6/3	8/15	10/8*	Percent control: Bittercress 6/3 to 8/13	Bittercress 8/15 to 10/6	Bittercress 10/8 to 12/3	Groundsel 7/3 to 8/13	Groundsel 8/15 to 10/6	Barnyardgrass 7/3 to 8/13	Barnyardgrass 8/15 to 10/6
Napropamide 8G	3	3	3	93.2 b**	99 b	98 ab	94 a	96 a	99.4 ab	100 a
Napropamide 50W	3	1.8		90.6 b	99 b	100 a	90 a	97 a	100.0 a	100 a
Napropamide 50W + simazine 80W	3 1	1.8 0.6		94.4 b	100 a	99 a	93 a	97 a	99.6 a	100 a
Simazine 80W	1.6	1.6	1.6	99.7 a	99 b	96 b	82 a	46 b	97.4 b	94 b

*Applications October 8 were on bittercress only.
**Mean separation within columns by Duncan's multiple range test at 5% level.

Table 4. Effects of napropamide, simazine, dichlobenil, and oxadiazon on growth of nursery stock in two container growing media, Experiment 3

		Fresh weight of plant tops as percent of untreated checks					
		Bark mix			Sawdust mix		
Herbicide	Rate (lb/A)	Rhododendron	Azalea	Cotoneaster	Cotoneaster	Broom	Heather
Untreated check		100 ab*	100 ab	100 ab	100 ab	100 ab	100 ab
Napropamide	3 + 3	117 a	97 ab	109 a	111 a	100 ab	103 ab
Napropamide	6 + 6	118 a	103 a	104 ab	103 ab	95 ab	105 ab
Napropamide	12	97 ab	98 ab	99 ab	99 ab	110 a	107 ab
Napropamide + simazine	3 + 3 1 + 1	116 a	101 ab	112 a	105 ab	96 ab	104 ab
Napropamide + simazine	6 + 6 1.2 + 1.2	76 b	103 a	98 b	94 b	90 b	91 b
Napropamide + dichlobenil	3 3	114 a	91 b	100 ab	104 ab	98 ab	101 ab
Napropamide + oxadiazon	3 3	103 ab	97 ab	102 ab	105 ab	106 ab	98 ab
Simazine	1.2 + 1.2	110 ab	92 ab	113 a	109 a	98 ab	90 b
Dichlobenil	3	117 a	94 ab	105 ab	105 ab	105 ab	96 ab
Oxadiazon	3	97 ab	102 ab	96 ab	98 ab	89 b	113 a
Oxadiazon + simazine	3 1.2	113 a	91 b	102 ab	111 a	100 ab	106 ab

*Mean separation within columns by Duncan's multiple range test at 5% level.

Table 5. Control of bittercress, common groundsel, and barnyardgrass with napropamide, simazine, dichlobenil, and oxadiazon in two nursery container growing media, Experiment 4

Herbicide	Rate (lb/A)	Percent control (weeks after treatment) Bittercress 6	Bittercress 14	Groundsel 6	Groundsel 14	Barnyardgrass 6	Barnyardgrass 14
Sawdust mix							
Napropamide 8G	6	85 d*	--**	96 a	97 ab	99.6 ab	99.6 a
Napropamide 8G	12	95 c	99.4 ab	96 a	100 a	99.4 ab	100.0 a
Napropamide 8G + simazine 4G	6 + 1.2	96 bc	--**	83 a	94 bc	100.0 a	100.0 a
Napropamide 8G + dichlobenil 4G	3 + 3	100 a	98.1 b	100 a	99 a††	100.0 a	97.6 a
Napropamide 8G + oxadiazon 2G	3 + 3	100 a	99.7 a	95 a	90 c	100.0 a	100.0 a
Dichlobenil 4G	3	99 ab	85.9 c	100 a	99 ab††	92.1 b	71.1 b
Oxadiazon 2G	3	100 a	100.0 a	86 a	31 e	94.4 ab	96.4 a
Oxadiazon 2G + simazine 4G	3 + 1.2	100 a	100.0 a	94 a	72 d	98.9 ab	98.7 a
Untreated check		(194)†	(319	(24)	(198)	(31)	(41)
Bark mix							
Napropamide 8G	6	31 c	--**	79 a	75.6 b	97 abc	98.4 a
Napropamide 8G	12	47 c	97 a	90 a	93.5 ab	100 a	99.8 a
Napropamide 8G + simazine 4G	6 + 1.2	61 bc	--**	70 a	72.5 b	98 abc	98.6 a
Napropamide 8G + dichlobenil 4G	3 + 3	100 a	93 a	100 a	99.6 a	100 a	99.4 a
Napropamide 8G + oxadiazon 2G	3 + 3	100 a	100 a	97 a	80.3 b	98 ab	99.8 a
Dichlobenil 4G	3	98 ab	29 b	100 a	97.8 a	95 bcd	60.6 b
Oxadiazon 2G	3	100 a	100 a	97 a	25.2 c	89 d	93.0 a
Oxadiazon 2G + simazine 4G	3 + 1.2	100 a	100 a	91 a	35.6 c	94 cd	95.2 a
Untreated check		(21)	(157)	(11)	(114)	(42)	(76)

*Mean separation within columns and within mixes by Duncan's multiple range test at 5% level.

**A second application was made on these treatments after 6 weeks.

†Figures in parenthesis are numbers of seedlings in 5 cans.

††Different letters for the same mean value resulted from arcsine transformation of percentages for analysis of variance.

Table 6. Control of bittercress, common groundsel, and barnyardgrass with repeat applications of napropamide and simazine in sawdust mix, Experiment 4

		Percent control					
		Bittercress		Groundsel		Barnyardgrass	
Herbicide	Rate* (lb/A)	7/8 to 8/19	8/21 to 10/15	7/8 to 8/19	8/21 to 10/15	7/8 to 8/19	8/21 to 10/15
Napropamide 8G	3 + 3	76 b**	99 a	60 ab	99 a	97 a	100 a
Napropamide 8G + simazine 4G	3 + 3	96 a	100 a	62 a	97 a	96 a	100 a
Simazine 4G	1.2 + 1.2	93 a	100 a	31 b	15 b	23 b	93 a

*Herbicides were applied 7/8 and 8/21.

**Mean separation within columns by Duncan's multiple range test at 5% level.

ALLELOPATHIC EFFECTS OF CANADA THISTLE EXTRACTS

R. L. Zimdahl, T. J. Henson, and W. J. Stachon[1]

Abstract. The allelopathic effects of water and ethanol extracts of the roots and foliage of Canada thistle were studied. Radicle and hypocotyl lengths of several test species were measured 5 days after germination on filter paper bathed in the extract.

The radicles of seeds exposed to distilled water extracts were consistently smaller than the controls, but the hypocotyls were often longer. There was a decrease in turgidity, color, and general vigor of the seedlings exposed to the extract.

Ethanolic extracts of roots and foliage affected seedling development. Whether the root extract or foliage extract produced the greatest effect was species specific. No species was unaffected by treatment with any of the extracts. The significance of these findings and future work will be discussed.

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WEED CONTROL IN ESTABLISHED ASPARAGUS WITH TRIFLURALIN[1]

F. O. Colbert, W. T. Cobb, and L. G. Peterson[2]

Introduction

In primary field screening trials, established asparagus showed excellent tolerance to trifluralin with no residue in the edible spears. Therefore, university and Eli Lilly and Company scientists have conducged research for the past two years to support the addition of established asparagus to the trifluralin label.

Methods and Materials

Research trials were established in the major asparagus production areas of California and Washington. The trials were initiated on mineral soils classified as coarse, medium, or fine texture, but excluded the high organic soils; i.e., peats and mucks.

In all trials (replicated small plots and nonreplicated large-scale trials), trifluralin was applied and soil incorporated within two hours after application. Trifluralin was applied at rates of 9.5 to 2 or 4 lb/A (a.i.), either as a single application pre- or postharvest or as a split application of pre- plus postharvest to established asparagus. Data gathered from all trials included weed

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[1]Trifluralin is marketed under the trademark of TREFLAN by Elanco Products Company.

[2]Plant Science Representatives, Eli Lilly and Company, Fresno, California.

control and crop injury. Asparagus spears were harvested from selected trials throughout the cutting period.

Results

Results, based on crop vigor and market quality, indicate established asparagus exhibits excellent tolerance to trifluralin at rates up to 4 lb/A (a.i.). In five trials harvested at least once a week during the cutting period, the use of trifluralin did not cause a reduction in yield per acre either in the number of spears or total harvest weight as shown in Tables 1 and 2.

Table 1. Effect of trifluralin when applied as a single application to established asparagus on injury and yield per acre

Soil texture	Rate (lb/A)	Crop injury*	Yield/A % of control	Number of harvests
Sandy loam (coarse)	1	0	99	19
	2	0	98	
	0	0	100	
Loam** (medium)	2†	0	113	25
	0	0	100	
Clay** (fine)	2	0	125	23
	4	0	126	
	0	0	100	
Clay (fine)	2	0	122	24
	4	0	130	
	0	0	100	

*0 = no injury; 10 = death of plant

**University of California research trials conducted by F. Ashton, B. Benson, K. Glenn, and H. Agamalian.

†Highest rate tested.

Table 2. Effect of trifluralin on asparagus injury and yield per acre when applied as a split application of pre- plus postharvest

Soil Texture	Rate* (lb/A)	Crop injury** 1974	Crop injury** 1975	Crop yield† % of control 1974	Crop yield† % of control 1975
Sandy loam	0.5 + 0.5	0	0	97	111
(Coarse)	1 + 1	0	0	105	111
	0 + 0	0	0	100	100

*Chemical applications made 1/3/74 and 6/6/74
**0 = no injury; 10 - death of plant
†Total of 15 and 10 separate harvests for 1974 and 1975, respectively.

A summary of weed control data from trials evaluated in 1974 and 1975 demonstrated commercially acceptable control of the following weed species: barnyardgrass, green foxtail, lovegrass, bearded sprangletop, common lambsquarters Russian thistle, tumble pigweed, redroot pigweed, and puncturevine.

As shown in Table 3, in trials were established field bindweed (<u>Convolvulus arvensis</u>) was present, trifluralin at 1.5 to 2 lb/A provided at least 90 percent suppression of this weed species.

Table 3. Percentage field bindweed control from a single postharvest application of trifluralin

Soil texture	Rate (lb/A)	Field bindweed control (%)	Observation (Mo. after Appl.)
Loam	0.75	50	2
(medium)	1.5	95	
Silt loam	0.75	60	2
(medium)	1.5	95	
Clay loam	1	80	4
(fine)	2	90	
Clay	0.75	57	4
(fine)	1	75	
	1.5	93	
	2	100	

Summary

Results from research trials initiated during the past two years have shown trifluralin will provide effective weed control and exhibits excellent safety to established asparagus plantings.

Currently, Eli Lilly and Company is conducting large-scale field trials under an Environmental Protection Agency experimental permit. The principal points included in this experimental permit are summarized as follows:

1. Trifluralin can be applied as a single or split application at the following times:
   a. Winter to spring: apply after ferns are removed and prior to harvest.
   b. Spring to summer: apply after harvest and prior to ferning.
2. Trifluralin is recommended at a rate range of 1 to 2 lb/A (a.i.) as a single application or as a split application with the total amount applied during the calendar year not to exceed the single application rate for the given soil texture.

INFLUENCE OF TIME AND RATE OF METRIBUZIN APPLICATION ON POTATO YIELD AND QUALITY

R. H. Callihan, G. F. Stallkneckt, R. B. Dwelle,
M. Blicharczyk, and A. C. Scoggan[1]

Abstract. Early season applications of metribuzin to hand weeded potatoes on silt loam soil resulted in taller potato plants, higher yield, larger tubers and more U.S. No. 1 tubers than mid or late season applications. Late July postemergence applications of 1.0, 2.0, or 4.0 lb/A metribuzin resulted in shorter plants, delayed senescence, lower yield and fewer U.S. No. 1 tubers when compared with 0, 0.25, 0.50, and 0.75 lb/A. Tuber specific gravity and fry quality were not significantly affected by metribuzin rates as high as 4 lb/A. Residues of metribuzin and its major metabolites in tubers were below EPA tolerance at recommended application rates, but late season applications of 1 lb/A or more exceeded tolerance.

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[1]University of Idaho Research and Extension Center, Aberdeen; Plant Breeding Station, Plochocin, Poland, and Mobay Corporation, Boise, Idaho

CONTROL OF NUTSEDGES IN COTTON WITH PERFLUIDONE

J. W. Whitworth and Jose Vides[1]

Abstract. Increasing infestations of yellow and purple nutsedge (*Cyperus esculentus* L. and *C. rotundus* L.) in the croplands of New Mexico have created a serious problem, especially in fields that are cropped to cotton. Reports from other cotton growing states and experience in New Mexico indicated that perfluidone (1,1,1-trifluoro-N-[2-methyl-4(phenylsulfonyl)phenyl] methanesulfonamide) could be very effective in controlling nutsedge in cotton but performance was very erratic. Laboratory, greenhouse and field experiments were conducted on suspect variables including cotton varieties, herbicide formulations and placement and time of application.

Of the ten varieties of cotton tested in the laboratory, a widely grown New Mexico variety, 1517-V, showed a 43% reduction in the growth of the shoot at 9.1 kg/ha of perfluidone as compared to only 8% for Stoneville 74, a type that is widely grown in the Southeast.

Slight, but significant differences between the liquid and wettable powder formulations of perfluidone were noted in laboratory experiments. At the higher dosages tested, 8 and 16 ppm, the liquid formulation caused a greater inhibition of root growth from cotton seed incubated for 6 days in rolls of blotter paper.

Under both greenhouse and field conditions, placement of perfluidone in the soil was more important than rate. Dosages of 2.3 or 4.6

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kg/ha, placed around or below the tubers of both species of nutsedge or the seed of cotton, invariably resulted in impressive control of nutsedge and unacceptable injury to cotton. Shallow placement of the herbicide above the nutsedge tubers and cotton seed gave little or no control of the nutsedges and visible but minor injury to cotton. Under New Mexico conditions, the placement of perfluidone in the soil which gives good control of nutsedge results in an unacceptable level of stand reduction and injury to cotton. (New Mexico State University).

INCORPORATION OF HERBICIDES AT LAYBY OF COTTON WITH SWEEP OR ROLLING CULTIVATORS[1]

John H. Miller and Charles H. Carter[2]

Abstract. The herbicides trifluralin (α,α,α-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine), nitralin [4-(methylsulfonyl)-2,6-dinitro-N,N-dipropylaniline], diuron [3-(3,4-dichlorophynyl)-1,1-dimethylurea], fluometuron [1,1-dimethyl-3-(α,α,α-trifluoro-m-tolyl)urea], prometryn [2,4-bis(isopropylamino)-6-(methylthio)-s-triazine], and bensulide [O,O-diisopropyl phosphorodithioate S-ester with N-(2-mercaptoethyl)benzenesulfonamide] were applied at layby of cotton (*Gossypium hirsutum* L. 'SJ-1') as directed sprays. Then they were incorporated with a sweep cultivator or with a rolling cultivator during three seasons on two soil types (Hesperia fine sandy loam and Panoche clay loam). As measured by cotton yield, weed control, and residual herbicide, the sweep cultivator and rolling cultivator performed equally well for the incorporation of herbicides. Herbicide responses varied with season and with soil type, but the responses were independent of methods of herbicide incorporation.

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[1]Approved for publication by Agr. Res. Ser., U. S. Dep. of Agr. Contribution of Agr. Res. Ser., U. S. Dep. of Agr., and the California Agr. Exp. Sta. This paper reports research on chemicals that require registration by State and Federal agencies before they can be used. No recommendations for use of these chemicals are made or implied here.

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Introduction

For many years the application of herbicide at the time of last cultivation (layby) has been an accepted practice in western irrigated cotton (1, 2, 3, 4, 5, 6, 7). Originally in this practice, the substituted-urea herbicides were applied as directed sprays on the soil surface after the last cultivation. In the arid West, these herbicides applied to the soil surface depended on irrigation for their movement into the area of weed-seed germination. More recently, the group of herbicides used by layby of cotton was increased to include several that perform better when they are incorporated mechanically in the upper layer of soil.

The purpose of this research was to compare the rolling cultivator with the sweep cultivator for the incorporation of herbicides applied at layby of cotton.

Materials and Methods

The experiment was repeated for three seasons (1968, 1969, and 1970) on two different soils (Hesperia fine sandy loam and Panoche clay loam) that were relatively free of weeds. All plots received normal cultivation until herbicide application.

Six herbicides (trifluralin at 0.84 kg/ha, nitralin at 0.84 kg/ha, diuron at 1.68 kg/ha, fluometuron at 1.96 kg/ha, prometryn at 1.96 kg/ha, and bensulide at 4.48 kg/ha) were applied in 374 liters water/ha as directed sprays at layby of cotton. The effects of using these herbicides were compared to those of using no herbicides. Immediately after herbicide application to twin sets of plots, herbicides were incorporated with a rolling cultivator operated at 8 km/hr in one set of plots, whereas herbicides were incorporated with a high-speed sweep cultivator operated at 6.4 km/ha in the other set. Both cultivators tilled the upper 5 cm of soil. No other tillage was used after herbicide incorporation. Plots were furrow-irrigated one day after herbicide application. Number of irrigations after herbicide application differed for the two soils. The clay loam received two irrigations whereas the fine sandy loam received four. Four-row plots were 4.1 m wide and 19.8 m long. Treatments were arranged in randomized blocks and were replicated four times.

Before herbicide application, Japanese millet (Echinochloa crus-galli (L.) Beauv. var. frumentacea (Roxb.) W. F. Wight) was sown broadcast and covered by cultivation to assure a weed population for evaluation of herbicide efficacy. Soil samples from each plot were taken with a hand trowel from the upper 10 cm of soil in the cotton bed after cotton harvest (before post-harvest tillage) for bioassay in the greenhouse to estimate herbicide residues in the soil 6 months after application. Random samples of soil, enough to fill a metal flat 35 by 50 by 7.5 cms, were blended for each plot and planted to five bioassay plants--tall morningglory (Ipomoea purpurea (L.) Roth), sugarbeet (Beta vulgaria L.), grain sorghum (Sorghum bicolor (L.) Moench), barley (Hordeum vulgare L.), and Japanese millet. The plants were grown for 1 month and evaluated by species to provide a mean herbicide injury rating for the five bioassay plants.

Other data consisted of the yeild of machine-harvested seed cotton and estimates of weed control. Weed control and bioassay plant injury were rated on a 0 to 10 basis, in which 0 equaled no control or injury and 10 equaled absence or death of plants. All data were collected from the center two rows of the plots. Analyses of variance were used to examine the data for a single season within a soil type and for data combined over seasons and soil types.

Results and Discussion

Yield of seed cotton. Methods of herbicide incorporation had no significant influence on yield of seed cotton (Table 1).

The effect of herbicides on yield of seed cotton varied with season and soil type. On clay loam in 1968 and 1969 and on fine sandy loam in 1970, herbicide treatment did not influence seed cotton yield. On fine sandy loam in 1968, plots treated with bensulide yielded more than plots treated with trifluralin. Yields from the other herbicide treatments did not differ from yields from bensulide or trifluralin. On fine sandy loam in 1969, plots that received herbicides produced more seed cotton than plots that received no herbicide; however, no yield differential was found among herbicides. On clay loam in 1970, plots treated with prometryn or bensulide yielded less than plots treated with the other herbicides.

Yields were not influenced by an interaction of incorporation methods with herbicides. The second order-interaction (methods by herbicides by season) also was not significant.

The mean yields over the six experiments were similar for both herbicides and incorporation methods.

The mean yields for experiments were different (clay loam--1968 > clay loam--1969 or 1970 or fine sandy loam--1968 > fine sandy loam--1969 or 1970).

Weed control. Methods of incorporation did not differ in their influence on weed control (Table 2).

When compared to no herbicide, herbicides always improved weed control. Weed control with herbicides varied with season and with soil type. Weed control did not differ among herbicides on clay loam for any of the three seasons. Weed control ratings for no-herbicide plots showed that weed populations on the clay loam were less than those on the fine sandy loam.

Also, we were unable to detect that herbicides differed in weed control efficacy on fine sandy loam in 1969; however, weed control was poorer than on clay loam experiments. Weed control in 1969 on fine sandy loam was considerably better on the beds than in the furrows. A disproportionate amount of herbicide appeared to have been displaced from the furrow area of the plots, suggesting that both the rolling cultivator and the sweep cultivator had been operated at a depth greater than 5 cm.

Differential weed control from herbicide use was found in 1968 and 1970 on fine sandy loam. In 1968, weed control with trifluralin was better than with nitralin, which in turn was better than with diuron, prometryn, or fluometuron. Weed control with bensulide was not different from weed control with trifluralin or nitralin. In 1970, weed control with trifluralin, nitralin, diuron, or bensulide was better than that with fluometuron or prometryn.

Herbicides did not significantly interact with incorporation methods for weed control.

Herbicide residue. Bioassay data (Table 3) indicated that herbicide residues in the soil 6 months after application were not influenced by method of herbicide incorporation. Herbicide residues differed, but these residues were influenced by season and by soil type. In 1968, the herbicide residues in fine sandy loam, ranked from greatest to least, were as follows: diuron > fluometuron = prometryn > nitralin = bensulide > trifluralin. Herbicide residues in clay loam ranked as follows: diuron = fluometuron = bensulide > prometryn = nitralin > trifluralin. In 1969, diuron residues exceeded those of all other herbicides in fine sandy loam. In clay loam, herbicide residues ranked as follows: diuron > fluometuron = bensulide > prometryn = trifluralin. In 1969, diuron residues exceeded those of all other herbicides in fine sandy loam. In clay loam, herbicide residues ranked as follows: diuron > fluometuron = bensulide > prometryn = trifluralin. Nitralin residues did not differ from those of trifluralin or bensulide. In 1970, the herbicide residues in fine sandy loam ranked as follows: diuron = fluometuron > all other herbicides. Herbicide residues in clay loam ranked as follows: diuron = prometryn > fluometuron > trifluralin = bensulide. Nitralin residues did not differ from those of trifluralin or fluometuron.

Residue data showed no evidence of an interaction of herbicides with incorporation methods.

Herbicide residues were lower in 1969 than in 1968 or 1970. The reason for lower residues in 1969 is not clear. Irrigation schedules within soil types, had been similar for each year. Rainfall data during the period preceding soil sampling showed that 1.5 cm of rain fell in 1969, compared to 4 cm in 1968 and 4.6 cm in 1970. Weed control on beds was better than that in furrows on fine sandy loam in 1969. If, as suspected, the incorporation tools were operated too deep, herbicides could have been diluted more with soil. This dilution might explain the lesser residues in the fine sandy loam in 1969; but not for the clay loam in 1969.

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Table 1. The influence of method of incorporation and cotton-layby herbicides on cotton yield.

		Seed cotton (kg/ha)											
		1968			1969			1970			Six experiment means[a]		
Herbicide	Rate kg/ha	Rolling cult.	Sweep cult.	Herb. $\bar{x}$	Rolling cult.	Sweep cult.	Herb. $\bar{x}$	Rolling cult.	Sweep cult.	Herb. $\bar{x}$	Rolling cult.	Sweep cult.	Herb. $\bar{x}$
					Fine sandy loam								
None	--	3382	3382	3382ab[b]	2369	2425	2397b	2542	2526	2535a	3272	3179	3224
Trifluralin	0.84	3254	3186	3220b	2834	3097	2966a	2559	2699	2630a	3277	3351	3314
Nitralin	0.84	3315	3354	33335ab	2800	2895	2848a	2822	2486	2654a	3376	3334	3356
Diuron	1.68	3511	3618	3565ab	2710	2923	2817a	2458	2430	2445a	3270	3399	3334
Fluometuron	1.96	3403	3578	3490ab	2453	3091	2772a	2610	2772	2691a	3255	3438	3347
Prometryn	1.96	3483	3382	3433ab	2811	2811	2811a	2458	2475	2467a	3203	3284	3244
Bensulide	4.48	3466	3808	3638a	2912	2800	2856a	2503	2582	2542a	3244	3366	3305
Method $\bar{x}$		3403	3473		2698	2863		2565	2567		3270	3336	
Expt. $\bar{x}$				3437			2781			2566			
					Clay loam								
None	--	4122	4122	4122a	3571	3640	3605a	3643	2974	3308a			
Trifluralin	0.84	4142	4091	4116a	3360	3556	3459a	3515	3478	3496a			
Nitralin	0.84	4273	4290	4282a	3556	3599	3577a	3489	3382	3436a			
Diuron	1.68	4175	4254	4215a	3416	3696	3556a	3349	3478	3414a			
Fluometuron	1.96	4086	4110	4098a	3640	3500	3571a	3338	3582	3460a			
Prometryn	1.96	4125	4313	4219a	3556	3655	3605a	2783	3063	2923b			
Bensulide	4.48	4038	4206	4122a	3655	3739	3696a	3890	3063	3977b			
Method $\bar{x}$		4137	4198		3536	3627		3288	3286				
Expt. $\bar{x}$				4168			3582			3287			

[a]Means over seasons and soil types.

[b]Data followed by the same letter within a season and soil types do not differ significantly at 5% level of probability (Duncan's multiple-range test). All other data, except experimental means, do not differ significantly.

Table 2. The influence of method of incorporation and cotton-layby herbicides on weed control

Herbicide	Rate kg/ha	1968 Rolling cult.	1968 Sweep cult.	1968 Herb. $\bar{x}$	1969 Rolling cult.	1969 Sweep cult.	1969 Herb. $\bar{x}$	1970 Rolling cult.	1970 Sweep cult.	1970 Herb. $\bar{x}$	Six experiment means[b] Rolling cult.	Six experiment means[b] Sweep cult.	Six experiment means[b] Herb. $\bar{x}$
		Weed control (0-10 rating)[a]											
Fine sandy loam													
None	-	2.7	2.8	2.8d[c]	0.8	1.0	0.9b	5.5	5.5	5.5c	4.7	4.9	4.8d
Trifluralin	0.84	9.6	9.7	9.6a	8.6	8.0	8.3a	9.8	9.9	9.8a	9.6	9.5	9.6a
Nitralin	0.84	8.3	8.8	8.5b	8.0	8.4	8.2a	9.6	9.8	9.7a	9.2	9.5	9.3b
Diuron	1.68	7.5	7.1	7.3c	8.8	8.4	8.6a	9.8	9.8	9.8a	9.1	8.9	9.0c
Fluometuron	1.96	7.0	6.8	6.9c	8.0	8.5	8.3a	9.3	8.6	9.0b	8.8	8.8	8.8c
Prometryn	1.96	7.1	7.0	7.1c	8.6	8.0	8.2a	8.9	8.5	8.7b	9.0	8.8	8.9c
Bensulide	4.48	8.9	9.0	8.9ab	7.4	8.6	8.0a	9.9	9.7	9.8a	9.4	9.5	9.4ab
Method $\bar{x}$		7.3	7.3		7.2	7.3		9.0	8.8		8.5	8.6	
Expt. $\bar{x}$				7.3			7.2			8.9			
Clay loam													
None	--	6.5	6.5	6.5b	6.3	6.8	6.5b	6.0	6.4	6.2b			
Trifluralin	0.84	10.0	9.9	9.9a	9.9	9.8	9.9a	9.9	9.8	9.8a			
Nitralin	0.84	9.6	9.9	9.8a	9.7	9.9	9.8a	9.9	9.9	9.9a			
Diuron	1.68	9.7	9.7	9.7a	9.3	9.6	9.4a	9.5	8.9	9.2a			
Fluometuron	1.96	9.5	9.8	9.7a	9.3	9.3	9.3a	9.3	9.3	9.3a			
Prometryn	1.96	10.0	10.0	10.0a	9.6	9.6	9.6a	9.9	9.4	9.6a			
Bensulide	4.48	10.0	10.0	10.0a	10.0	10.0	10.0a	10.0	9.8	9.9a			
Method $\bar{x}$		9.3	9.4		9.2	9.2		9.2	9.0				
Expt. $\bar{x}$				9.4			9.2			9.1			

[a] 0 = no control, 10 = complete control.
[b] Means over seasons and soil types.
[c] Data followed by the same letter within a season and soil type do not differ significantly at the 5% level of probability (Duncan's multiple-range test). All other data, except experimental means and over-all herbicide means, do not differ significantly.

Table 3. The influence of method of incorporation and cotton-layby herbicides on herbicide residues 6 months after application

		Mean injury rating (0-10) to five bioassay plants[a]											
		1968			1969			1970			Six experiment means[b]		
Herbicide	Rate kg/ha	Rolling cult.	Sweep cult.	Herb $\bar{x}$	Rolling cult.	Sweep cult.	Herb. $\bar{x}$	Rolling cult.	Sweep cult.	Herb $\bar{x}$	Rolling cult.	Sweep cult.	Herb. $\bar{x}$
Fine sandy loam													
Trifluralin	0.84	2.4	3.3	2.9d[c]	0.8	0.9	0.9b	2.8	2.6	2.7b	2.3	2.4	2.3d
Nitralin	0.84	5.0	4.9	5.0c	1.7	1.9	1.8b	4.7	2.9	3.8b	4.0	3.7	3.8cd
Diuron	1.68	9.2	9.5	9.4a	3.5	5.0	4.3a	9.2	8.2	8.6a	7.4	7.5	7.4a
Fluometuron	1.96	8.1	6.4	6.3b	0.3	2.5	1.4b	8.0	8.1	8.1a	5.5	5.5	5.5b
Prometryn	1.96	6.1	7.9	7.0b	0.8	0.6	0.7b	2.1	3.9	3.0b	4.1	4.6	4.3bc
Bensulide	4.48	5.2	4.5	4.9c	1.0	1.0	1.0b	2.4	2.5	2.5b	3.6	3.8	3.7cd
Method $\bar{x}$		6.0	6.1		1.4	2.0		4.9	4.7		4.5	4.6	
Expt. $\bar{x}$				6.0			1.7			4.8			
Clay loam													
Trifluralin	0.84	2.0	1.3	1.7c	1.9	1.1	1.5c	3.9	5.0	4.5c			
Nitralin	0.84	4.1	4.1	4.1b	2.1	2.5	2.3bc	6.3	5.8	6.1bc			
Diuron	1.68	7.8	7.4	7.6a	4.8	5.6	5.2a	9.6	9.5	9.6a			
Fluometuron	1.96	7.1	7.7	7.4a	3.2	1.8	2.5b	6.5	6.7	6.6b			
Prometryn	1.96	3.6	4.7	4.2b	2.1	0.9	1.5c	9.7	9.4	9.6a			
Bensulide	4.48	6.4	6.2	6.3a	2.4	2.8	2.6b	4.1	5.7	4.9c			
Method $\bar{x}$		5.2	5.2		2.8	2.5		6.7	7.0				
Expt. $\bar{x}$				5.2			2.6			6.8			

[a] 0 = no injury, 10 = kill.

[b] Means over seasons and soil types.

[c] Data followed by the same letter within a season and soil type do not differ significantly at the 5% level of probability (Duncan's multiple-range test). All other data, except for experimental means and over-all herbicide means, do not differ significantly.

BENTAZON FOR POST-EMERGENCE BROADLEAF WEED CONTROL IN DRY BEANS AND PEAS

J. E. Orr and C. W. Carter[1]

Abstract. Bentazon (3-Isopropyl-1*H*-2,1,3-benzothiadiazin-4(3*H*)-one 2,2-dioxide) has been tested extensively since 1969 in the U.S. and abroad for selective post-emergence broadleaf weed control in many crops. It has displayed considerable promise in large-seeded legumes and in 1975 was registered for use in soybeans (*Glycine max*). It is sold under the trade name of BASAGRAN ™. During this period of time, extensive testing has also been conducted on dry beans (*Phaseolus spp.*) and dry peas (*Pisum spp.*) and the compound has proven to be equally effective in these important crops.

Bentazon is formulated as a 4 lb/gal water soluble liquid and is relatively nonvolatile. It has a water solubility of 500 ppm at 20°C.

Testing on dry beans and peas in the West has shown that bentazon is most effective when applied to weeds in the 2-4 leaf stage. To avoid crop injury, beans should have at least 1 fully expanded trifoliate leaf and peas should be in the 4-6 node stage.

Bentazon should be applied to crops and weeds that are actively growing. Under irrigated cultures, applications just following the first irrigation have been most effective.

Bentazon has proven to have excellent efficacy on many of the problem weeds in beans and peas. These include hairy nightshade (*Solanum*

[1]BASF, Wyandotte Corporation, Boise, Idaho

saracchoides), Canada thistle (Cirsium arvense), and yellow nutsedge (Cyperus esculentus). Hairy nightshade can be controlled with 1 lb/A in a single application. Canada thistle (6-8 in. tall) and nutsedge (4-6 in. tall) may require two applications of 3/4-1 lb. per application.

BASF Wyandotte Corporation has submitted a petition to EPA requesting an Experimental Use Permit for the 1976 growing season for use of bentazon on dry beans (including lima beans) and dry peas. Other crops of interest in the West are corn, rice, mint, alfalfa, green beans, green peas and cereals.

RESULTS FROM EXPERIMENTAL PROGRAM IN SUGAR BEET AND GRASS SEED CROPS WITH NC 8438

W. L. Ekins[1]

Abstract. NC 8438 (2-ethoxy-2,3-dihydro-3,3-dimethyl-5-benzofuranyl methanesulphonate) was tested extensively during 1975 in grower fields under a U.S. Environmental Protection Agency Experimental Use Permit for preemergence control of weeds in sugar beets. Approximately 700 trials ranging from 1 to 20 acres in size were conducted in sugar beet regions of the U. S. Grower equipment was used for making the applications.

NC 8438 applied preemergence at rates of 1.0 to 4.0 lb/A gave selective control of many annual weeds, including redroot, pigweed, common lanbsquarters, volunteer small grains, kochia, Russian thistle, foxtails and barnyardgrass.

At recommended rates, NC 8438 showed excellent crop selectivity. Occasional "leaf fusion" was observed during early crop growth stages; however, this effect was transient and disappeared six to eight weeks after application. Crop stand was unaffected by the NC 8438 treatment.

NC 8438 effectively controlled susceptible weeds in sugar beets grown under rainfall or irrigated conditions. Under furrow irrigation, best results were obtained when NC 8438 was incorporated one to two inches deep in the soil. Power incorporation gave most

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consistent results followed by the rolling cultivator. Sub-surface layering showed some promise. Under sprinkler irrigation or rainfall conditions, preemergence surface-applied treatments proved most effective.

NC 8438 applied in combination with pryazon or TCA controlled a wider spectrum of weeds in some geographic regions, compared to NC 8438 alone.

Up to 10 weeks residual control of susceptible weeds were obtained with NC 8438.

In research trials, the postemergence mixture of NC 8438 + desmedipham applied at 1.5 + 0.75 lb/A, effectively controlled a wide spectrum of weed species. Best results were obtained in Michigan and Ohio under rainfall conditions.

In grass seed crops, research trials have shown NC 8438 applied preemergence or postemergence at rates of 1.0 to 2.0 lb/A to be effective in controlling annual bluegrass and rattail fescue. Tolerant crops include ryegrass and established stands of Kentucky bluegrass.

RESPONSE OF SUGARBEETS AND WEEDS TO MBR 12325

E. E. Schweizer[1]

Abstract. Greenhouse and field studies were conducted to determine the response of sugarbeets (Beta vulgaris L. 'Mono-Hy A1') and weeds to postemergence applications of MBR 12325 [N-[5-[(1,1,1-trifluoromethyl-sulfonyl)amino]-2,4-dimethylphenyl]acetamide]. In greenhouse studies grass species---barnyardgrass [Echinochloa crus-galli (L.) Beauv.], wild oats (Avena fatua L.), and yellow foxtail [Setaria glauca (L.) Beauv.]---were sprayed when they had five true leaves. Broadleaf species---common lambsquarters (Chenopodium album L.), redroot pigweed (Amaranthus retroflexus L.), and wild mustard [Brassica kaber (DC.) L.C. Wheeler var.]---were sprayed when they had ten, six, and four true leaves, respectively. The herbicide was applied in an aqueous mixture at 374 l/ha as a topical spray at rates of 0.035, 0.070, 0.140, 0.280, 0.560, and 1.12 kg/ha. The height of each weed species was measured weekly and dry weights determined 4 to 5 weeks after treatment.

In field studies, MBR 12325 was applied in an aqueous mixture at 280 l/ha as a topical spray at rates of 0.33, 0.66, and 0.99 kg/ha to sugarbeets that had four, eight, or twelve true leaves. We determined the response of sugarbeets to the herbicide by visually assessing the vigor of the plants and by harvesting the roots in October.

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[1]Western Region, Agr. Res. Serv., U.S. Dep. of Agr. Fort Collins, Colorado 80523

Greenhouse study. The height and growth of the broadleaf weeds were reduced more by MBR 12325 than were the grassy species. At the 0.99 kg/ha rate, the height of common lambsquarters, redroot pigweed, and wild mustard was reduced 73, 77, and 84% respectively; the comparative values for barnyardgrass, yellow foxtail, and wild oats were 37, 37, and 43% respectively. The average reduction in the dry weight of the three broadleaf weeds was 83% as compared to 44% for the three grassy weeds.

Field study. Sugarbeets were more tolerant to MBR 12325 when they were treated at the four- and twelve-leaf stages of growth than at the eight-leaf stage. At the eight-leaf stage, the suppression of foliar growth was proportional to the rate of herbicide applied, and it was still evident 7 weeks after application. This suppression was reflected in a significant reduction in the yield of roots and sucrose. In general, the sucrose content of the roots decreased as the herbicide rate increased when sugarbeets were treated at the four- and eight-leaf stages.

EXPERIMENTAL HERBICIDE MBR 12325 PLANT GROWTH REGULATOR

G. D. Massey[1]

Abstract. MBR 12325 (N- [2,4-dimethyl-5-[[trifluoromethyl) sulfonyl] amino] phenyl]-acetamide) shows promise as a post emergence herbicide for possible use on beans, sugar beets, safflower and other crops. Most weeds are affected to a degree with the compound; however, highly susceptible weeds include sunflower, johnsongrass (seedling and rhizomes) hemp sesbania, cocklebur, morning glory, several mustard species, annual sow thistle, cheese weed, wild oats, giant foxtail, volunteer sorghum, and a number of seedling grasses.

Growth regulator activity includes grass retardation and seed-head suppression, tree and ornamental growth retardation, sugar content enhancement, and yield increases in certain crops.

It is formulated as a salt solution containing 4 lb. of compound per gallon.

Present toxicological information indicate that the chemical has a rating of "slightly toxic" with an LD_{50} of 4000 mg./kg.

[1]3M Company, Fresno, California

THIN LAYERING OF HERBICIDES FOR FIELD BINDWEED CONTROL IN ESTABLISHED ORCHARDS AND VINEYARDS

E. J. Roncoroni, C. L. Elmore and A. H. Lange[1]

The spray blade technique, also referred to as subsurface layering, has shown promise for the control of field bindweed (Lange et al. 1972). This technique involves passing a blade 4 to 6 inches below the soil surface and injecting a layer of herbicide from nozzles mounted under and towards the back of the blade. This layer of herbicide inhibits shoots of the field bindweed from passing through from below. Season long control has been obtained if this layer is not disrupted. Cracking of the soil or a disturbance of the layer by tillage will allow field bindweed to emerge through the cracks or distrubed area. When application is made in the spring in California annual weeds and field bindweed seedlings growing above this herbicide layer are controlled if this area is allowed to dry between irrigations. A shallow cultivation will also control annual weeds. But care must be used to avoid disrupting the continuity of the herbicide layer.

In established orchards and vineyards the blade technique can be used between rows but not in the row. As a pre-plant treatment this method works exceptionally well but roots of the young trees or vines must be planted below the herbicide layer.

A layering method was then developed for use in established trees and vines by using a French plow (Lange et al., 1972). This technique

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[1]Staff Research Associate, Botany Department, Extension Weed Scientists, University of California, Davis, Parlier.

involved moving the soil away from the tree or vine, the herbicide is then applied and the soil was mechanically moved back onto the herbicide treated area forming a layer.

A new layering technique referred to as thin layering is accomplished without moving the soil around the established tree or vine as is done with the French plow method.

Herbicide is sprayed on the undisturbed area down the tree or vine row and a one-half to one inch layer of soil from outside the treated area is placed over the herbicide. A rotary ditcher (FMC Side-winder[R] ditcher or Reddick[R] ditcher) with minor modifications is used for applying this thin layer of soil. The ditcher has been used for several years by growers principally for constructing drainage ditches. The power to operate the ditcher is obtained from the tractor's power takeoff. Soil is removed by means of a propeller that digs the ditch and the soil is scattered over an area up to 20 feet in width. The area was restricted from 20 feet to 4 feet by adding a metal shield to obtain the desired one-half to one inch of soil that uniformly covered the herbicide. The second minor modification was to add metal strips in front of the propeller to help gather surface soil. This minimizes the ditch required for soil to cover the herbicide layer.

Field trials in orchards and vineyards have shown that this method of layering controlled field bindweed and most annual weeds (Tables 1 and 2).

A field trial was established to compare three methods of herbicide application for the control of field bindweed. Trifluralin and dichlobenil were incorporated with a tractor mounted power tiller to a depth of 3-1/2 inches. The second method of application was with a subsurface spray blade operated at a depth of 4 inches and method three was the thin layer technique.

Gallon container stock of Buxus sempervirens (Japanese Boxwood) was used as an indicator plant for herbicide injury. In the incorporated and subsurface layered plots plants were planted after the herbicide application. The base of the container root ball was planted to the depth of incorporation of the herbicide, 3-1/2 to 4 inches deep. In the thin layer plot area the plants were allowed to become established and then the herbicide layer was applied.

Established and seedling field bindweed control was visually evaluated 2 and 6 months after the herbicide applications (Tables 3, 4 and 5). Buxus sempervirens was evaluated for vigor 6 months after planting.

When trifluralin and dichlobenil were applied using the blade method 92 to 98 percent control of field bindweed was achieved. Except with trifluralin at the 1lb/A rate, field bindweed control was 85 percent or greater using the thin layering method. When the herbicides were power tiller incorporated, field bindweed control was less than 75 percent, except with dichlobenil at the 6 lb/A rate, which gave 92 percent control. Seedling field bindweed was controlled in the thin layer and power tiller incorporated plots whereas seedling field bindweed was growing in the 4 inch untreated area above the subsurface herbicide layer.

Dichlobenil injury occurred with the thin layering method. Less injury was observed with the other two methods.

This thin layering method should help supplement the spray blade and power tiller incorporated technique for the control of field bindweed and other annuals in orchards and vineyards because of the ability to control weeds in the planted row.

Literature Cited

Lange, A. H.; H. Agamalian; D. R. Donaldson; C. L. Elmore; W. D. Hamilton; O. A. Leonard and H. M. Kempen, 1972. Bindweed Control in Vineyards, A Progress Report. MA-41 University of California Agri. Ext.

Table 1. Thin layering in 3 herbicides for weed control in prunes

		Weed Control*			
		Annual Weed		Field Bindweed	
Herbicide	Lb/A	2 mo	5 mo	2 mo	5 mo
Trifluralin	2	6.5	6.8	5.5	3.5
Trifluralin	4	8.5	8.2	9.0	6.8
Dichlobenil	3	9.5	7.5	8.5	6.5
	6	9.6	9.0	9.4	6.6
Napropamide	4	6.5	6.5	5.5	4.8
Napropamide	8	8.0	9.0	3.8	2.8
Control	-	0.0	0.5	2.0	5.8

*Weed control ratings: 0 = no control, 10 = 100% control. Average of 4 replications.

Table 2. Field bindweed control in grapes using the thin layering technique

Herbicide	Lb/A	3 mo control*
Trifluralin	2	7.9
Trifluralin	4	9.0
Dichlobenil	4	7.6
Dichlobenil	8	8.6
Napropamide	4	8.0
Napropamide	8	7.6
Control	-	6.2

*Weed control rating: 0 = no control, 10 = 100% control, average of 4 replications.

Table 3. Evaluation of three methods of herbicide application for field bindweed control

Herbicide	Lb/A	Field bindweed control after 2 months*		
		Incorporated**	Blade†	Ditcher††
Trifluralin	1	4.2	9.9	9.5
	2	4.2	9.8	9.8
	4	6.2	9.9	9.9
Dichlobenil	4	6.5	10.0	9.9
	6	7.5	9.8	10.0
Control	-	2.3	2.3	3.0

Table 4. Evaluation of three methods of herbicide application for field bindweed control

Herbicide	Lb/A	Field bindweed control after 6 months*		
		Incorporated**	Blade†	Ditcher††
Trifluralin	1	5.2	9.2	4.8
	2	5.2	9.8	8.9
	4	7.2	9.5	8.5
Dichlobenil	4	7.2	9.5	9.5
	6	9.2	9.5	10.0
Control	-	0.5	0.5	0.8

Table 5. Evaluation of three methods of herbicide application for seedling field bindweed control

Herbicide	Lb/a	Seedling field bindweed control after 6 months*		
		Incorporated**	Blade†	Ditcher††
Trifluralin	1	8.0	2.5	10.0
	2	8.8	4.0	10.0
	4	8.5	5.2	10.0
Dichlobenil	4	10.0	5.8	10.0
	6	10.0	5.2	10.0
Control	-	5.5	3.0	6.8

Table 6. Effect of trifluralin and dichlobenil on Buxus sempervirens (Boxwood) using 3 application methods

Herbicide	Lb/A	Herbicide phytotoxicity after 6 months***		
		Incorporated**	Blade†	Ditcher††
Trifluralin	1	1.2	0.8	1.8
	2	1.8	1.0	1.3
	4	1.8	1.2	1.3
Dichlobenil	4	2.2	1.0	3.3
	6	1.8	1.2	5.0
Control	-	1.0	0.5	1.0

*Weed control ratings 0 = 100% control average of 4 replications.
**Herbicide incorporated with a tractor mounted incorporator.
†Sursurface layering method.
††Thin layering method using a ditcher.
***Vigor ratings: 0 = no injury; 3 = marginal leaf chlorosis; 5 = leaf chlorosis, marginal and leaf tip necrosis; 10 = dead average of 4 replications.

NAPROPAMIDE AND ORYZALIN, TWO NEW SELECTIVE HERBICIDES FOR WEED CONTROL IN YOUNG ORCHARDS AND VINEYARDS

A. Lange, C. Elmore, B. Fischer, H. Kempen and E. Stevenson[1]

Introduction

Annual weed competion in young orchards and vineyards can often reduce the first years growth as much as 50%. In fields with extremely heavy weed populations and limited irrigation, trees and vines have been killed from competition with weeds in the first year. Competition from perennial weeds is even more detrimental than annual weeds to newly planted trees and vines. Even though a persistent tillage program can give a practical control of perennial grasses, many growers still have serious problems with perennial weeds.

Preplant incorporation of trifluralin has effectively controlled many grass and broadleaf weeds, but the required preplant incorporation does not lend itself well to orchard and vineyards and cannot be properly done in wet soils early in the spring. Occasionally, temporary stunting has occurred when high rates of trifluralin treated soil was used to back fill around the roots of newly planted vines.

Several contact herbicides can be used to control emerged weeds during the growing season. A drawback to contact herbicides is that

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several timely treatments are needed and the young trees or vines are sometimes injured because of the difficulty of preventing the herbicide from hitting the foliage or bark.

The most practical weed control program is to use residual herbicides immediately after planting the trees or vines. Residual herbicides may be applied in a 4 to 6 foot strip down the rows before the weed seeds germinate. Established weeds are controlled by adding a contact herbicide. It is generally considered more practical to control the weeds down the center with tillage.

Before napropamide and oryzalin were registered, very few pre-emergency herbicides were available for newly planted non-bearing trees and vines. Both of these herbicides have been widely tested throughout California's fruit growing areas and offer excellent selective control of most germinating annual and perennial weeds in young trees and vines.

Naturally weed control with either napropamide or oryzalin can be unsatisfactory. Failures have usually been associated with 1) resistant weed species, or 2) herbicide loss from an excessive delay between herbicide application and rainfall or irrigation or 3) treating moist soil and not following with enough water before weeds have germinated. In the absence of rainfall, irrigation water must be applied soon after application or these herbicides must be mechanically incorporated in order to kill germinating weed seeds. In a Hanford sandy loam an initial 1/4 inch of sprinkler irrigation has been the minimum amount for adequate incorporation of these herbicides.

Both herbicides are selective and will not control certain weeds. Combinations of herbicides usually give better weed control. Combinations of napropamide or oryzalin with simazine at low rates have produced good season-long weed control with little or no foliage symptoms. Repeated annual applications for 4 years in one test and longer in others have caused no problems. In some tests control of perennial bindweed has been obtained. Occasionally, on sandy soils low in organic matter, some symptoms have resulted from moderate to low rates of simazine, especially under sprinkler irrigation. However, the simazine label does not recommend usage on soils having less than 1% organic matter. No injury has been observed from soil surface applied high rates of napropamide when applied alone on a large variety of young trees tested, even on light soils low in organic matter either under sprinkler or flood irrigation. Very high rates of oryzalin (16 lb/A) have caused some stunting on newly planted vines in sandy soils, whereas stunting has not resulted from normal 2 to 4 lb/A rates.

Conclusion

Napropamide and oryzalin, two new herbicides for orchards and vineyards, have given good weed control without injury to nonbearing newly planted trees. They have given no adverse effects even at very high rates. Like all selective herbicides they do not control all weeds, however, they control a broad spectrum of weeds, being particularly effective on grasses and some families of broadleaf weeds. In field tests effectiveness has been greatly improved when used in combination with an herbicide which controls tolerant species.

Table 1. A comparison of napropamide and oryzalin applied for annual grasses and broadleaf species in stonefruit tree species

Herbicides	Lb/A	Average* weed control: Lovegrass	Barnyardgrass	Pigweed	Misc. broadleaf weeds
Napropamide	2	7.5	9.5	4.0	6.5
Napropamide	8	9.5	10.0	5.0	8.0
Oryzalin	2	8.5	10.0	10.0	7.5
Oryzalin	8	9.5	10.0	10.0	9.0
Untreated	-	2.2	1.0	8.0	1.0

*Average of 2 replications. Based on 0 to 10 scale where 0 = no effect and 10 = complete contact. Sprinkler then flood irrigated (basin flood). Treated 4/10/72. Evaluated 5/26/72.

Table 2. A comparison of preemergence herbicides for weed control and phytotoxicity to newly planted grape rootings and unrooted cuttings

Herbicides	Lb/A	Weed control*		Phytotoxicity*		
		Grass	Yellow Nutsedge	Grape Rooting	Grape Cutting	Grape Vigor
Simazine + napropamide	1/2+4	9.0	1.0	2.0	4.0	7.6
Oryzalin	4	9.6	0.0	0.3	0.6	5.6
Oryzalin	16	10.0	2.0	5.3	5.3	6.3
Untreated	-	0.0	2.6	2.0**	6.6**	1.6**

*Average of 3 replications. Based on 0 to 10 scale where 0 = no effect and 10 = complete kill. Treated 3/7/74. Evaluated 5/20/74. Overall grape vigor evaluated 9/12/74.

**Severe stunting from weed competition.

Table 3. The effect of 3 years of herbicide combinations on annual weed control in an almond orchard

Herbicides	Lb/A	Average* W/C	Average* Phyto.
Simazine + Napropamide	1+4	9.3	0.0
Simazine + Napropamide	2+8	8.3	0.0
Oxadiazon + Oryzalin	4+4	8.3	0.0
Simazine + Oryzalin	2+4	7.6	0.0
Untreated	–	2.6	0.0

*Average of 3 replications. Based on 0 to 10 scale where 0 = no effect and 10 = complete control. Last treatment 12/20/73. Evaluated 9/13/74.

Table 4. The effect of applying combinations of herbicides on the control of winter annual weeds in a young plum orchard

		Average* Weed Control					
Herbicides	Lb/A	Chick-weed	Shepherds purse	Scarlet pimpernel	Red Maids	Filaree	Fiddle-neck
Simazine Oryzalin	1-1/2 2	10.0	10.0	9.2	10.0	6.5	10.0
Simazine Oryzalin	1-1/2 4	10.0	10.0	9.8	10.0	9.5	10.0
Simazine Napropamide	1-1/2 4	10.0	10.0	10.0	10.0	10.0	10.0
Simazine Napropamide	1-1/2 8	10.0	10.0	10.0	10.0	10.0	10.0
Untreated	–	0.0	0.0	0.0	0.0	0.0	0.0

*Average of 4 replications. Based on 0 to 10 scale where 0 = no effect and 10 = complete control or kill. here was no phytotoxicity from any treatment. Treated 11/20/74. Evaluated 3/1/75.

Table 5. A comparison of the effect of herbicides on trunk diameter after one season's growth of young newly planted orchard trees on a flood irrigated Hanford sandy loam

Herbicides	Lb/A	Percent of untreated*					
		Peach	Almond	Cherry	Apple	Pear	Ave
Simazine	2	187	157	84	89	113	110
Napropamide	2	129	124	48**	105	109	103
Napropamide	8	132	124	88	147	122	123
Oryzalin	2	174	105	116	95	122	122
Oryzalin	8	177	149	116	105	109	131
Untreated	-	100	100	100	100	100	100

*Diameter measured 10 inches above the soil line; average of 4 replications.

**Represents a loss of growth because of weed competition and competition with the other tree species.

Table 6. Weed control with repeated annual herbicide applications in young vineyards

Herbicides	Lb/A	Average* weed control					
		3/22/72	3/8/73	9/6/74		6/3/75	
		Annuals	Annuals	Grass	Broad Leaf	Annuals	Bind-weed
Simazine + Napropamide	2+4	8.4	9.1	9.5	6.0	9.9	0.0
Simazine + Napropamide	4+8	7.9	9.9	9.8	6.2	9.9	0.8
Simazine + Oryzalin	2+2	8.9	8.8	4.8	6.2	9.6	7.2
Simzaine + Oryzalin	2+4	8.6	9.1	8.8	6.8	8.7	7.0
Simazine + Oryzalin	4+8	8.8	9.5	10.0	8.5	9.9	9.9
Untreated	-	0.0	4.8	1.0	0.5	0.8	0.5

*Average of 4 replications. Treatment dates 2/18/72, 12/26/72, 4/9/74, and 1/22/75. Based on 0 to 10 scale where 0 = no effect and 10 = complete control.

ENVIRONMENTAL CONCERNS AND MULTIPLE USE OF

TRANSMISSION RIGHTS-OF-WAY

Fred H. Gross[1]

Environment .. Ecology .. Aesthetics .. Eco-systems .. Beautification .. Impact.

These words have been jammed down our throats by environmentalists and pseudo-environmentalists many times in the past few years. These words and many others have become a concern of the public. Although maybe reluctantly at first, this concern has been accepted by the Public Utilities, and Right-of-Way Maintenance programs have been developed which take these concerns into consideration.

Because we have become aware of the impact that our electrical transmission systems have on the surrounding environment, we either have or are presently revising our right-of-way maintenance programs to take into consideration these new "concerns", which could even be called restrictions. As a result, utility rights-of-way today have less adverse impact on the surrounding community than they did several years ago. A major change in policy has taken place. Programs now involve "preservation" rather than "destruction" of natural resources.

I would like to give you a brief history of Bonneville Power Administration's right-of-way maintenance program from the period before herbicides through an era of broad scale aerial application of

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herbicides to the present time, as we embark on a selective right-of-way management program with emphasis on compatible utilization of the right-of-way.

From a meager beginning 35 years ago with a 36 mile line occupying 500 acres of right-of-way, Bonneville has grown to its present size of 12,500 miles, occupying 200,000 acres of right-of-way in the states of Oregon, Washington, Idaho, Western Montana, and a small part of Wyoming. About 86,000 acres require vegetation management each year; 3000 miles have danger trees on each side of the right-of-way. Most of our rights-of-way are by easement and involve 30,000 different landowners. In addition to the rights-of-way themselves, we must maintain approximately 6000 miles of access roads.

The West Coast is blessed with some of the most prolific growing areas in the country. Abundant moisture and long growing seasons produce rapid growth rates. Past clearing practices permitted uncontrolled machine clearing which resulted in baring the ground, providing an ideal seed bed for fast growing weed species such as red alder, willow, and bigleaf maple. Access to transmission lines became next to impossible in a few years. Before herbicides, force account crews could not keep the rights-of-way clean. Therefore, contracts were let for cutting and disposal. In 1950 the price was $300-$500 an acre and the contractors were going broke. They couldn't cut it as fast as the cut stumps would resprout. A young alder would grow only 10-12 feet the first five years, but would be 40-50 feet high at the end of the next five.

Fortunately, herbicides became practical tools just as the battle appeared to be lost. Art Wetsch, my predecessor, did much to develop the use of herbicides for right-of-way maintenance programs. The phenoxy herbicides, 2,4-D, and 2,4,5-T were found to be very effective on broadleaf woody species. Working in cooperation with herbicide manufacturers and universities and colleges, effective programs were developed to economically remove alder and willow and other broadleaved woody species which were the problem at the time.

Herbicide application was either by high pressure ground hoses or by air-blast machines such as the roto-mist. Aerial sprays were tried but this was before thickeners, special spray booms, and other drift-reducing techniques were available. After attempting to spray our right-of-way by air and actually getting a god job done (by drift) on parallel lines owned by someone else, we gave up. The resulting browning of the countryside caused by broadcast application of herbicides was not objectionable--then! The dead stems disintegrated in a couple years and the result was a "clean and green" right-of-way.

This look did not last for too long. We soon found that other species such as conifers were taking over where the alder had been. These species do not present a real threat at first because they are slower growing than the broadleaf species. When they did become tall enough to need control, the only effective herbicide was TCA.

The only effective application method for TCA is by ground spray equipment. Control was excellent--but unacceptable from an aesthetic standpoint. In 1963 a new herbicide, "Tordon 101" was introduced by the Dow Chemical Company which was effective on both coniferous species and most broad leaved species. Aerial application techniques were developed using special booms and thickeners which permitted effective helicopter application of "Tordon 101."

Thus, conifer control by air was possible at a reasonable cost and without the danger of unacceptable spray drift. Unsightly browning was not as severe as that caused by TCA or 2,4-D and usually ground cover species recovered by the end of the first growing season or by the next spring. With this new herbicide (and there have been other new effective chemicals introduced since Tordon) it appeared as though all right-of-way maintenance problems had been licked.

Then came the National Environmental Policy Act of 1970. At first many of us were apprehensive and afraid that the restrictions imposed by the Act would limit operations and cause right-of-way maintenance costs to skyrocket. However, after the provisions of the Act had been thoroughly reviewed and directives were issued, it was soon realized that right-of-way maintenance programs could be developed which would meet the requirements of the Act and still be compatible with the operation of transmission line systems. BPA has twin objectives which are to:

1. provide an adequate and reliable power supply, and
2. protect the environment.

In the past not too much emphasis was placed on protecting the environment. However, with this new directive as a motivating force, our right-of-way maintenance policy was revised, placing emphasis on:

1. a more judicious use of herbicides--that is, consider alternative methods before programming herbicides alone,

2. development of mutually beneficial use of the right-of-way by the landowner such as agriculture, orchards, Christmas tree farms, and parks where responsibility for vegetation control is given to the landowner,

3. a danger tree policy which permits tall stable trees to remain off the right-of-way provided that meet certain criteria.

Now let us discuss each of these objectives in more detail. As I have mentioned earlier, the aerial application of herbicide was the main method of vegetation control employed by BPA. Approximately 80% of our annual program of 10,000-15,000 acres was by helicopter, resulting in the blanket application of herbicide to all vegetation on the right-of-way, whether or not it would ever be a hazard to the operation of the transmission line. This policy resulted in unnecessary destruction of a natural resource. Today our program is just reversed, with aerial control only 10 to 15% of the total. Ground control methods permit the selective control of vegetation with application of the herbicide to target vegetation only.

Vegetation becomes a hazard to the operation of a transmission line when it grows tall enough to cause a flashover from the conductor or becomes so dense as to impede maintenance operations. Many different species occupy rights-of-way. Each grows at a different rate and matures at a different height. They do not all become a hazard to the operation of the line at the same time and therefore do not require control at the same time.

We have found the following ground control methods to be effective:

1. Foliar application of herbicides with high pressure ground spray equipment, backpack sprayers, and airblast machines such as the roto-mist.

2. Basal spraying the stems of the vegetation with a coarse spray of oil and herbicide mixture.

3. Girdling with a small hatchet around the entire circumference of the stem to form a cup and filling the cup with herbicide.

4. Hand application of soil-active pelletized or granular herbicides.

5. Hand cutting which requires stump treatment of resprouting species and disposal of the slash.

All of these methods are very selective. Foliar sprays require very careful application techniques to prevent drift and overspray. Rain is required to activate pellets and granules. Care must be exercised so as not to place them where they will wash or be carried away from the zone being treated. The basal and girdling methods of applying herbicides are the most selective. We have had very good results with contracting for basal application and hand cutting. The main advantage of the basal method is that most species are susceptible throughout the year. Thus, application can be made in the winter months, preventing a brownout of the foliage.

The sensitivity of the area where the work is to be done will determine which method of control will be used. Cutting, of course, is the most selective and depending on the disposal requirements creates the least adverse impact on the environment. Disposal can really have an impact on the cost of a cutting operation. The least expensive is to cut and either leave slash lay or lop off the limbs and scatter. Next least expensive is to cut and burn the debris. Then there is chipping and scattering the chips on or off the right-of-way.

We have looked at the approved methods for a selective right-of-way maintenance program. How are these methods applied in the field? As stated before, a selective right-of-way maintenance program controls only that vegetation which will be a hazard to the operation of the line. Vegetation is a hazard only if it will come closer than 10 feet to the conductor (at maximum sag conditions) for voltages through 115 kV and 18 feet for 345 kV and 500 kV lines. Those sections of rights-of-way which are close to violating this condition are programmed for control first.

All vegetation which will violate the conductor clearances stated above during the next 15 years is designated for control. Fifteen years may seem like a long cycle to establish before re-treating is necessary. However, exact growth rates are not known at this time and they vary considerably for the same species, depending on location. We hope to establish more accurate data as we get more experience. Conductor clearances are not always easy to measure. Therefore, safety factors and cushions are included in the 15 year growth period. Because many of our rights-of-way are already infested with tall, fast growing weed species, we will be satisfied to establish a 5 year cycle. Should we find through operating experience that 15 years is unrealistic, necessary adjustments will be made.

It is easily seen that by controlling only that vegetation which, when mature, comes within established distances from the conductor, control will not be necessary in deep canyons and ravines. In adopting this policy, the decision must be made to accept the liability associated with delays in restoring service should trouble occur and conductors drop into the uncleared areas. Design features such as stronger structures, conductor and insulator assemblies with higher than normal factors of safety may be built into the structures on each side of canyons, thereby lessening the chance of an extended outage.

In the Pacific Northwest where the lines cross many mountain ranges, merchantable timber can be allowed to grow in those canyons with 125' to 150' conductor to ground clearance.

The ultimate goal of a good right-of-way management program is to convert all rights-of-way to uses which are compatible with the operation of the transmission line. Up until recently we have had very definite ideas as to what constituted a compatible use of a transmission line right-of-way, and the uses were very limited. When only the gutter of a building encroached on the right-of-way the owner was forced to move the building or tear it down at his expense. Aerial patrols frequently found trailers moved on the right-of-way in a backwoods location. Sometimes such encroachments constitute a severe hazard to the owner. Realizing that some inequities exist in what other uses we permit on the right-of-way, our Branches of Land, Transmission Design, and Maintenance, along with the field personnel who are responsible for controlling the rights-of-way are reviewing this problem and hope to establish better rules that offer guidance and allow enforcement of established policy.

Activities which lend themselves to possible right-of-way use are:

1. Recreation -- Parks, trails, playing fields, and other activities involving pedestrians.
2. Forestry and Range -- Grazing, sawmills, and lumber yards.
3. Industrial -- Gravel pits, land fills, parking lots.
4. Residential -- Gardens, yards, small buildings.
5. Agricultural -- Pasture, grain and seed crops, orchards.
6. Miscellaneous -- Utilities underground and above ground, streets, storage.

Lastly, I would like to explain our recently adopted danger tree policy. Danger trees are those trees located off the right-of-way which are hazardous to the transmission line. Until a couple of years ago a danger tree was defined as <u>any tree</u>, stable or unstable, which would fall within a certain distance from the outside conductor.

During the initial clearing of the right-of-way, the danger tree zone is cleared to this standard criteria. In heavily timbered areas it is necessary to clear 200 to 300 foot swaths to provide safety for a line located on a 125' right-of-way. Easement rights permit the removal of these danger trees only once. During the ensuing years trees again begin to grow in the danger tree zones; 20 to 25 years later a stand of timber has grown up adjacent to the right-of-way. Until recently our maintenance danger tree policy was the same as for new construction, the falling tree criteria. As we began to budget and program for the removal of this second crop of danger trees, we soon found that we would be baring the countryside by removing the trees in accordance with the present policy. Groves of trees located in farmers' backyards would have been scheduled to be cut.

We began to search for an alternate approach to this problem. We work very closely with the U.S. Forest Service. Since they are forest managers, we explained our situation to them and asked for suggestions. They have studied a very similar problem which exists in their recreation areas. Trees are a very important feature of many forest parks. To prevent accidents, hazardous trees which could easily be blown over must be removed. Through research, the Forest Service developed techniques allowing them to identify hazardous and unhealthy trees. It was also learned that healthy trees exposed to the elements for a number of years soon become stable. Based on these studies, a new danger tree policy was established. This policy is described as follows:

1. Remove or trim only those trees which are within the minimum safe working distance of the conductor when it is displaced to its maximum swing distance. The minimum safe working distance will vary depending on the line voltage.

2. Remove <u>ALL</u> hazardous trees that are leaning, burned, damaged, diseased, or weakened for any reason, which when falling would strike

the outside conductor in a static (no-wind) condition. This takes into account the conductor sag, and makes an uneven right-of-way edge.

3. Remove all trees exposed by the removal of other trees which appear to be unstable and need support. Upon removal of overstory trees for any reason, understory trees may not be stable because they have been protected by the surrounding trees. Therefore, to allow them time to become stable, cut those trees which, if in falling any time during the next 4 years, would fall within the minimum safe working distance of a conductor while in the static condition.

Bonneville has developed a computer program which is used in conjunction with aerial photos to locate possible danger trees. Aerial photographs flown to a scale of 1" = 1000 feet are used. The program was originally developed to work in conjunction with the "Kelsh" Plotter, however, more sophisticated equipment with greater versatility is now being investigated.

A computer listing of danger tree locations by station is given to the field. Line Maintenance personnel then make a determination from actual field checking as to which of the listed trees must be removed. Depending upon how many trees are involved procurement of rights to cut the tree may be done by the field people for scattered trees or by our Branch of Land when a large number are involved.

Tremendous cost savings have been realized by adopting this new danger tree approach. Only a couple years of operating experience are available at this time. Should we find that the number of line outages caused by falling danger trees is not acceptable we will modify the program. It is worth pointing out at this time that the main problem from danger trees or any tree growing alongside the line is man-caused. The guy with the chainsaw in his hands, the logger, the farmer, falls many more trees into the line than any other cause. Even though our experience is rather limited, so far we are encouraged by our operating records.

One last item I would like to touch on is a right-of-way inventory program which we are about to initiate. In the days of broadcast or "clean-and-green" maintenance, it was not necessary to know every detail about our rights-of-way. Schedules were developed based on the results of previous treatment programs and misses and skips were spot-treated. Everything was treated whether it needed it or not. Today as we convert to a selective right-of-way maintenance program, it is necessary to know exactly what occupies the rights-of-way, how fast it grows, where it is located, factors affecting growth, what was the previous method of control, and treatment records.

This information is not readily available on any records now being kept. Therefore, we plan to take an inventory of all of our rights-of-way which will give us all of the details necessary for an effective selective right-of-way management program and many other benefits. Data to be inventoried are:

1. ownership
2. soil types
3. precipitation
4. growing season
5. aspect

6. slope
7. land classification
8. dominant species and secondary species
9. density
10. agricultural use
11. location of critical areas
12. identification of the height of brush at time of inventory
13. growth rate
14. conductor height above the ground
15. right-of-way restrictions
16. record of previous herbicide applications
17. recommended future treatment

You can see this is a rather ambitious program and we realize it will not be possible to obtain all of this information at one time. Also, the user will have the option of accumulating only those items which he deems necessary to properly carry out his program. Existing office records plus photomaps of each right-of-way will be used as data sources for the inventory.

Automatic Data Processing will be used for storage and printout of required data. In addition, copies of the photomaps used for the inventory will be given to the user. Permanent features will be marked on these maps.

You are probably wondering what kind of staffing is required to implement such an ambitious program. We realized when we first embarked on a selective right-of-way maintenance program that additional staffing would be necessary. Our right-of-way maintenance work is carried out by our line crews. The program and scheduling is the responsibility of the Transmission Maintenance Superintendent's office. Therefore, we have added a Right-of-Way Maintenance Specialist to the Superintendent's staff. His responsibility will be to plan and program right-of-way maintenance activities. In those districts where there are large brush programs a Right-of Way Maintenance Foreman has been added to the line crew. With these additional positions and with the help of temporaries, and contracts, we feel we can accomplish the program described to you. A Right-of-Way Management Specialist has been added at the Branch of Maintenance level, which is responsible for policy and standards.

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