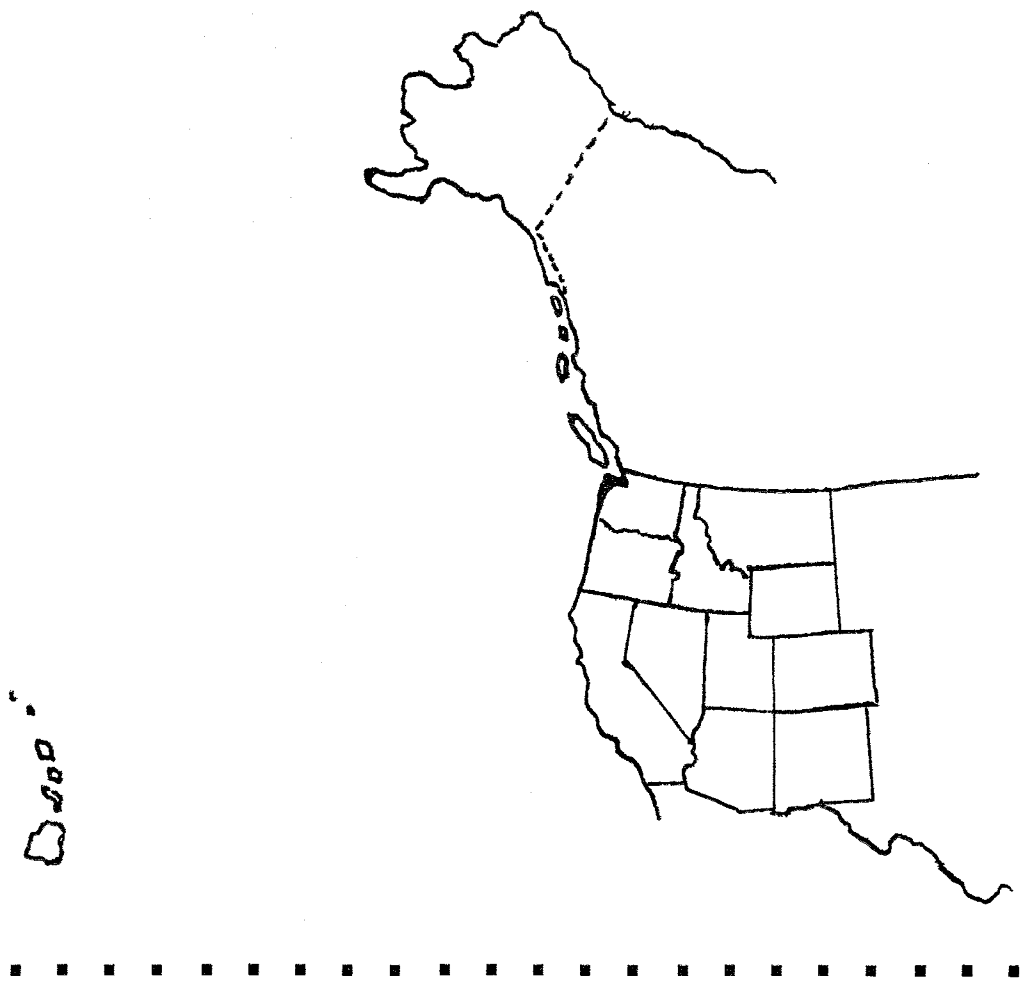
Proceedings

1965 WESTERN WEED CONTROL CONFERENCE



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Western Weed Control Conference

Hilton Hotel—Albuquerque, New Mexico
March 17, 18, 19, 1965

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Thursday Afternoon, March 18, 1965

GENERAL SESSION
Chairman: Louis A. Jensen

Friday Morning, March 19, 1965

GENERAL SESSION
Chairman: David E. Bayer

*No Paper

A LOOK AT THE WESTERN WEED CONTROL CONFERENCE AFTER 27 YEARS

J. M. Hodgson[1]

Members of the Western Weed Control Conference and visitors, it is my privilege to welcome you to the 20th assembly of this conference. We, the Officers, very much appreciate your presence and your response having provided the program material that has been assembled. We hope that your attendance will improve your work in weed control.

We extend our appreciation and thanks to the program committee, especially the work of Dr. E. E. "Gene" Hughes who arranged for the facilities and by his dilligence made my job much easier. I am also grateful to the other officers and those who have helped with registration. Several things in regard to the operation of the conference have come to my attention during the past two years. Some of these I shall discuss that you may take some action on these matters in the business meeting if you wish.

At the Denver Conference in 1950, the Executive Committee proposed that, ". . . with states conferences meeting annually" the regional conference could well serve its purpose if held biennially. This proposal was not wholeheartedly accepted, the motion was passed. Since that time, except for 1963, we have held biennial conferences. In 1963 we held a conference to change the schedule so that our conference would alternate years with the Weed Society of America (WSA).

In November of 1950, Dr. F. L. Timmons, Chairman of the Research Committee, acting on the suggestion of some of the researchers who had opposed a biennial conference, polled all research workers in the conference regarding a meeting of research workers in March 1951. This meeting was for the purpose of organizing the research committee and planning the report for the next conference. The 43 members who replied were unanimously in favor, and the meeting that was held was the beginning of the Research Committee Meetings conducted in years when the conference did not meet. At first this was a closed meeting for research workers only, to report informally on work in progress and discuss research problems. This met with some disapproval among conference members from other phases of weed control, for this reason later meetings were open for their attendance also. As more began to attend, the Research Committee meeting grew rapidly, and developed about the same attendance as a regular conference. This dual kind of operation has sometimes caused confusion as to which officers are responsible for a particular meeting, especially to those outside of the conference area.

At the Research Committee meeting in Salt Lake City in 1964 the question of continuing the Research Meeting in alternate years was discussed. The new policy of the Weed Society of America of meeting annually had recently been established at that time, and it was pointed out that the Research Meeting of the WWCC would occur near the same time as the WSA conference in 1966. There was some discussion of dropping the Research Meeting, however, those in attendance (all phases of the conference) voted to continue it. This action might be questioned since our Constitution defines the Research Committee as "All members actively engaged in research in weed control".

I believe that we should decide whether it is the desire of the majority of the research workers to continue to hold and support a research meeting in alternate years. A considerable number were not present in Salt Lake in 1964, probably because they had recently attended the WSA. A mail survey could be conducted as originally. If the Research Committee Meeting is to be continued, then there is a need for by-laws to guide the operation. Matters of finance, records of business meetings and other items should be settled. The present operation seems to be by traditions passed on to the new officers verbally, and results of elections and other transactions are sometimes forgotten or revised.

I suggest that any group of the conference contemplating a conference wide meeting such as the Research Committee should have the approval of the Executive Committee and that details of such a meeting should be agreed upon by officers at least 6 months before it is held. This should strengthen and provide better support of such a meeting.

At Las Vegas in 1960, the Conference authorized the President to appoint a business manager. There was little definition of the responsibilities of this office, and since that time there has been some question of his duties and those of the other officers. The Business Manager is presently handling distribution and sales of the conference **Proceedings** and the **Research Progress Report;** in this way they can be kept at one location. This was done at my suggestion as President. If this is not the desire of the conference, the necessary changes should be made at the business session. Minutes of the business meeting at Las Vegas state that the conference voted to give the President authority to appoint a business manager.

The constitution and by-laws are quite brief, and some matters are not completely defined. In some cases this makes for simpler operations. On the other hand, there have been times where we have not followed the instructions of the Constitution. For instance, minutes of the conference business meetings are to be published in the **Proceedings** according to by-law Number 2, and because this has not always been done, we don't have a record of the transactions of certain meetings. Such a record is very important to any organization.

These considerations give a limited view of the Western Weed Control Conference and concern the present day operations which I hope can be outlined in our Business session. Our conference provides us the means of co-ordinating research, extension, regulatory and industrial phases of weed control which results in improved weed control practices and more efficient agricultural production. Let us look at some of the records and accomplishments.

The Western Weed Control Conference met first in Denver in 1938. Preparations had been underway for 2 years and much of the groundwork was completed when H. L. Spence of Idaho, Acting Chairman, called the meeting to order on June 16 that year. Reports and informal discussion of weed control problems were the order of business.

An important part of this first meeting was the acceptance of objectives and by-laws for operation of the conference (2).

The following goals were set by that group of weed fighters:

"**Objectives:**

To foster regional organizations and a national organization of weed control agencies to act as regional and national clearing houses in connection with weed problems.

"Purposes:

1. To cooperate with other regions and agencies in the solution of weed problems.
2. To encourage national and state research in weed control.
3. To foster educational work on weeds through all appropriate agencies.
4. To formulate plans for organized weed control programs.
5. To function as a clearing house on weed matters.
6. To assist in the development of uniform weed, seed, and quarantine legislation in the States.
7. To foster adequate national weed, seed and quarantine legislation in the States."

These objectives have changed very little as noted in the present constitution and by-laws. During the past 27 years, many things have been accomplished. In 1944, the North Central Weed Control Conference was formed. Mr. Walter Ball, one of the originators of the Western Weed Control Conference, met by invitation with the group from the North Central States to assist in the organization of

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that conference. The Northeastern Weed Control Conference was organized in 1947 at Ithaca, New York. The Southern Conference was organized in 1948 at Stoneville, Mississippi.

The first National Weed Control Conference, held at Kansas City, Missouri, December, 1953, came about through the cooperative efforts of all four of the regional conferences. This coordination of weed control activities began with the meeting and establishment of the Western Weed Control Conference in 1938.

Some of you have attended most of the conferences of our organization. We are all appreciative of the efforts of those early weed workers, mostly in the regulatory and extension phases, who initiated the conference. It has been a highly successful endeavor in the coordination of the various phases of weed control. Mr. Walter S. Ball has been one of the stalwarts in the initial organization and the continuing work of this conference. He served as Secretary-Treasurer from 1938 until 1954 and was President of the 1956 Conference, Table 1. It was highly appropriate that the 1964 conference at Portland elected him an honorary life memebrship in the WWCC.

Table I. The Western Weed Control Conferences, Officers and total membership 1938-1965.

Conference			Officers			
No.	Date	Plae	Chairman or President	Vice President	Secretary Treasurer	Number Attending
1st	1938, June 16-17	Denver, Colorado	H. L. Spence Jr.	C. L. Corkins	W. S. Ball	24
2nd	1939, June 9-10	Berkeley, California	H. L. Spence Jr.	C. L. Corkins	W. S. Ball	28
3rd	1940, June 21-22	Seattle, Wash.	G. R. Hyslop	J. I. Griner	W. S. Ball	25
4th	1941, June 27, 28	Salt Lake City, Utah	C. L. Corkins	G. G. Schweis	W. S. Ball	87
5th	1942, June 26	Salem, Ore.	W. W. Robbins	E. Hutchings	W. S. Ball	32
6th	1944, June 25, 26	Salt Lake City, Utah	E. Hutchings	C. D. Gaines	W. S. Ball	45
7th	1945, June 6, 7	Boise, Idaho	L. Burge	L. E. Harris	W. S. Ball	83
8th	1946, Feb. 26, 27	Reno, Nevada	B. E. Kuhns	B. J. Thornton	W. S. Ball	162
9th	1947, Feb. 6, 7	Portland, Oregon	H. E. Morris	V. H. Freed	W. S. Ball	183
10th	1948, Feb. 2, 3, 4	Sacramento, Calif.	V .H. Freed	B. J. Thornton	W. S. Ball	401
11th	1949, Feb. 2, 3, 4	Bozeman, Montana	B. J. Thornton	V. A. Cox	W. S. Ball	243
12th	1950, Feb. 1, 2, 3	Denver, Colorado	E. W. Whitman	W. W. Robbins	W. S. Ball	331
13th	1952, Feb. 5, 6, 7	Reno, Nevada	W. W. Robbins	C. I. Seely	W. S. Ball	223
14th	1954, Mar. 22, 23, 24	Tucson, Arizona	C. I. Seely	R. Warren	W. A. Harvey	187
15th	1956, Feb. 15, 16	Sacramento, Calif.	W. S. Ball	W. A. Harvey	W. C. Robocker	478[a]
16th	1958, Mar. 18, 19	Spokane, Washington	H. Wolfe	R. A. Fosse	W. R. Furtick	282
17th	1960, Feb. 22-25	Denver, Colorado	R. A. Fosse	W. R. Furtick	E. E. Heikes	495[b]
18th	1962, Mar. 20-22	Las Vegas, Nevada	W. R. Furtick	E. E. Heikes	E. J. Bowles	252
19th	1963, Feb. 6, 7	Portland, Oregon	E. E. Heikes	J. M. Hodgson	A. Stark	230
20th	1965, Mar. 17-19	Albuquerque, New Mexico	J. M. Hodgson	L. A. Jensen	S. W. Strew	250

[a]Joint meeting with California Weed Control Conference. [b]Joint meeting with Weed Society of America.

The "revolution" in chemical weed control has occurred since the organization of the Western Weed Control Conference (4). The major concern of the 24 men who first met in Denver at the first WWCC was how to control Camelthorn, field bindweed, whitetop, Russian knapweed and other noxious perennials that were rapidly spreading and limiting crop production. This was before 2,4-D or monuron or simazine. Sodium chlorate, borax, and carbon bisulfide and arsenicals were the "promised" chemicals to eliminate perennials and some were used by the "carload", and a carload did not go very far. Cultivation was the only practical control method on many field infestations.

A survey of the conference membership over the years reveals that the "chemical revolution" in weed science has indeed had a major effect on our membership. Conference membership in 1938 was composed mainly of regulatory and extension workers; two researchers were present at that meeting, but there were none from the industrial aspects of weed control, Table 2. Since about 1947 conference membership has included more members from industry than from any other group. Although a larger number of members from the regulatory phase participated in the 1962 conference than in the years just previous to this time, they represented a smaller proportion of the total membership than ever before. The extension phase of the membership also shows a similar pattern over the same years. The number of men in research has shown a gradual increase since the conference began.

Researchers have apparently been spending practically all their time investigating various phases of chemical weed control, (Table 3). The reports pertaining to research work in the conference **Proceedings** and in the **Research Report** were counted for each year that the entire conference met. They were grouped according to the major categories of chemical, cropping, mechanical, and biological weed control as defined by Crafts and Robbins (1), and one additional category of life history and ecology studies. It was necessary to give double credit on some reports where chemical, cultural and cropping methods were studied and reported in one paper, and some arbitrary decisions were necessary in classifying the reports.

There were more reports on chemical control studies than all other methods by a ratio of about 8:1. This presents a picture of the great impact that chemicals have had and are having in weed control. They are providing an invaluable means of control which is often more economical and effective than hand labor and earlier methods. As many of you have observed, the use of chemicals in weed control have increased rapidly.

In 1938 six reports on the use of chemicals all involved the control of noxious perennials.

In 1952 there were 113 reports, only 13 of which concerned control of perennial noxious weeds.

In 1963 there were 121 reports, only 5 of which were on control of noxious perennial weeds.

We have acknowledged that chemicals have become predominant in weed control methods, but what of the other methods of weed control? Is there so little possibility of improving methods of cropping and cultivation

Table 2. Components of membership of the Western Weed Control Conference for certain years.

Year	Number of members from five phases of weed control					Total
	Regulatory[a]	Extension[b]	Research[c]	Industry[d]	Farmer	
1938	13	9	2	0	0	24
1944	24	6	5	9	1	45
1947	46	22	26	81	8	183
1950	62	37	29	197	6	331
1954	38	20	41	83	5	187
1958	68	31	64	89	30	282
1962	46	23	60	122	0	251
1963	25	24	77	103	0	229

a. Regulatory - Those from county weed programs, State Dept. of Agric., Seed Labs, etc.
b. Extension - County Agents, Extension specialists and those from SCS, and the Bureau of Reclamation having similar duties.
c. Research - State Experiment Station and ARS, U.S. Dept. of Agric.
d. Industry - Chemical and equipment companies and commercial applicators.

Table 3. Kinds of weed control research as shown by reports of the Research Progress Report and the Proceedings of the WWCC 1938-1963. (2) (3)

Year	Chemical	Cropping	Mechanical	Biological	Life History & Ecology
1938	6	1	2	0	1
1939	5	1	1	0	0
1940	2	0	3	0	0
1941-1948	32	3	8	1	3
1949	16	0	0	0	0
1950	23	0	2	0	0
1952	122	1	1	1	6
1954	114	2	1	1	0
1956	133	0	8	0	4
1958	112	5	6	1	9
1963	121	3	4	1	10
Total	686	16	36	5	33

and biological agents that we should forget about them? And what of the study of the weeds themselves, their life history and ecology? Has this information on the troublesome species already been found? This survey indicates a total of 33 reports for the years indicated, and these involve only parts of the story on about 10 species.

It must be conceded that the 2 billion dollars spent for chemical weed control in 1962 (4) is a strong supporting factor for research on chemical control of weeds. However, the figures indicate that there is an increasing interest in research in phases other than chemical weed control. Recent federal appropriations for research on control of weeds without chemicals or with less reliance on chemicals will further increase this effort. One of the main points suggested by this summary of research work is the need for more study of weeds. This information is basic to all methods of weed control.

Extension and regulatory weed control activities of the conference were not analyzed. However, the data on attendance definitely indicates that their participation has not kept pace with that of Industry or research. Is this a result of less need for a conference in which to exchange ideas or is it a case of being overshadowed by the increased emphasis from industry? I believe that it is the latter and that there is more need than ever for wisdom in the extension and regulatory phases. This becomes quite apparent as the precise and sometimes technical rules for the safe use of pesticides are determined. Both of these phases of our conference have a vital part to play in weed control, and I hope the conference will continue to help in that role.

Our only purpose in meeting today is for more effective and more efficient weed control. You are all aware of the losses weeds are incurring.

The conference program promises, again, to provide a wide range of information about chemicals for weed control and some about weeds themselves. I hope that the time spent will be profitable to each of us in our responsibilities.

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SEED DORMANCY CONDITION—TIMETABLE FOR WEED CONTROL

David W. Staniforth[1]

Seed dormancy is a major adaptation of annual weeds which permits them to survive and flourish in spite of the many agronomic practices designed to favor the establishment of the crop and to maintain it in a superior competitive position during the growing season. In temperate zones, seed dormancy is a survival mechanism which prevents the fall germination of newly matured seeds of species which are not winter hardy. In the corn belt such species as giant foxtail (**Setaria faberii**), yellow foxtail (**Setaria lutescens**), and Pennsylvania smartweed (**Polygonum pensylvanicum**) are important weeds of corn and soybean fields and possess seed dormancy patterns which require an extended period of exposure to cool temperatures for the termination of this seed dormancy. An understanding of the environmental conditions under which dormancy is terminated and germination proceeds, is basic to the development of superior weed control methods.

To date, investigations of weed seed dormancy have shown some of the causes of dormancy in a limited number of species, have described methods of breaking dormancy for purposes of germination tests in the laboratory, and have shown clearly the importance of such factors as sensitivity to light, immature embryos, impermeable seed coats and germination inhibitors in the maintenance of dormancy. Excellent reviews of the subject have been compiled (1,2,4,7). Recent work in our laboratory (5,8) has shown that the seeds of yellow foxtail and Pennsylvania smartweed show very high germination percentages following after-ripening outdoors in the winter months. These results suggest then that a major difficulty may not be that seeds are dormant in the spring, but more that optimum conditions for germination of all the seeds, are not present in the spring. Before considering the implications of this statement I will discuss briefly some studies concerned with the dormancy patterns of two or three major weed species of our region.

Seed dormancy in velvetleaf (**Abutilon theophrasti**) is due primarily to an impermeable seed coat (6). Germination inhibitors in the seed coat may play a secondary role but their importance in the maintenance of seed dormancy in the field seems minor. Embryo dormancy does not appear to be a factor in dormancy of this species. Maturing seeds develop a thick-walled, lignified palisade layer early in the development of the seed coat. The chalazal opening in the seed coat probably facilitates rapid loss of water from the seed during the final stages of seed maturation and drying in the field. Moisture content of seed may drop from 45% to 10% in 2-3 days; this rapid dessication may result in uneven stress on the seed coat in the region above the chalazal opening and the eventual fracture of the seed coat in this region.

Of those seed which fall to the ground in a cultivated area, a small percentage may remain at the surface, while the majority will be buried at various depths in the soil, depending on cultivation practices. Those at the surface may become permeable to water as a result of further drying, and the possible effects of freezing and thawing. Those buried in the soil may remain dormant for extended periods, provided the soil remains moist.

Permeable seed may or may not germinate immediately, depending on the level of water soluble germination inhibitor present. This level may be reduced by moist conditions, or be more or less effective in controlling germination depending on the light conditions to which the seed are exposed. The inhibitor mechanism would not be an important factor in the long term maintenance of dormancy, but might be an important mechanism in delaying germination for a few days or weeks. Extensive sampling of seed from various levels down to six inches in the field yielded only water impermeable seed. No imbibed, but non-germinating seed were obtained in such soil samples. Thus it appears that drying out of seed results in a rupture or fracture in the seed coat, and renders the seed permeable to water and thus breaks or terminates dormancy. The scope of this study did not include a complete investigation of the range of drying conditions required to terminate the dormancy of a sample of the wild population of seed. The techniques of seed scarification, hot water dipping and high temperature dry heat are quite artificial, and the results obtained with them do not reflect accurately the processes which occur in the field. The use of these techniques, however, suggested the explanation of the probable sequence of events which lead to termination of dormancy in the field.

Seed dormancy in yellow foxtail was studied using the techniques of embryo culture, biochemical analysis, seed after-ripening and germination. At least two mechanisms were operative in the maintenance of seed dormancy in yellow foxtail; one conditioned by the caryopsis, the other by the hull. Freshly harvested seed showed a high percentage of caryopsis dormancy which was terminated readily by the combination of low temperature and high moisture in soil. However, seeds after-ripened in this way in the laboratory did not germinate unless the hulls were removed. Leaching in water promoted germination of these seeds in the intact condition. Isolated embryos from either dormant or non-dormant seeds grew normally on nutrient medium, suggesting that embryo dormancy may not be a major factor. Attempts to characterize seed dormancy condition on the basis of biochemical differences was not successful in this study.

Further studies with green and giant foxtail and with Pennsylvania smartweed (5) showed that these seeds are often in a high state of germinability, even though they may not germinate in the field. This peak in germination occurs in the period from March to late June.

The major external factors necessary for germination of weed seeds are adequate soil moisture, optimum temperature and an adequate supply of oxygen. The importance of each of these factors has been demonstrated many times, but few investigators (3) have considered low availability of oxygen, or high levels of carbon dioxide as possible causes of limited seed germination. Studies which might lead to new techniques to promote more uniform weed seed germination could lead to new efficiency in the use of both herbicides and cultural methods of weed control. At the present time our knowledge of the mechanisms of seed dormancy and of the factors which limit the germination of viable weed seeds is not perhaps complete enough to substantiate in detail the practical implications of the ambitious title I have chosen. Much vital information is lacking about seed dormancy as such, and about weed seed germinability. Progress might be swifter if we separated these two closely related segments of weed seed physiology, at least in our thinking and perhaps in our research. The presence of large numbers of viable weed seeds in the top six inches of soil in a field, present a real challenge when we find that these same seeds which do not germinate uniformly or completely in the field, do germinate readily in a laboratory germinator. A fuller understanding of the factors which control seed germination in the field can be expected to lead to the development of an expanded base for new selectivity mechanisms in the herbicide technology.

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FACTORS AFFECTING WEED CONTROL WITH SOIL INCORPORATED HERBICIDES

L. S. Jordan, J. M. Lyons, W. H. Isom, B. E. Day, and J. D. Mann[1]

Weed control with preemergence herbicides varies with different soil conditions, method of incorporation, and method of application of water. Many herbicides perform better with overhead irrigation and with incorporation into soil with furrow irrigation. Many factors affecting performance of soil incorporated herbicides have not been critically studied under uniform conditions. Data is presented in this paper on effects of methods of incorporation, soil moisture, soil characteristics, and location on preemergence weed control with spray and granular forms of different herbicides.

Materials and Methods

Experiments were conducted at three areas in Southern California of differing climatic environments: Location 1)—Imperial Valley Field Station, Imperial County, a desert climate; Location 2)—South Coast Field Station, Orange County, a coastal climate; and Location 3)—Citrus Research Center and Agricultural Experiment Station, Riverside County, a climate intermediate to coastal and desert. Description of the experimental parameters at each location is given in Table 1.

Fields at each location were furrowed and divided in half. One half was pre-irrigated and the other left dry. Japanese millet (**Echinochloa crusgalli frumentaceae**) was sown uniformly over the entire field. The herbicides, ethyl N,N-dipropylthiocarbamate (EPTC) 3 lb/A, isopropyl N-(3-chlorophenyl)carbamate (CIPC) 6 lb/A, 2,4-bis(isopropylamino) - 6 - methyl-mercapto-s-triazine (prometryne) 2 lb/A, and alpha,alpha,alpha-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine (trifluralin) 1 lb/A were applied as sprays or granules to 100 ft^2 plots. Sprays were applied with a precision sprayer delivering 50 gal/A of spray. Granules were distributed with a hand shaker. Herbicides were incorporated immediately with a power driven rotary-tiller, ground driven rotary-spikes, a ground driven wheel-hoe, and a ground driven row-wheel, or left on the surface. Six weeks later the plots were rated independently by 7 individuals on a 0 (no effect) to 10 (complete kill) basis to determine toxicity of the herbicides to grass and broadleaf weeds. Resulting data were analyzed with an IBM 1620 electronic computer, using analysis of variance and multiple range tests. Results are shown in tables 2 through 9.

Results

1. Over-all effectiveness of incorporation equipment and herbicides.

CIPC and trifluralin performed best with either the rotary-tiller or wheel-hoe, with the rotary-spike and row-wheel being better than surface application. Grass and broadleaf weed control by EPTC and grass control by prometryne was greatest with rotary-tiller incorporation, with significant decreases occurring with the wheel-hoe, rotary-spike, wheel-hoe, and surface applications, in that order. The comparative effectiveness of incorporation equipment for broadleaf weed control with prometryne was similar with respect to the rotary-tiller but differed from other herbicides with other incorporation equipment.

2. Performance of spray or granular forms with different incorporation.

The rotary-tiller and wheel-hoe performed equally and best for spray and granular forms, with a few exceptions. The granule usually was equal to or better than the spray. The exceptions are as follows: CIPC—row-wheel, broadleaves; EPTC—wheel-hoe; prometryne—wheel-hoe, rotary-spike, and row-wheel. Overall, the granules were slightly more effective for grass control but not for broadleaf control.

3. Effectiveness of incorporation methods on wet or dry soils.

Overall, for grass control, the rotary-tiller and wheel-hoe were best and equal with wet and dry soil, the rotary-spike and row-wheel were equal but less effective with wet soil, the row-wheel was least effective with dry soil, and surface application resulted in poorest grass control.

Broadleaf weed control was generally equal and best with the rotary-tiller and wheel-hoe with wet soil, but the rotary-tiller was significantly better with dry soil. Exceptions to these generalizations were noted for individual herbicides. For example, trifluralin performed best with the wheel-hoe with wet soil.

CIPC performed best with wet soil if incorporated, but better on dry soil if left on the soil surface, except for broadleaf control with the rotary-spike. EPTC performed best with wet soil except when incorporated with the rotary-tiller. Trifluralin controlled grass best in wet soil with the wheel-hoe, in dry soil if left on the surface, and equally under both moisture conditions with the other three implements. Broadleaf weed control with trifluralin was better with wet soil for all except the rotary-tiller, with which there was no difference between soil moisture levels. Prometryne performed equally or better with dry soil except for grass control with rotary-tiller and broadleaf control with wheel-hoe incorporation.

4. Interactions of method of incorporation, soil moisture, and herbicide form.

Grass and broadleaf weed control with spray or granular herbicides on wet and dry soil was best and equal with the rotary-tiller and wheel-hoe; the rotary-spike and row-wheel were less effective and performed the same, and surface applications gave poorest control of grasses and broadleaves, except when granules were used with dry soil.

Broadleaf weed control was better with sprays applied to wet soil, as was grass control, when the sprays were left on the surface. Granules performed better with the wheel-hoe with wet soil, controlled the grass better on dry soil when left on the surface, and controlled broadleaf weeds better in dry soil when the row-wheel was used.

Grass control by CIPC and EPTC was better with wet soil when spray was used, but control was the same with wet and dry soils when the granules were used. With branular trifluralin and prometryne grass control was better with the dry soil, but when applied as sprays these two herbicides performed the same for grass control. For broadleaf weed control both forms of CIPC, EPTC, and trifluralin performed best with wet soil. Prometryne sprays were not different in wet and dry soil, but the granules gave better control with dry soil.

The relative performance of the four herbicides varied with formulation, species, and soil moisture.

5. Interactions of location, form, and soil moisture on incorporated herbicides.

At the desert location, the granular form of each herbicide performed better than the spray. At the coastal location the spray form of EPTC and prometryne controlled grass better, but the two forms of CIPC and trifluralin were the same. Broadleaf control by the two forms at the coast, for all except trifluralin, was the reverse of the desert location, with the spray giving better control. At the intermediate location, grass and broadleaf control followed the same pattern, with the spray form of EPTC and the granular form of prometryne giving best control, while both forms of CIPC and trifluralin gave the same control.

It is interesting to compare the two forms of each herbicide at each location. In some instances the forms gave equal control, while at others there was a reversal between locations, with the spray being better at one and the granule at the other.

At the desert and coastal locations, the decreasing order of effectiveness of the incorporation equipment is:

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Table I. Experimental Parameters

		Location		
		Desert	Coastal	Intermediate
Soil Classification		Holtville silty clay	Moreno sandy loam	Ramona sandy loam
Soil Analysis				
Saturation percentage		54.0	28.0	25.0
pH		7.9	7.8	7.6
Organic matter %		1.5	0.8	0.6
Sand %		17.0	67.3	67.7
Silt %		35.5	17.0	22.8
Clay %		47.5	15.7	9.5
Parameters at Time of Herbicide Application				
Soil Moisture—Wet treatment		15.8	9.4	3.7
% Dry treatment		3.6	5.0	0.9
Soil Temperature—Wet treatment		90	63	81
(Surface F) Dry treatment		102	63	84
Air Temperature—F		82	55	74
Humidity		low	high	high
Light		clear	cloudy	clear
Soil Condition—Wet treatment		friable	compactable	friable
Dry treatment		hard clods	friable	friable
Weather During Experimental Period				
Maximum air temperature		104	88	90
Minimum air temperature		41	41	40
Average maximum air temperature		85	73	81
Average minimum air temperature		50	52	49
Precipitation		none	0.02	none
Equipment Operation				
Rotary-tiller (power driven)	speed (mph)	2	2	2
	depth (inches)	2	2	2
	performance (wet)	good	good	center of bed not well mixed
	performance (dry)	good	good	center of bed not well mixed
Wheel-hoe (ground driven)	speed	4	4	4
	depth	2	2	2
	performance (wet)	good	good	good
	performance (dry)	clods jammed	good	good
Rotary-spike (ground driven)	speed (mph)	4	4	4
	depth (inches)	2	2	2
	performance (wet)	good	good	good
	performance (dry)	clods jammed	good	good
Row-wheel (ground driven)	speed	4	4	4
	depth	2	2	2
	performance (wet)	good	soil plugged	good
	performance (dry)	poor depth control	good	good
Predominant Weed Species				
Grass species		**Echinochloa crusgalli frumentaceac**	**Echinochloa crusgalli frumentaceac**	**Echinochloa crusgalli frumentaceac**
Broadleaf species		**Chenopodium murale**	**Amaranthus graecizans**	**Capsella bursa-pastoris**
			Portulaca oleracea	**Brassica sp.**

1) rotary-tiller, 2) wheel-hoe, 3) rotary-spike, and 4) row-wheel. Some variations occur, with two implements giving equivalent control but being significantly different if location, soil moisture, or species is changed.

At the intermediate location, the order of effectiveness differs substantially from that noted above for the other locations. Most significant is the low performance of the rotary-tiller. It should be remembered that the implement used at the intermediate site was not the one used at the other locations. The other implements gave better weed control than was obtained from surface application.

At the desert location, the best control with each method of incorporation or surface application was obtained with wet soil. The same was generally true with grass control at the coast, except dry soil was better with the wheel-hoe and no difference occurred with the rotary-tiller. Broadleaves at the coastal site were not controlled differently on wet or dry soil, except for better performance of the wheel-hoe on wet soil. At the intermediate location, control was the same on wet and dry soil, except for grass control being better on wet soil with the rotary-tiller and dry soil with surface applications.

Under coastal and desert conditions, the general trend of performance decreased in order of the implements as listed above. At the intermediate location, the rotary-tiller rated lower in efficiency. Variations of effectiveness of equipment were noted. Under some conditions two or more implements performed the same, but not if conditions and herbicides were changed.

The amount of control and relative ranking of control by the herbicides varied with location. Trifluralin controlled grass equally at all three locations, but controlled broadleaf best at the desert and least at the intermediate site. Prometryne performed best at the desert site, with poorest control at the intermediate location. EPTC controlled both weed types best at the intermediate site, with less but equal grass control at the other two locations, and poorest broadleaf control at the coast. CIPC gave poorest control of both types at the intermediate site, best grass control at desert and coastal sites, and best broadleaf control at the desert location.

Discussion

Generally, the four herbicides fell into two groups, so far as incorporation requirements are concerned. Trifluralin and CIPC performed best with either the rotary-tiller or wheel-hoe. EPTC and prometryne required the power driven rotary-tiller for best results under all conditions. As apparent soil mixing decreased, these herbicides became less effective. Evidently, trifluralin does not require as much soil agitation for adequate distribution of the herbicide for weed control. It is difficult to determine how well the herbicides were distributed through the soil by the different equipment. It has been shown that even with apparently thorough mixing of the soil the herbicides may not be uniformly distributed. Rainfall or sprinkler irrigation usually gives the best distribution of herbicides, but where these are not available the best method is the use of a properly designed rotary-mixing device. The wheel-hoe looks promising for use with some herbicides but its use is limited if hard clods or debris are present.

The rotary-tiller and wheel-hoe were generally most effective with either spray or granular applications, with the rotary-tiller being better for granules of EPTC and prometryne. This probably results from lack of a uniform distribution of the granules over the surface than is obtained with the spray. Thus, more soil mixing is required to distribute the granules of EPTC and prometryne close to germinating weed seedlings. The speed at which the herbicide is released from the granule is probably important. Herbicides released rapidly from granules are more toxic, initially, because of more rapid movement of larger quantities through the soil. Less precise placement of the granule in the soil layer is required.

When soil moisture is considered, weed control was equal with the rotary-tiller and wheel-hoe, except when granules were used in dry soil. This indicates that herbicides from both sprays and granules are more uniformly distributed through moist soil. The same was true for sprays with dry soil but not for granules. The soil moisture may have caused 1) better initial release of the herbicides from the granules, 2) faster movement of the released herbicide into contact with germinating seeds, and 3) more rapid germination of seeds, allowing roots to grow to the herbicide.

The effect of location on the performance of the incorporation equipment is interesting. The rotary-tiller gave the best results at the desert and coastal locations for all herbicides except trifluralin. For trifluralin at these locations the rotary-tiller and wheel-hoe performed the same. At the intermediate location the rotary-tiller did not perform as well as the other implements. A band of weeds growing in the center of the beds indicated less mixing of the soil in this area. At the desert location, hard clods were picked up by the rotary-spike and wheel-hoe, which stopped their rotation. Clods prevented the row-wheel from penetrating the soil to an adequate depth. All four implements operated well if the soil was pre-irrigated. At the coastal location, the rotary-spike and row-wheel picked up the moist soil until the rotating parts were filled and they performed more as rollers than incorporators. In dry soil at the coastal location, and with both levels of moisture at the intermediate location, all the equipment appeared to operate well. The power-driven rotary-tiller is less affected by soil factors and may be used under a wider range of conditions. The wheel-hoe is less sensitive to soil variations than the row-wheel and rotary-spike. The use of ground-driven equipment is limited to conditions allowing them to function properly. Under adverse conditions, the power-driven equipment should be used even though the power requirements are greater.

Considering forms alone under all conditions, the granular form of ETPC, CIPC, and trifluralin were more effective than the spray, while prometryne sprays were better at the time of rating. However, six months after treatment the prometryne granules were the only treatment showing residual toxicity to barley. This indicates that prometryne was released slowly and had longer soil residual.

Generally, both forms performed better in pre-irrigated soil if all weed control is averaged. Exceptions occur, with some granules performing better in dry soil, e.g., prometryne. This probably results from differences among properties of the granules.

The granular form of all four herbicides performed better than the spray at the desert location. There were no differences between the two forms of CIPC and trifluralin at the other locations, but the prometryne spray was better and EPTC granules were better at the intermediate and spray better at the coastal location.

Thus, the granules performed better in the hot desert area on heavy soils, while the sprays were equally good or better in the lighter and cooler soils, except as noted. The granules prevented rapid loss of the materials under desert conditions, while under cooler conditions the sprays were better because the herbicides were more readily available to control the germinating seedlings. The reason for the reversal of effects in the lighter and cooler soils with EPTC is not known.

When moisture level in the soil at the time of treatment is considered, some interesting results may be noted. Keeping all variables constant, except moisture level, the herbicides performed better in moist soil, with the exception of prometryne granules which were more effective in dry soil. Weed control with all equipment was better on pre-irrigated soil. Generally, both forms performed better if incorporated into wet soil, but were less effective on wet soil if left on the surface. At the desert location, results were better in pre-irrigated soil where all equipment performed well. At the coastal site, overall grass control was lower because the wet soil clogged some equipment. There was no overall difference at the intermediate location if all factors other than moisture were held constant. These observations indicate that it is better for the soil to be moist, but not too wet for the equipment to operate, if herbicides are being incorporated. If the herbicides are not being incorporated, the surface should be dry when they are applied.

The effects of location on performance of herbicides and equipment has been discussed with other factors above. The differences in performance of equipment resulted largely from the presence of clods at the desert location, too much soil moisture at the coastal location, and equipment failure at the intermediate location. Each herbicide varied in effectiveness with location. This resulted from several interacting factors such as: volatility of the herbicide, formulation, adsorption to the soil, soil moisture, soil properties, weed species, and local climate. In other words, to determine how an herbicide will perform in different areas, it should be tested in each area under the conditions with which it will be used. Data from other locations will aid in determining formulation, methods of application, management, and selectivity, but will not eliminate the need for local testing.

THE INFLUENCE OF HERBICIDES ON SOIL METABOLISM

J. W. Whitworth, B. C. Williams, W. Garner[1]

Professor Clark of New Mexico State University has developed a method for determining the oxygen uptake of large inhomogeneous biological samples. The effects of atrazine, diuron, picloram betasan, and trifluralin were tested in a liquid extract. In addition, trifluralin was tested on Amarillo fine sandy loam.

The Clark method utilizes a vessel equipped with an electrical pressure switch, an electrolysis cell to furnish oxygen upon demand, a KOH containing reservoir for CO_2 absorption, and a means of recording coulomb input to the electrolysis cell. The method was designed for and has been successfully applied to the evaluation of the kinetics of Biological Oxygen Demand (BOD) of sewage.

This afternoon, we wish to show how Clark's BOD method may be used to obtain certain data about soils which may provide useful parameters in evaluating soil fertility and the effect of environmental contaminants such as herbicides.

Slide 1 gives an idea of the arrangement of several vessels in a sargent incubator. For those cost minded, each vessel with its power pack represents about two hundred dollars while incubators can be purchased for about six hundred. Thus, for the not too prohibitive sum of one thousand dollars, one has a macro-Warburg which is a useful physiological tool either with soil, sewage, small animals or plants.

Slides 2 through 4 give diagramatic presentation of the components for the system. The digester, slide 2, is a standard two liter resin kettle. When the vessel is used to contain a soil column, the CO_2 absorbant chamber is placed in a squat beaker on top of the soil rather than suspended from a hook cap.

The contents of the vessel are sealed from the atmosphere by the electrolysis cell. As oxygen is depleted from the system, the internal pressure decreases, opening the contact between the switch electrode and the electrolyte. When the relay is tripped, a 100 ma DC current is supplied to the electrolysis electrodes. At this current level, one hour of electrolysis produced about 30 milligrams of oxygen.

For short term experiments a chart recorder can be used. With long term studies twice daily reading proved sufficient.

The electrolysis cell is shown in greater detail in slide 3. Switching action is effected when internal vessel pressure drops below atmospheric pressure, acid is drawn up in the central tube, through the small hole connecting the anode and cathode compartments, and drawn away from the upper contact. Breaking this contact releases a hold-open relay causing electrolysis. Hydrogen produced at the cathode is vented to the atmosphere. The oxygen produced at the anode is vented to the sample to make up that which was metabolically utilized.

Slide 4 shows the electrical circuit which we may examine in detail. The incoming 110 Volts is dropped to 16 Volts by Transformer 2 prior to rectification by the selenium rectifiers. The switching circuit is 110 Volt AC. One part of the circuit is common with the DC and connects with the cathode while the other lead connects to the switching electrode. Breaking the switching circuit closes the circuit to both the rectifier (3) and the digital clock (1).

The liquid cultures were incubated in liter flasks and consisted of a native, mixed microbial culture growing on an extract similar to that found in enriched soil. In each of the soil studies a two liter resin kettle was filled with air-dried Amarillo fine sandy loam to form a column of soil 28 centimeters in diameter and 32 centimeters deep. The soil had been passed through a 20 mesh sieve prior to filling the kettle. The soil sample was brought to moisture equivalent (⅓ bar hydraulic tension which approximates field capacity for moisture). The oxygen uptake of the soil samples was determined over varying periods of time. When glucose was introduced into the soil, it was added as a solution of 0.1 or 0.5 percent by weight with the amount of water required to bring the air dry soil to moisture equivalent. Addition of cellulose was in the dry state with thorough mixing to insure the best possible distribution of cellulose throughout the soil mass. In the first study and the final half of the last study, the incubation temperature was at 30° C ± 1° C. Incubation temperature was 25° C ± 1° C for all other studies

The Amarillo fine sandy loam soil was selected as the test soil. This soil is a key agricultural soil of the Southern Great Plains covering an extensive area in eastern New Mexico. A further consideration in selecting this soil was that it handles well under the moisture conditions of these studies. Some physical and chemical data on this soil are reported in Figure 5. From these data, this soil could be described as a typical soil of the southern plains area. It is a slightly basic soil which should be highly productive when supplied with adequate nitrogen, phosphorus, and water.

The reproductibility of the soil oxygen demand at 38° C ± 1° C is shown in Figure 6. Maximum deviation between replicates is less than 3 per cent.

Sample size has a definite influence on soil metabolism. The family of curves shown in slide 7 illustrate that the specific oxygen uptake is a function of soil column geometry. Since the oxygen uptake is inversely related to specific surface area, we are lead to the conclusion that anaerobes are releasing materials which serve as metabolites for aerobes.

In slide 8 the transitory effect of the addition of glucose can be noted. When pure cellulose is included as an additive, there is an initial lag period followed by an increasing stimulation.

Slides 9 through 12 show the effect of various herbicides on the oxygen uptake on liquid cultures. The oxygen uptake is expressed as a percentage of the untreated check.

Atrazine and diuron at rates in excess of field application (80-288 ppm) caused a general depression in oxygen uptake.

Trifluralin at excessive rates (480-960 ppm) caused a short term increased oxygen uptake of 140 to 180 percent of the check followed by a marked depression.

Picloram at 240 ppm caused an increase of 110 to 120 percent, whereas, rates of 480 ppm depressed uptake to 40 percent of the check.

Betasan (Prefar) at 480-960 ppm caused a steadily increasing uptake of oxygen that amounted to as much as 240 to 320 percent of the check. The uptake was still going up after 140 hours of incubation. Even at rates that approached the equivalent of those used under field conditions, Betasan caused a marked increase in oxygen uptake.

When incorporated into Amarillo fine sandy loam at rates equivalent to approximated 15 times field application, trifluralin depressed oxygen uptake about 10 percent. The addition of 0.5% cellulose did not alter this depression.

The findings reported here are in general agreement with those reported by other workers. When herbicides are applied at excessive rates, definite responses in soil microflora and consequently changes in oxygen uptake were noted. However, as rates approach the level used under field conditions, very few measurable changes in oxygen uptake were detected. The one exception to this general statment was the herbicide Betasan.

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THE ABSORPTION, TRANSLOCATION AND METABOLISM CHARACTERISTICS OF SEVERAL CHLOROPHENOXY ACID HERBICIDES IN A WOODY SPECIES

Logan A. Norris[1]

Abstract—Problems involved in the control of chemically resistant undesirable woody species may profitably be approached by analyzing the factors responsible for the expression of resistance in the field. Bigleaf maple has proven to be a difficult species to control with aerially applied phenoxy herbicides.

Research concerning the influence of formulation and molecular structure of the parent compound on herbicide absorption, translocation and metabolism in bigleaf maple was described. The absorption characteristics of the acid, triethanol amine salt and 2-ethylhexyl ester formulations of 2,4-D and 2,4,5-T were determined. It was shown that the less polar formulations were absorbed to a greater degree.

Other tests showed that the degree of chlorination of the ring and the configuration of the side chain influenced the absorption and translocation characteristics of 2,4-D, 2,4,5-T, 2,4-DP and 2,4,5-TP in bigleaf maple. Studies of chemical stability in treated foliage showed that decarboxylation was not an important means of detoxification of these compounds in this species. Analysis of alcohol extracts of treated leaves by paper chromatography revealed that the alpha-phenoxypropionic herbicides were less stable than the phenoxy acetic herbicides. For compounds with the same side configuration, the degree of chlorination of the ring did not influence stability.

Tests of chemical stability of 2,4-D and 2,4,5-T in intact seedlings after one week showed that a given herbicide differed in stability in different plant parts, and different herbicides differed in stability in a given plant part. These differences are believed to be important in determining chemical selectivity in this species.

The poor translocation characteristics of the other compounds tested prompted studies with 2,4-DB. It was shown that detached single leaves could rapidly decarboxylate 2,4-DB. Studies of the absorption and translocation characteristics of the 2-ethylhexyl ester of 2,4-DB revealed a slightly lower absorbability but a markedly superior translocatability when compared with the other phenoxy herbicides tested.

A study using intact seedlings and gas chromatography established that 2,4-D is the primary product of the oxidation of 2,4-DB. The form of the translocated compound was shown to be 2,4-DB. The roots exhibited a greater capacity for the beta oxidation of 2,4-DB than either the stems or the leaves. (Oregon State University, Corvallis)

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STUDIES IN THE PHYSIOLOGY OF SPROUTING IN UNDESIRABLE WOODY PLANTS

J. R. Goodin[1]

Although considerable progress has been made in the control of top growth of woody plants, the major task remains in determining how to prevent sprouting from underground storage tissues following interruption of top growth by herbicides, mechanical clearing or fire. So severe is the problem that certain portions of the chaparral-type vegetation may begin sprouting within days after the top-growth interruption, and fully reproduce the original size of the plant in three to four years.

Many attempts have been made to control sprouting by application of phenoxy herbicides or ammonium sulfamate to new shoots or cut surfaces. Occasionally these treatments are quite successful; most of the time less than desirable results are obtained.

In all cases investigated, those species which sprout and resprout are characterized by a large crown tissue just below the surface of the soil. This storage tissue gives rise to the shoot primordia, either latent or adventitious, which ultimately reproduce the above-ground portions of the plant. Translocation of herbicides into these tissues is extremely difficult, and with repeated spraying of new growth over a period of years, shoots may continue to develop and grow vigorously. Such follow-up maintenance in an attempt to eliminate woody vegetation is extremely costly and time consuming.

With this problem in mind, and addressing ourselves to the sprouting and resprouting phenomenon, we have initiated in our laboratory a series of experiments designed to study the physiology of sprouting and organ differentiation (both roots and shoots) in sterile culture. Our primary objective for the past several months has been to develop a medium suitable for the growth of a number of chaparral species. At the present time, we are growing in sterile culture **Salvia mellifera, Salvia apiana, Arctostaphylos glauca, Quercus dumosa, Adenostoma faeciculatum,** and **Ceanothus spinosus.** Most of our detailed experimentation has been concerned with black sage, and we have attempted to establish optimum conditions for the most rapid callus growth rate. With physiological concentrations of auxin, and at optimal concentrations of kinetin (100 ug to 500 ug per liter), these cells grow a little more rapidly in continuous light than in dark. However, at supraoptimal concentrations of kinetin, maintaining the optimal auxin concentration, those cells grown in the dark are more capable of withstanding the toxic effects of kinetin than those in continuous light. These data, while only indirectly related to the general problem of organ differentiation from a mass of undifferentiated tissue, will be important in later experiments in which auxin-kinin-gibberellin relations will be studied in an effort to control organ differentiation. Earlier workers have shown that manipulation of these factors can control root and shoot formation.

We have been interested in determining at what point during the year a given plant has the greatest potential for organ differentiation and development. An experiment has been designed in which explant-tissues from black sage are taken at two week intervals throughout the year. Although still in progress, preliminary data suggest that in a Mediterranean climate, the period of most rapid growth of the sterile explant coincides with the period of most active growth of the intact plant. In addition, this period of most active growth, occurring in the spring following winter rain, appears to be the period during which an isolated tissue has the greatest potential for differentiating shoots and roots. Although we have not yet been able to consistently cause organs to differentiate from a callus tissue, root and shoot primordia have arisen from tissue explants taken from field plants during the period of rapid growth. This potential seems to decrease rapidly in the summer and fall when the plant is most dormant.

These data confirm the feasibility of culturing woody chaparral species and studying their physiological and morphological responses to exogenously-applied growth substances. In subsequent experiments we hope to compare genetically comparable tissues for different reactions to growth substances. For example, **Arctostaphylos glandulosa**—a sprouting species, will be compared with **Arctostaphylos glauca**—a non-sprouting species. Such experimentation may give evidence for the hormonal relationships giving rise to the various sprouting phenomena.

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DIMETHYL SULFOXIDE AS A HERBICIDE CARRIER UNDER DIFFERENT CONDITIONS OF LIGHT INTENSITY

Herbert M. Hull[1]

The unusual medicinal properties of dimethyl sulfoxide (DMSO) have become quite well known to the public through news releases of the past year. This highly polar compound has a very low mammalian toxicity and can penetrate tissue rapidly and enter the bloodstream. In so doing, it greatly enhances the penetration of various compounds mixed with it. DMSO is miscible with water in all proportions, and with most organic solvents including olefins, organic nitrogen compounds, organic sulfur compounds, and aromatic hydrocarbons. Aliphatic hydrocarbons, however, are largely insoluble in DMSO.

The various therapeutic effects of DMSO by itself, as well as the synergistic effect when used as a penetrating agent with other medicines, are quite well documented. Relatively little has been done, however, with DMSO as a herbicidal adjuvant. L. A. Norris and V. H. Freed did report at the 1963 research section of this Conference that DMSO at a high concentration (50-100%) markedly enhanced foliar penetration of C^{14}-2,4,5-T in bigleaf maple seedlings. However, subsequent translocation to the stem, roots, and new growth was not significantly altered. Incorporation of DMSO with stem-injected 2,4,5-T actually decreased translocation of the herbicide to new growth, and particularly to the roots. In the case of basal treatment, basipetal transport to the roots was enhanced to some extent with median concentrations of DMSO. At the 1964 Conference, D. E. Bayer and H. R. Drever reported that the toxicity of dalapon and diuron to oats was not significantly altered by the addition of DMSO to the formulations. However, diuron at 4 lb aihg plus 1% Colloidal X-77 was considerably more effective carried in 100% DMSO than in 10% DMSO. Toxicity was determined by reduction of fresh weight as measured 12 days after spraying at 40 gpa.

In our first experiment with velvet mesquite (**Prosopis juliflora** var. **velutina**), we grew and maintained seedlings in both greenhouse and growth chamber (210 plants under each condition). The chamber was held at 100±3° F. maximum temperature and 71±1° minimum, with a programmed gradual diurnal change from one to the other. Greenhouse maximum temperatures sometimes ran 12 degrees higher than chamber maximums, but minimums were approximately equivalent. The entire experiment was replicated in greenhouse and chamber; both were under approximately an 11½ hour photoperiod. Herbicides included dicamba, picloram, and the triethylamine salt of 2,4,5-T. All were used at 1,000 ppmw ai or ae, as pertinent, with the addition of 0.5% Tween 20. Carriers for each of the herbicides included DMSO in aqueous concentrations of 0, 5, 20, 50, and 100%. The same range was also used for the no-herbicide controls. Application of 0.02 ml was made to the upper surface of the basal leaf only of each of the 2-week-old plants. Specific physiological responses were recorded at various intervals following treatment, and height and fresh weight of shoots and roots were determined after the fifth week.

Overall herbicidal effect (a summation of apical epinasty and formative effect, injury to non-treated foliage, stem dieback, and repression of height and weight) was greatest with the higher (50 and 100%) concentrations of DMSO. Although the higher rates enhanced activity of all three herbicides, greatest enhancement occurred with 2,4,5-T. The 20% concentration of DMSO was antagonistic toward the action of all herbicides, particularly 2,4,5-T, and in some cases resulted in such minimized injury and growth repression that the plants were hardly discernible from the controls. Responses of the two replications were remarkably similar.

Herbicides used in combination with DMSO produced an unusual pattern of injury. Rather than affecting principally the roots and apical region of the plant, as occurs when DMSO is not present, addition of DMSO resulted in considerable injury to leaves immediately above the treated leaves as well. Without DMSO in the herbicidal formulation, such leaves completely escape visible injury usually.

Since synergism with DMSO occurred to a greater extent with 2,4,5-T than with either dicamba or picloram, the phenoxy compound was used in further tests involving the interaction of DMSO content and light intensity. Plants were grown in the chamber, as before, but on a 16-hour photoperiod. Light intensities were adjusted to 1,000, 200, 100, and 25 ft-c by varying distances from light source to plants, and by partially encasing some with wire frames covered with various numbers of layers of white muslin sheeting. Two-week seedlings, grown under each of the light conditions, were treated by applying a total of 0.04 ml of the herbicidal formulations to the upper surface of the two cotyledons of each plant. The formulations consisted of 1,000 ppmw ae of the triethylamine salt of 2,4,5-T plus 0.5% Tween 20, carried in either distilled water or a 50-50 mix of DMSO and water. One group of plants was left untreated as a control at each light intensity.

Two days after treatment, apical epinasty, contact injury to the cotyledons, and translocated injury to the leaves immediately above were all greater when DMSO was present. Light intensity showed no significant correlation with degree of injury of the above types. However, after 2 weeks, apical injury and stem dieback were inversely correlated with light intensity in the 2,4,5-T groups receiving no DMSO. With DMSO, these responses were so severe that no correlation with light intensity could be detected. The 2,4,5-T alone markedly repressed shoot height and fresh weight, but addition of DMSO caused a further significant repression at all light intensities. On the other hand, 2,4,5-T alone did not cause any repression of fresh root weight at any light intensity, but when combined with DMSO a significant repression occurred at all intensities, the degree of repression being proportional to light intensity.

The translocated type of 2,4,5-T-DMSO injury generally occurred first at the outer tip of the leaflets. Microscope preparations of leaflet longitudinal sections showed chloroplast destruction and dissolution of parenchyma cell walls in the most severely injured portions. In areas of lesser injury, chloroplast destruction was confined to the inner layer of palisade and spongy cells, suggesting translocation of the toxicants outward from the finer vascular bundles toward the leaf surface. Parenchyma cell walls in areas of moderate and slight injury showed a convoluted appearance, particularly in the palisade layers. Cross sections of stems taken near treated leaves or cotyledons showed a larger number of starch grains present in the pith and primary xylem than in stems of untreated controls.

The findings described in the above experiments and in several others, as well as those presented by other investigators, suggest that DMSO induces an extremely rapid foliar absorption of certain organic substances, but that its effect on translocation is erratic and perhaps dependent upon specific conditions still to be discovered. Anatomical investigations of tissue taken at various distances from a treated leaf or cotyledon suggest that DMSO and 2,4,5-T are not necessarily translocated together, and, indeed, may even move by separate mechanisms.

Whether the DMSO-enhanced herbicidal action described in this report will also be found in larger field specimens of velvet mesquite is not yet known.

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EFFECT OF 2,4,5-T ON THE ALKALOID CONTENT IN TALL LARKSPUR (DELPHINIUM OCCIDENTALE) AND FALSE HELLEBORE (VERATRUM CALIFORNICUM)

M. Coburn Williams[1]

Abstract — Tall larkspur, **Delphinium occidentale** S. Wats., and western false hellebore, **Veratrum californicum** Durand, were treated with the triethylamine salt of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) at 4 and 8 lbs/A (tall larkspur) and 4, 8, and 12 lbs/A (false hellebore) in early July. Both percent leaf alkaloid content and milligrams of alkaloids per leaf increased significantly in both species. Maximum increase in alkaloids in tall larkspur and false hellebore occurred 7 to 10 days after treatment.

Results indicate that the effect of herbicides on naturally occurring toxic agents in poisonous plants must be considered in control studies. (Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, in cooperation with the Utah Agricultural Experiment Station, Logan.)

TRANSLOCATION OF HERBICIDES IN WOODY PLANTS FOLLOWING APPLICATION TO LEAVES, BARK, CUT-SURFACES AND STUMPS

O. A. Leonard[1]

Common methods of applying herbicides to woody plants are broadly classified as foliar, bark, cut-surface, soil (root), and stump. The present discussion will consider all of these types of application except soil (1, 2, 3, 4).

Foliar application is the most common method. Although the term "foliar" implies that the leaves are the main consideration, spray also is deposited upon the bark. The relative significance of leaf and bark deposite should be evaluated with various herbicides upon woody species. One of the studies reported was on such an evaluation.

Several labeled herbicides were used in these studies including 2,4-D (acid), 2,4,5-T (acid, triethylamine, butoxyethanol ester, methyl ester) amitrole. Labeled substances other than herbicides that were used included $C^{14}O_2$ (to obtain labeled photosynthate in leaves exposed to light) and $P^{32}O^4$; these were used to determine the influence of herbicide treatment upon natural transport patterns.

Plant species included in these studies were red maple (**Acer rubrum**), white ash (**Fraxinus americana**), blue oak (**Quercus douglasii**), interior live oak (**Quercus wislizenii**), and grape (**Vitis vinifera**).

Results and Discussion

Foliar application

Red maple and **white ash** plants treated were 2-3 feet tall and had almost stopped growing when the study was conducted. These plants were thoroughly sprayed with the following: 2,4,5-T butoxy ethanol ester (4 lb ae 100 g), 2,4,5-T triethylamine (4 lb ae 100 g), or amitrole (3 lb 100 g.) Directly following the application, the same herbicides were applied in radioactive form to 4 mature upper leaves or to the bark on the stems in the same vicinity as the treated leaves (but on other plants). The plants were collected 30 days later for obtaining autoradiographs, counting data, and chromatographs.

Translocation of labeled 2,4,5-T and amitrole was considerably superior from bark application than from leaf application in both white ash and red maple (Table 1). The superiority of the bark over the leaf was evident with both forms of 2,4,5-T as well as amitrole. The applications, of course, were made on relatively thin bark.

Amitrole translocated better than either form of 2,4,5-T following leaf application (Table 1). When applied to the bark, the 2,4,5-T butoxy ethanol ester translocated better than either the triethylamine of 2,4,5-T or amitrole.

Translocation of 2,4,5-T out of the treated leaves was slight in white ash but scarcely detectable in red maple. Autoradiographic evidence supported the counting data shown in Table 1. Amitrole translocated out of the treated leaves of both white ash and red maple, being more intense with the latter species (Table 1); similar evidence was obtained from the autoradiographs.

Translocation of 2,4,5-T and amitrole from bark application was greater in red maple than in white ash. Most of the translocation of 2,4,5-T following absorption was upward into the leaves. Evidence in Table 1 indicates that most of the movement was into the leaves directed connected to the treated portion of the stem, but the leaves below this section of the stem also were labeled. Treatment of the bark with amitrole also resulted in much label being present in the mature leaves; however, there was also considerable label in the stems and roots. Again, the counting data was supported by the autoradiographic evidence.

Chromatographic evidence was only possible from those portions of the plants that were strongly labeled—sometimes only from the portion of the plant actually treated. After 30 days, ester of 2,4,5-T was almost completely hydrolyzed to the acid form. Nearly all of the label was in the form of 2,4,5-T acid for both red maple and white ash; however, several low-activity spots were present in the treated leaves of red maple but none were evident in white ash. Although much amitrole still was present as such in the treated bark and leaves of both species, several other spots also were present.

Chromatograms of untreated leaves closely associated with the bark treatment indicated that most of the label was present as unaltered 2,4,5-T acid; however, free amitrole did not appear to be present.

Grape rootings were treated with labeled 2,4-D acid, 2-4,5-T acid, and amitrole (no unlabeled herbicide). All of the labeled herbicides moved to the roots. In another test, 50 micrograms of unlabeled 2,4-D or amitrole were applied to the leaf receiving the herbicides in label form. Translocation was not greatly altered by the unlabeled herbicides in this experiment; however, the application was made only to one leaf per plant and was not comparable to a normal method of applying herbicides. Photosynthate flowing towards the roots from untreated leaves may have prevented alteration in the transport pattern by the unlabeled 2,4-D.

A foliage spray of 2,4-D or picloram (20,000 ppm) applied to rootings altered the translocation of C^{14}-photosynthate in the rootings. Less labeled photosynthate went to the roots but large quantities moved into the stems, petioles and large veins of mature leaves.

Bark application

Red maple. Some aspects of bark application have already been discussed under the previous heading of foliar application. Bark applications are normally performed using a herbicide dissolved in oil—usually one of the esters of the phenoxyacetic acids. The following tests were made using labeled, 2,4,5-T butoxyethanol and methyl esters applied in diesel oil. Applications were made to the upper portion of the tap root, lower portion of the stem and upper portion of the stem on red maple about 1 month before leaf scenescence. Only the labeled herbicides were used in these tests (no unlabeled herbicide added).

A relatively high percentage of the label from 2,4,5-T (either ester) moved away from the point of application, mainly upward. The greatest movement occurred with tap root treatment and the least from applications made to the basal portions of the stem. Sufficient translocation occurred from application to the upper portion of the stem to label the tap roots weakly.

Cut-surface application

Blue oak. Studies on translocation following cut-surface application were mainly on blue oak. These studies were conducted in the field on 6-inch diameter trees and in the greenhouse on small trees. The results of these studies will be summarized.

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

Table I. Translocation of labeled 2,4,5-T (butoxyethanol ester and triethylamine) and amitrole following application to mature leaves (4 leaves) or the associated bark of white ash and red maple. The trees had previously been sprayed with herbicidal dosages of the same herbicides. The plants were harvested 30 days later and the distribution of radioactivity determined.

Plant part	Percent Distribution of C^{14}					
	2,4,5-T ester		2,4,5-T amine		Amitrole	
	Leaf Applic.	Bark Applic.	Leaf Applic.	Bark Applic.	Leaf Applic.	Bark Applic.
			White Ash			
Stem above treatment	0.3	1.8	0.2	0.2	0.3	0.3
Treated area						
Leaves (4)[1]	97.1	17.7	97.5	9.6	89.3	19.1
Stem	0.3	68.3	0.4	86.8	1.7	73.0
Stem below treatment	0.4	1.2	0.5	0.3	1.4	1.2
Root	0.3	1.5	0.4	0.1	4.0	1.8
Leaves[2]	1.6	9.5	1.0	3.0	3.3	4.6
			Red Maple			
Stem above treatment	0.0	0.7	0.0	0.3	4.0	4.5
Treated area						
Leaves (4)	99.1	31.2	99.7	5.5	78.0	20.4
Stem	0.2	31.6	0.1	87.7	4.0	48.9
Stem below treatment	0.0	0.1	0.0	0.3	6.0	3.1
Root	0.0	0.1	0.0	0.2	5.0	4.4
Leaves[1]	0.7	36.3	0.2	6.0	3.0	18.7

1. Leaves in treated area were either treated or connected to bark which was treated.
2. All leaves except those in treated area.

Six inch diameter blue oak trees treated with 2,4-D amine or the potassium salt of picloram applied to cuts (herbicidal dosage) prevented the downward translocation of $P^{32}O_4$ applied to the same cuts (as measured 4 feet below the point of treatment); however, excellent translocation occurred with $P^{32}O_4$ when the herbicides were not used. A similar test on madrone (**Arbutus menziesii**) indicated that the same treatment was less severe on this species.

Greenhouse tests with labeled 2,4-D and 2,4,5-T applied to cuts in the stems indicated that only low levels of activity reached the roots; the inclusion of unlabeled 2,4-D and 2,4,5-T to the same cuts depressed translocation into the roots close to the vanishing point.

Red Maple and white ash. Labeled 2,4,5-T butoxyethanol ester or triethylamine applied to cuts resulted in considerable upward translocation but very limited downward movement in these species. In considerable contrast to this, amitrole readily translocated into the roots following cut application.

Stumps. Translocation in stumps was studied largely with interior live oak. Labeled 2,4-D or 2,4,5-T acid was applied to the cut surfaces on top of the stumps. Downward movement of 2,4-D or 2,4,5-T was increased by rain or a herbicidal dosage of the amine form of the same herbicide (unlabeled).

Conclusions

Foliage application results in the sprays being deposited upon both the leaves and the bark. In some species, such as grape, considerable uptake and distribution of the phenoxyacetics occur following such treatments; however, very little transport of the same herbicides occurs from the treated leaves of red maple and white ash. On the other hand, other herbicides may be absorbed and translocated readily in the same species; amitrole is absorbed and translocated well in these species and also in grape.

Even though the translocation from treated leaves may be poor, transport may be excellent within the stems. Thus the butoxyethanol ester of 2,4,5-T applied to the bark was readily absorbed and transported away from the treated area in red maple and white ash. Unfortunately, the transport was almost entirely upward into the leaves and from these very little retransport occurred. Nevertheless, the good transport of an esterform from bark application does indicate why good top kills of many woody species can be obtained from dormant bark applications; poor downward transport indicates the reason for failure to control root sprouting.

Aqueous forms of herbicides are not as readily absorbed by the bark as the oil soluble forms. In the present tests, the ester form of 2,4,5-T was readily absorbed while the amine form was relatively poorly absorbed; amitrole was intermediate between the 2 forms of 2,4,5-T. Evidently, while ester forms are superior to aqueous forms with respect to absorption, even the latter are taken through the bark.

Herbicidal dosages of the auxin-type herbicides (picloram, 2,4-D, and 2,4,5-T) create alterations in the normal transport within plants. This alteration in flow was shown to occur in grape rootings. Translocation to the roots is reduced, while translocation within the shoot itself becomes redirected; in fact, transport into the petioles and large veins of mature leaves occurs. It is likely that all of the treated leaves transport less substance out of them because of the new "sinks" that are created within them.

Cut-surface applications to stems with the auxin-type herbicides results in moderately complete introduction of such herbicides into the woody plants. Transport is mainly upward in the transpiration stream in the xylem. In blue oak there was almost no basal movement in the phloem that was indicated, especially when the trees were treated with a herbicidal dosage (½ gm ae per in. diameter) of an auxin-type herbicide; downward transport was inhibited not only for the herbicide applied but also for substances normally highly mobile in such plants ($P^{32}O_4$). It is suggested that the sieve tubes are badly disrupted by the use of large dosages of such herbicides. The disruption is more severe in some plants than in others; in blue oak it was more severe than in madrone. Other types of herbicides (such as amitrole or MH) readily translocate into the roots following cut-surface application.

Herbicides applied to stumps move downward in a very slow and uncertain manner. The downward movement of 2,4-D and 2,4,5-T amines are especially hastened by rainwater and are also enhanced in addition by an excess of such herbicides applied to the tops of such stumps. It is suggested that a very slow polar downward movement of these herbicides occurs in the cambium or its immediate vicinity. However, clear-cut evidence of polar movement in the stumps and roots remains to be demonstrated.

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THE STATUS OF SODIUM IN SALTCEDAR (TAMARIX PENTANDRA PALL.)

Eugene E. Hughes

Abstract: Saltcedar, as the name implies, is able to thrive in river floodplains, with the salt content of the soil ranging up to 9,000 ppm. It can do this, under certain conditions, by virtue of its ability to take up salt, move it through the stem to the foliage where it is exuded through special glands resembling stomata.

Studies were made at Los Lunas, New Mexico, on the movement of sodium through plants growing naturally in the field, its point of storage or buildup, and subsequent removal. It was found that peak sodium buildup in the foliage occurred at the same time as the low point in the carbohydrate reserves in the roots. Both occurred about two weeks after the period of maximum growth of foliage.

On the premise that this buildup of salt in the foliage could affect results of herbicidal applications, we conducted additional studies of this buildup and removal. The studies showed that: 1) 55-60% of the sodium in the foliage can be removed by soaking 5 minutes in distilled water; 2) rainfall evidently removes a considerable amount of salt and deposits it on the soil surface; 3) by washing the foliage of greenhouse plants twice a week for two months with distilled water, collecting and analyzing the resulting solution for sodium, it would be seen that the sodium level of the foliage was initially lowered but that a point was reached where the plant could replace the sodium between washing; 4) the bottom foliage on stems one year old, or older, is higher in sodium than top foliage or than on current year's growth; 5) undisturbed plants have considerably higher foliage sodium content than plants that have grown back after mowing; and 6) the major sodium salt moving through the plant is sodium sulfate.

Further studies will be made to determine whether the buildup of salt in the foliage of saltcedar, at the low point of carbohydrates, has any effect on herbicidal applications. (Crops Research Division, U.S. Department of Agriculture in cooperation with The New Mexico Agricultural Experiment Station, Los Lunas).

ACCURATE APPLICATION OF GRANULAR AQUATIC HERBICIDES

A. J. Culver, Jr.[1]

The Plant Biology Station, of the Pesticides Regulation Division, located at Oregon State University, Corvallis, Oregon is charged with the responsibility of field, laboratory and greenhouse testing of fungicides, herbicides and plant growth regulators to determine if the label claims made by manufacturers are valid. We have been testing aquatic herbicides both in the greenhouse and in the field for about 4 years. In the early stages of this work it became very evident that the available equipment for the application of both granular herbicides and sprays was very inaccurate. Accurate application of a pesticide to a plot is necessary and is imperative when evaluating the performance of the pesticides. For several years a large number of granular herbicides came to our station to be evaluated. During this period a need was felt for better application equipment and we set about to rectify this situation. Most methods available for application of granular pesticides are well known to you gentlemen and need no further discussion here. To give you some idea of the problem I should like to show the first slide.

This is a lake covered with Parrot-feather (**Myriophyllum**). No water is visible. The second slide is a view of another lake. This lake, too, is covered with **Myriophyllum** from bank to bank. Now it is patently impossible to move a boat through this type of plant materials with a motor. You cannot do it. The only way you can get a boat through this growth is to drag it. But while you are dragging it you must also apply your herbicide. This is a problem. The equipment I'm about to describe was devised to eliminate this problem as well as others in this sort of an aquatic situation. In describing this equipment I would like to describe a little of its development. It was obvious from the first that a boat was necessary to float the operator and equipment. So we obtained a boat, next slide, which would be stable enough and yet be small enough to handle in the type of situation in which we work. This boat was then pulled manually by a man on the bank from one side to the other with a long rope. This wore out men in a hurry and it was impossible to control rate of movement in the lake. But it was concluded that since the spreaders which we were using were not particularly accurate then the speed of forward motion was not of too great consequence. We had a limited manpower situation, consequently, we had to devise a better way of moving the boat. This was done by putting a winch in the boat itself, stretching a cable or a rope across the lake and letting the winch do the work. Then it became apparent we must and could somehow tie the motion of the boat to the rope and use the rope as if it were a ground on which a ground wheel was running and use this ground wheel to operate the spreader which would deliver the pesticide. The next slide will show this device.

This winch is very simple, consisting of a small Briggs and Stratton motor driving a washing machine transmission to which is attached a Capstan drum. The rope which you see here is the rope stretched across the body of water being treated. The engine drives the gear train which drives the Capstan drum pulling the rope in at the bow and out over the stern, moving the boat forward. The bicycle wheel is the ground wheel and the shaft is a common shaft connecting the rope with the ground wheel so that the ratio is the same. The ground wheel can be used to drive anything that can be driven with this amount of power. Such as a metering device. The winch worked very well and we were able to use it for both unloading and loading the boat on the trailer, for pulling the boat up the bank and for moving logs which might be in the way. The problem of the spreader was more acute and after constructing one of Danielson and Chambers positive feed worm spreaders and testing it we found that this was not the answer. This spreader is illustrated in the next slide.

Danielson spreader works very well with fine particle size granules below 10 mesh but for granules above 10 mesh we had trouble. The larger granules tend to pack in the worm and are badly crushed due to the cut-off action. Gravity type spreaders driven by the ground wheel are dependent of the head of material in the hopper and the action of the small agitator to keep the material from bridging and are not suitable for this type of application. The spreader that finally evolved was inspired by watching a combine operate. The delivery of the seed on the draper inspired the germ of the idea. The next slide illustrates our spreader. I will describe it quickly.

A draper or a canvas belt is supported between two

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rolls, one driven by a chain from the ground wheel, the rear roll on the delivery side of the spreader. The forward roll is an idler. The belt on the draper moves in a rearward direction and carries a layer of granules from the hopper out under the shutter. The thickness of the layer of granules can be regulated by raising or lowering the shutter. The speed of the draper can be controlled by changing the sprocket ratios of the drive chain. This model is four feet long and will hold one hundred pounds of granules. It will treat a swath four feet wide and as long as the drive rope. The next slide illustrates the manner in which the spreader is mounted on the boat and also illustrates the method of operation in the field. The next slide is a table which illustrates the consistency of delivery which can be obtained with this unit. Are there any questions?

PRINCIPLES, TECHNIQUES, AND EQUIPMENT FOR MINIMIZING DRIFT OF PESTICIDES TO NONTARGET AREAS BY SPRAYING AN INVERT EMULSION ON TARGET

Lyle O. Hill[1]

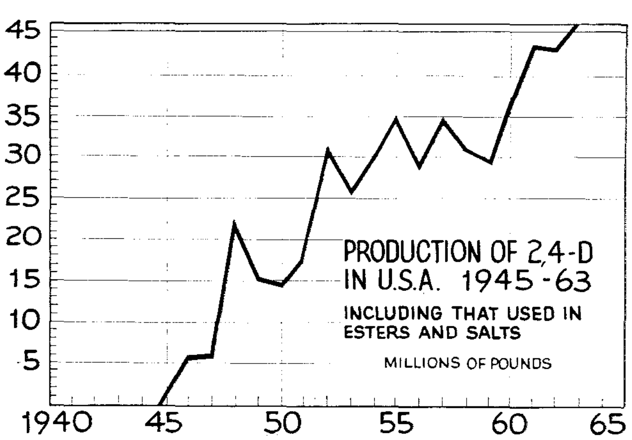
When 2,4-D was first used to kill a weed, a new era in man's control of nature was introduced. This chemical's value, still unequalled, is due, first, to its tremendous activity, and, second, to its undreamed-of selectivity.

Probably no other single chemical has saved the human race so many man-hours of back-breaking labor as has 2,4-D. It has improved our standard of living more than any recent wartime development. Ten years ago, it was estimated that a chemical worker in a 2,4-D plant could kill more weeds than 5,000 men working from sunup to sundown with a hoe. I would guess that our modern production methods have, by now, made this chemical laborer about twice as efficient as he was years ago.

In 1945, I started producing and selling 2,4-D. It was during this first season that I was confronted with a damage claim against one of our customers. While spraying the weeds in his back yard lawn, the customer allowed 2,4-D to drift on his neighbor's grapes along their adjoining fence. You can guess the rest of the story.

The damage claims blamed on 2,4-D during these twenty short years are staggering. If all the claims that were taken to court or settled out of court could be totalled, I believe they would exceed a billion dollars. In spite of the out-lawing of 2,4-D in many places and the threat of its being barred in many other places, the use of 2,4-D has grown in both pounds of acid and acres treated. Its values has been many times these damage claims, which explains its continued twenty-year growth as shown by the curve in Figure 1.

FIGURE 1



During these trying times the values of 2,4-D and 2,4,5-T have been established, and demands for their use have soared. Many of us soon began to study ways of applying these chemicals without the hazard of drift. I personally worked with frilling, tree injectors, granular formulations, thickening agents, and invert emulsions looking for ways to decrease the hazard of these materials to nearby desirable plants. For the past seven years I have been directly concerned with a bifluid system of spraying invert emulsions, commercially available as the Rhap-Trol[2] Spray System.

This bifluid system was first conceived and patented by E. B. Stull, owner of Stull Chemical Company in Texas. Hercules Powder Company has acquired these patents from Stull in an agreement that permits Stull to reserve a license for limited use.

To show how these invert emulsions can be sprayed on target, the drift contained, and the pesticides on nontarget areas minimized, I would like to conduct the discussion in three parts:

(1) Stoke's Law and how its equation may be used as fundamental principle in predicting drift
(2) Requirements of coverage to kill plants
(3) Techniques and equipment used with the bifluid system to meet these requirements

Adaption of Stoke's Law to Predict Drift

To determine drift, Stoke's Law can be used to compute the rate and therefore the time of fall for droplets of different size. The drift of a droplet is the distance a crosswind will blow it during the time required for the droplet to fall. Therefore, you can see that Stoke's Law is fundamental to our problem. My old Physical Chemistry Text gives the equation for Stoke's Law in this form:

$$v = \frac{2gr^2(p-p_1)}{9n}$$

v = velocity at which a particle drops
g = force of gravity
r = radius of the particles
p = density of the particles
p_1 = density of air
n = viscosity of air

Would you know how to use this form of Stoke's equation? It requires metric units, and, unfortunately, we are accustomed to using a more cumbersome set of English units. By using a combination of units from each set and making a couple of assumptions, we can reduce this equation to a very simple and usable form:

$$D = \frac{1.49 \times 10^4\ VH}{R^2}$$

D = drift distance in feet
V = wind velocity in miles per hour
H = drop distance in feet
R = droplet diameter in microns

Now with a workable equation, let us study the minimum calculated drift and coverage. We can calculate how far a droplet of 100 microns (which is typical of droplets in a conventional spray system) will drift if it is sprayed at a height of 50 feet with a crosswind of 1 mile per hour. The equation then becomes:

$$D = \frac{1.49 \times 10^4 \times 50 \times 1}{(10^2)^2} = 75 \text{ feet of drift}$$

We can make a similar calculation for a droplet of 590 microns, which is the mass median diameter produced by the Rhap-Trol Spray System. The equation becomes:

$$D = \frac{1.49 \times 10^4 \times 50 \times 1}{(5.9 \times 10^2)^2} = 2 \text{ feet } 2 \text{ inches}$$

Let us look at conditions which may be encountered when spraying a right-of-way with a helicopter. In Table I we have compared the distance droplets of 100, 300, 590, and 800 microns will drift when sprayed from a height of 50 feet in a crosswind of 1, 5, and 10 miles per hour.

The 300 to 800 micron droplets are in a comparatively safe range even in a 10 mile per hour wind, for all are contained within 83 feet.

1. Agricultural Chemicals, Synthetics Department, Hercules Powder Company, Wilmington, Delaware
2. Hercules2. Hercules Trademark

Table I. Predictable drift of different particle sizes when sprayed at 50 feet.

Diameter of Particles in Microns*	In Crosswinds of I Mile Per Hr.	5 Miles Per Hr.	10 Miles Per Hr.
100	75 ft.	375 ft.	750 ft.
300	8 ft. 4 in.	42 ft.	83 ft.
590	2 ft. 2 in.	10 ft. 8 in.	21 ft. 5 in.
800	1 ft. 3 in.	5 ft. 9 in.	12 ft.

*One Micron = 1/25000 inches, or 1/1000 millimeters.

Now let us look at the same particles sprayed at a height of 5 feet, which would approximate roadside spraying conditions in Table II.

Table 2. Predictable drift of different particle sizes when sprayed at 5 feet.

Diameter of Particles in Microns*	In Crosswinds of I Mile Per Hr.	5 Miles Per Hr.	10 Miles Per Hr.
100	7 ft. 6 in.	37 ft. 6 in.	75 ft.
300	9 in.	4 ft. 3 in.	8 ft. 4 in.
590	3 in.	1 ft. 1 in	2 ft. 2 in.
800	2 in.	6 in.	1 ft. 3 in.

*One Micron = 1/25000 inches, or 1/1000 millimeters.

Here you can see that 300 to 800 microns are approaching a higher degree of safety.

Requirements for Coverage

From the above calculations you may ask, "Why not work toward droplets of 800 or 1,000 microns?" For the sake of controlling drift that would be excellent.

But why are we spraying? The answer is to kill weeds or brush. Dr. Richard Behrens has shown that 60 to 70 droplets containing 2,4,5-T are required to kill mesquite. He found that the equivalent of ½ pound of 2,4,5-T per acre was necessary for kill, and that additional amounts did not increase kill as long as this required number of droplets was applied. Thereby, he showed that over a droplet size range of 200 to 800 microns the most important factor was droplet spacing. At Dallas last week Lehman & Haas confirmed that about 70 droplets per square inch are most effective in kill of brush such as a mesquite bush. Succulent plants such as dandelions may require as few as 20 droplets of 2,4-D.

As droplet diameters are halved, the number of droplets increase 8 fold. It seems that when dealing with nature, it is always necessary to compromise. Table III gives a little more information which can be used for making this compromise. Table III shows the number of droplets one gallon would theoretically cover per square inch if uniformly sprayed over an acre, assuming each droplet to be the size stated. This table also gives the expected drift when sprayed at a height of 50 feet in crosswinds of 10 miles per hour.

Droplets of 300 to 800 microns can be sprayed from a helicopter equipped with our Rhap-Trol Spray System. This spray will give good kill at low gallonage per acre; for example, 4 to 12 gallons of product give an adequate number of droplets per square inch as shown by Table III. Thus, droplets large enough to contain the drift, but still small enough to spray the required number of droplets per square inch to kill, are now a commercial reality.

The Bifluid Spray System

Now, let us look at this bifluid system again. You can see there are two tanks, two pumps, two orifices. There is no premixing required. The herbicide concentrate, as manufactured at the plant, becomes the oil phase.

Table 3. Comparison of number of droplets and drift for various particle sizes.

Diameter of Particles in Microns	Calculated Number of Droplets Per Square Inch Per Gallon/Per Acre	Calculated Drift—50 Ft. Height in 10 M/W
100	1,164	750 ft.
300	52	83 ft.
590	5.6	21 ft. 5 in.
800	2.6	12 ft.
1000	1.1	7 ft. 6 in.

The nozzle, which is the key to the system, contains the mixing chamber. The energy that is created by the swirling action inherent in the nozzle design inverts this emulsion from the water phase to the oil phase. This water-in-oil emulsion, which exhibits plastic-type rheological behavior, has a yield point of about 100g. (Dr. John Walker of Hercules, who developed a method of measuring this yield point with the Gardner Mobilometer, will report on it later this year.) This high yield point discourages further break once the spherical droplet is formed.

Further, the invert droplet has a low volatile, oil film surrounding the water. This film greatly reduces water evaporation while the invert droplets are falling from the nozzle to the plant.

Our success in using the Rhap-Trol Spray System for ground and air applications indicates its great versatility. Here are some typical applications which are now in use.

1) A helicopter spraying over power lines has already been mentioned; to control aquatic weeds is another use of the helicopter.
2) Fixed-wing airplanes are effective for spraying brush that infests rangeland, for killing brush to release pine, and for controlling weeds in rice.
3) A back-pak sprayer is used to spray brush in fence-rows and along power transmission lines.
4) A tractor unit can be assembled to spray weeds in pastures and on roadsides.
5) A blower such as Meyer's has been used to spray weeds and brush on roadside and railroad rights-of-way.

SUMMARY

1) Stoke's Law with this simplified equation now becomes a tool with which to predict drift.
2) To control drift Stoke's Law points toward large droplets. To kill brush Behren's work shows the need of a large number of droplets. Table III shows a favorable compromise can and has been made.
3) The Rhap-Trol Spray System, which will be commercially available in 1965, is containing the drift within definite limits and killing weedy plants because it approaches this safest selection of droplet size.
4) Money can be saved with the Rhap-Trol Spray System because:
   a) Low gallonage can be used for economy
   b) Less chemicals is often required
   c) No product waste through premixing
   d) Higher crosswinds may be tolerated resulting in more spray hours during spray season
   e) Inexpensive equipment will be available for most every method of application
5) The ability of the Rhap-Trol System to keep the herbicide on target makes it look promising for the application of many other pesticides.

I HOPE YOU WILL PLAN TO SPRAY ON TARGET WITH OUR RHAP-TROL SYSTEM IN 1965.

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DACAGIN, A PSEUDOPLASTIC SPRAY AGENT

B. A. Sprayberry[1]

Ever since the advent of the use of 2,4-D and 2,4,5-T for weed and brush control, industry and the consumer have been faced with two major problems; namely, volatility and drift. The problem of volatility was partially solved by the use of the amine salts of 2,4-D and 2,4,5-T, where they would do the job, and more recently by the superior oil-soluble diamine salts of these two materials. However, the problem of spray drift has been more difficult to resolve. One special approach to the problem of spray drift for woody plant control involves the use of the water-in-oil emulsions which are more commonly known as invert emulsions. However, the use of inverts has been rather limited due to the fact that special spraying equipment is required for the application of these high viscosity materials.

Diamond Alkali Company has developed Dacagin, which is a pseduoplastic spray agent. By that, it is meant that the addition of Dacagin to water produces a spray gel, which is very liquid while under agitation in a spray tank or while being pumped, but will revert to a gel state when allowed to stand. Then upon resuming agitation, it will again become liquid. This liquid to gel to liquid cycle can be repeated any number of times. Dacagin spray systems, unlike the inverts, can therefore be used in most conventional ground rigs that are equipped with good mechanical agitation. In addition to the above property, which is called thixotrophy, Dacagin spray gel systems will permanently assume a higher viscosity when subjected to a high shear stress, as when it passes through a nozzle orifice under pressure. This means that the spray gel that hits the plant is a very substantial gel.

Dacagin has been extensively field-tested in all kinds of spray equipment, including back-pack knapsack sprayers, 3000 gallon tank commercial sprayers, conventional booms mounted on aerial and ground rigs and even air-carriers. In all cases, excellent drift control was obtained even under adverse wind conditions that would have been prohibitive to the safe application of conventional emulsions.

Dacagin sticks to plants, bringing the toxicant into intimate contact with the plant tissue. Because of its unique physical-chemical properties, it resists drying, thus retaining the toxicant in its more active "hydrated" state for a longer period of time. As the spray droplets begin to dry, a membranous film is formed, encapsulating the active ingredient and thus becoming further resistant to drying. This encapsulation logically reduces the danger of volatility when volatile materials such as the esters of 2,4-D or 2,4,5-T are used as the active ingredients. The Dacagin spray droplets will eventually dry to form a weather resistant film, which adheres to the plant and is very resistant to wash-off by rain. In fact, heavy watering only tends to rehydrate the film to a gel. Since Dacagin is water-based, it can be used on plants that are slightly wet, but its use is not recommended during rain.

Logically, any applicator who is concerned about physical spray drift also has reason to be concerned with volatility. It is therefore highly recommended that Dacamine formulations be used as active ingredients in Dacagin spray systems. These formulations are non-volatile and pack the weed and brush killing punch of the esters.

Dacagin pseudoplastic spray agent has been specifically developed for use with Diamond Alkali Company's Dacamine, Line Rider, Fence Rider and Crop Rider formulations. The Dacagin spray systems are prepared by slowly adding Dacagin pseudoplastic spray agent to the required amount of water with vigorous agitation. Continue to agitate for ten minutes and then add the active ingredient while continuing agitation. If desired, a small amount of oil may also be added to the Dacagin spray, but no more than five percent is recommended, as oil will considerably reduce the pseudoplasticity, as well as the viscosity of the system. To transfer the spray mixture from mixing tanks to spray tanks, use a centrifugal or positive displacement pump with 1½ to 2 inch hose fittings on both the intake and discharge ends.

Do not allow Dacagin spray gel to dry in the tanks. After use, it is recommended that the spray tank and equipment be flushed with water to remove any Dacagin spray gel that might dry to a film, thus fouling the screen and nozzles. If the equipment is not to be used for an extended period of time, and the operator desires to more completely clean his equipment, it is recommended that a polyphosphate type of water conditioner and detergent be used. A final rinsing and flushing should leave the tank and lines adequately clean.

It is felt that a definite need in the weed and brush control industry has been filled by the development of Dacagin, particularly when used in conjunction with Dacamine formulations.

1. Diamond Alkali Company, Cleveland, Ohio.

CONVERTING CALIFORNIA BRUSHLAND TO GRASS

George D. Burma[1]

INTRODUCTION

Nine million acres (8) of California range covered with unpalatable brush can be converted to grass when properly planned based on the author's 12 years of field experience as a Range Conservationist with the Bureau of Land Management. This area is located in the western foothills of the Sierra Nevada Mountains and the Coast Ranges. Topography varies from moderate to very steep slopes with elevations between 1000' and 5000'. Precipitation variations are from 10 inches to 40 inches falling as rain and snow during the winter season from October to April. Soils are shallow to deep, sandy loam in some areas of the Coast Ranges to heavy red clay in the Sierra Nevada foothills with often low fertility. The most prevalent brush species include chamise **(Adenostome fasciculatum),** buckbrush (**Ceanothus cuneatus**), scrub oak (**Quercus dumosa**), Interior live oak (**Quercus wislzenni**), manzanite (**Arctostaphylos sp.**), toyon (**Photinia arbutifolia**), and yerba santa (**Eriodictyon californicum**). All species listed above furnish browse for deer except manzanita (2). Mature stands of brush have little value for grazing by livestock (8); however, on newly burned areas, young sprouts may furnish considerable amounts of browse.

In most areas, the brush is undesirable except on very steep slopes where it does serve to protect the watershed. The advantages of conversion to grass are: less soil erosion, increased forage for livestock and wildlife, increased ground water, reduced fire hazard and greater ease of traversing for ranchers, livestock managers, wildlife managers, hunters and recreationists. In converting brush to grass in Central California, the Bureau of Land Management takes the following steps which have proven suc-

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cessful on nearly all projects:

1. Site Selection
2. Brush Eradication
3. Seeding
4. Spraying
5. Management

The procedures and techniques as practiced by the Bureau of Land Management are based on the results of research carried out by the California Division of Forestry, University of California, U. S. Forest Service and the Agriculture Research Service.

SITE SELECTION

In selecting the site, consideration is given to slope, precipitation and soils. Slopes of 50% or more are too steep for use of equipment and any disturbed soil may be subject to severe erosion (10). Usually the brush cover of the steeper slopes should be left intact.

Rainfall areas of 17 inches or less per year will grow only annual grasses (10). From 17 inches to 40 inches annual rainfall perennial grass seedings are successful.

The most important consideration in selecting a site is the type of soil. The best grassland soils are dark in color, medium to heavy in texture and contain a fair amount of organic matter. The surface soil may be slightly acid but is typically more basic with increased depth (9). Good grassland soils are 24 inches or more in depth, although a good production of annuals has been obtained on soils of 12 inches in depth and of clay-loam texture (10). Many good grassland soils have clay-pan subsoils (9). Data on soils is available from soil surveys conducted by the Soil Conservation Service or soil-vegetation surveys completed as a joint project of the California Division of Forestry and the University of California. The better sites are selected first, since the chances of success and returns are greater. However, if a brush or timbered area is covered by a wildfire, immediate steps are taken to effect rehabilitation.

BRUSH ERADICATION

Standing brush may be eradicated by controlled burning (6). Adequate firelines must be constructed, and preburning along hazardous portions of the fireline in early spring is recommended. On the day of the burn, adequate manpower and equipment must be available to prevent escape of the fire. Crushing of brush prior to burning is becoming a common practice because of the hazards involved in burning standing brush. Early spring and late fall, when brush is brittle and the ground firm are two good seasons for crushing. The results are better burns because the fuel is concentrated on the ground, safer burns because the dried brush burns during less hazardous weather and cleaner burns because most of the wood burns and no blackened stems are left standing. Crushing may be accomplished by going over the brush with a dozer blade raised 12 inches above the surface of the ground (1). Another method is to drag a log behind the tractor perpendicular to the line of travel. Pulling a heavy anchor chain between two tractors has also been successful (4). Areas of crushed brush are burned in the spring before fire conditions become hazardous. Late spring burning is preferable to fall burning as it results in less sprouting. In late spring, the combination of growth conditions are not favorable for sprouting. At the end of the growing season, root reserves are low and soil moisture has been depleted. In planned burning, certain areas are protected from fire to provide wildlife habitat.

SEEDING

The best time for seeding is in September, October or November prior to the first fall rains. On an ash seed bed, good stands of grass can usually be obtained by broadcasting with fixed wing aircraft or helicopter. Seeding with a rangeland drill, although more costly, results in better stands, especially of perennials (3). By using a drill, fertilizer may be added at the time of seeding to insure a better stand. Harding Grass (**Phalaris tuberosa**) and Smilo (**Oryzopsis miliacea**) are the perennial grasses used with Blando Brome (**Bromus mollis**) and Wimmera Ryegrass (**Lolium subulatum**), the annual grasses. Harding Grass is seeded on the better soils in the higher rainfall areas. At lower elevations of low rainfall, Blando Brome and Wimmera Ryegrass are seeded. A good mixture for seeding on the intermediate areas is 2 pounds of Harding Grass, 2 pounds of Smilo and 2 or 3 pounds of Blando Brome. Annual ryegrass (**Lolium multiflorum**), often called common ryegrass, has been seeded on the Public Domain in fire rehabilitation projects in cooperation with other agencies.

SPRAYING

Since 1958, nearly all Bureau of Land Management projects have been chemically sprayed to kill the brush seedlings and sprouts. Most dependable brush-sprout control by aircraft application has been achieved by spraying in the spring following a late spring, summer or fall burn. The spray mixture most commonly used consists of 2 pounds of 2,4-D (2,4-dichlorophenoxyacetic acid), one pound of 2,4,5-T (2,4,5-trichlorophenoxyacetic acid), 2 quarts of diesel fuel and enough water to make five gallons of solution. This mixture is applied at 5 gallons per acre by helicopter. On early projects, fixed winged planes were used; but because of steep terrain, they proved unsatisfactory. Only those formulations of 2,4-D and 2,4,5-T which have been tested by the University of California have been used. These formulations include propylene glyco Butyl ether ester, Butoxy ethanol ester and iso-octyl ester (5). The spray mixture is applied when seedlings and sprouts are growing vigorously and before soil moisture is depleted. This period occurs from April 15 to May 31. One application of the above mixture will kill 100% of the brush seedlings. Kills of 75% to 100% occur on brush sprouts of ceanothus, chamise, manzanita and yerba santa. Toyon, scrub oak and interior live oak require spraying 2 or 3 years in succession for good kills.

MANAGEMENT

Newly seeded areas of annuals can be grazed the first year if the seed is allowed to mature. Perennial seedings generally should not be grazed until the second year after seed maturity followed by a system of grazing which will insure proper use. Fencing, even distribution of water and salting grounds aid in an even distribution of livestock.

COSTS

Brush crushing—$4.00 to $9.00 per acre, average $8.00 per acre.

Controlled burning—$1.00 to $2.00 per acre, average $1.20 per acre.

Seeding

- Seed—$.50 to $6.00 per acre, average $3.50 per acre.
- Airplane seeding $.35 to $.75 per acre, average $.50 per acre.
- Rangeland drill $2.00 to $3.00 per acre, average $2.50 per acre.

Spraying

- Chemical $3.50 to $4.50 per acre, average $4.25 per acre.
- Helicopter $2.00 to $3.00 per acre, average $2.25 per acre.

The total maximum cost per acre is approximately $25.00. However, with the increased production, the cost of converting brush to grass can be recovered in 4 to 7 years (7).

RESULTS

Converting brush to grass reduces soil erosion. Under dense stands of chamise, the ground is quite bare. Heavy rains result in considerable soil erosion. In contrast, there is very little soil movement from a good grass cover.

A mature stand of chamise provides very little forage for livestock. Brush fields which have been converted to grass have a carrying capacity of from 3 acres to 1 acre per animal unit month. Studies (unpublished) made in 1963 by Carl M. Rice, Range Rehabilitation Specialist, Bureau of Land Management, Sacramento, California, on the Bollinger Ridge Project, Santa Clara County, an annual ryegrass seeding following a wildfire, indicated that 781 pounds of forage dry weight was available to livestock and/or big game. Studies made in 1964 on the Briceburg Project, Mariposa County, a perennial grass seeding following a wildfire indicated that 1720 pounds of forage dry weight was available to livestock and/or big game. Additional forage may be produced by applying nitrogen plus phosphorus and sulphur, if needed, to soils which respond to fertilizer. Trials are needed for each soil type and climate condition to demonstrate responses to various fertilizers.

Studies conducted by the University of California and the United States Forest Service indicate a considerable increase in yield of water from areas which have been converted from brush to grass. The deep-rooted evergreen species of brush found in Central California have a much higher rate of transpiration than grass.

In preparing for a controlled burn, roads and trails are improved and additional firebreaks are constructed. This increases the speed and ease with which equipment can be brought into the area for control of wildfires. Conversion of brush to grass greatly reduces the amount of fuel. The result is safer and easier control of wildfires.

Thick stands of brush are almost impenetrable to man and animal life. Conversion to grass makes it much easier to manage livestock. Hunters and recreationists can make greater use of the area.

Summary

Ten million acres of California range covered with unpalatable brush can be converted to grass when properly planned as based on the author's twelve years of field experience.

Recommended procedure: (1) Crush brush during summer months; (2) Burn brush the following spring; (3) Fall seeding of grass; (4) Spray with 2,4-D in the spring to kill brush seedlings and sprouts; (5) Proper management to maintain or increase desirable grasses.

The results: (1) Reduced soil erosion; (2) Up to 500% increase in carrying capacity for livestock and wildlife; (3) Reduced fire hazard; (4) Increased ground water supply; (5) Better accessibility for livestock management and recreation.

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FACTORS AFFECTING THE CONTROL OF PURPLE NUTSEDGE WITH R-4461

W. Powell Anderson, Max P. Dunford, and J. Wayne Whitworth[1]

Stauffer R-4461, N-(beta-0,0-diisopropyldithiophosphorylethyl)-benzene-sulfonamide, is a promising herbicide for use in horticultural and agronomic crops. It is currently being used as an herbicide in turfgrass and is available commercially under the trade name Betasan. A new trade name, Prefar, has been assigned to this herbicide by the company for use in agricultural crops. Prefar has not as yet been registered with the U.S.D.A. for use in any food crop.

On August 31, 1962, R-4461 was applied under field conditions at dosages of 10 and 20 lbs/A for the control of purple nutsedge. The treatments were soil incorporated by discing and each treatment was replicated three times. Evaluations of these treatments over a two and one-half year period have shown 100 percent control of purple nutsedge. However, subsequent treatments applied similarly at nearby locations during 1963 failed to give adequate control of this weed.

Influenced by the excellent potential for controlling nutsedge as expressed in the original test of 1962, tests were devised to study more closely this phenomenon under greenhouse conditions.

In a preliminary test, R-4461 was soil incorporated at dosages ranging from ½ to 40 lbs/A and nutsedge tubers planted directly in this soil. Results showed that the roots of nutsedge were inhibited from growing at dosages of 4 lbs/A and above. Shoot growth was not directly affected by the R-4461 treatments.

In a subsequent test, R-4461 was soil incorporated at dosages of 1, 2, 3, 4, 6, and 8 lbs/A and the nutsedge tubers planted in this soil. At four day intervals, the tubers were washed from the treated soil and transplanted to untreated soil where they grew for the duration of the experiment, a total of 33 days. The results of this test showed that as soon as the tubers were removed from the treated soil and transplanted in untreated soil root growth immediately began and was normal; within a short time the plants were indistinguishable from ones which had been only in untreated soil. Results also indicated that, at dosages of 6 lbs/A and below, the growth inhibitory effect of R-4461 diminished with time (see Tables).

The effect of soil-incorporated R-4461 upon the subsequent growth of roots from nutsedge tubers planted in this soil.

Days in treated soil	Length of longest root* lbs/acre 0	1	2	3	4	6	8
4	....	....	....	....	....	....	....
8	....	....	....	....	....	....	....
12	4	3	3	3	3	2	2
16	4	4	4	3	3	2	1
20	4	4	4	3	2	2	2
33	4	4	4	4	3	3	1

*Scale: 1 - 0 to ½; 2 - ½ to 1; 3 - 1 to 2; 4 - over 2 inches. Average of five replications and four tubers per replication.

Nutsedge tubers planted in untreated soil located below a two inch layer of soil into which dosages of 2, 3, 4, and 8 lbs/A had been incorporated grew right through this treated soil with no detrimental effects. The roots developed in the untreated soil and only the shoots were exposed to the treated soil. The soil was watered as needed by subirrigation.

From tests to determine the effect of the leaching action of water upon the control of purple nutsedge tubers with R-4461, it was found that six acre-inches of water

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percolated through the soil into which 4 lbs/acre of R-4461 had been incorporated did not leach out enough of the herbicide to greatly reduce its inhibitory effect on the nutsedge roots.

There was an indication that some of the R-4461 was leached from the layer of treated soil since the inhibition of roots was slightly less severe than that in treated controls.

Growth of roots from nutsedge tubers transplanted at 4 day intervals from R-4461-incorporated soil to untreated soil.

Days in soil		Length of longest root* lbs/acre						
treated	untreated	0	1	2	3	4	6	8
4	29	4	4	4	4	4	4	4
8	25	4	4	4	4	4	4	4
12	21	4	4	4	4	4	4	4
16	17	4	4	4	4	4	4	4
20	13	4	4	4	4	4	4	4
33	0	4	4	4	4	3	3	1

*Scale: 1 - 0 to ½; 2 - ½ to 1; 3 - 1 to 2; 4 - over 2 inches. Average of five replications and four tubers per replication.

In another leaching test, six acre-inches of water was percolated through soil columns to which R-4461 had been incorporated in a one inch soil layer located on the top of each column at a dosage of 15 lbs/A. Using nutsedge tubers for bioassay, it was determined that insufficient R-4461 was leached into any of the lower one inch soil segments of the columns to inhibit root growth.

In summary, it is apparent that R-4461 does have an effect upon the growth of purple nutsedge and that this effect is an inhibitory one on the roots of the plant and that the growth of the shoot is not affected directly. Effective dosages in the greenhouse begin at a dosage of 3 lbs/acre, soil incorporated. The root growth inhibition is of a temporary nature and as soon as the tubers are removed from the R-4461 treated soil, root growth is immediate and normal. Over a prolonged period of time the effect of R-4461 appears to decrease even though the tubers are not removed from treated soil; this effect is apparent at dosages below 8 lbs/A. R-4461 is not readily leached in soil in herbicidal amounts but it is leached to some extent as indicated by bioassay, using annual ryegrass as the indicator plant. Nutsedge tubers located below the layer of R-4461 treated soil will grow right through the treated soil and are not detrimentally affected.

It is apparent from these greenhouse experiments that R-4461 is not a promising herbicide for the control of purple nutsedge. However, there still remains the unexplained reasons for the eradication of this weed in the 1962 test; perhaps this is due to a change in the formulating of this material.

RESULTS OF PICLORAM FOR CONTROL OF PERENNIAL WEEDS

Harold P. Alley[1]

Picloram, 4-amino-3,5,6-trichloropicalinic acid, a new compound from the Dow Chemical Company, trade named Tordon, was introduced into Wyoming in the spring of 1963. Although limited amounts were available, numerous evaluations have been made on a number of deep rooted perennial weeds and undesirable woody species.

Considerable enthusiasm has been created throughout Wyoming for the control of perennial noxious weeds. Plots established in 1963 on Canada thistle, field bindweed and Russian knapweed show these species are being eradicated by an application of 1 lb on fall regrowth and 2 lb/A when treated in the bud-to-bloom stage of growth.

Table I. Percent Control of Canada Thistle 9 months after Herbicide Application.

Chemical	lb/A	Growth Suppression of Remaining Plants	Percent Control
Picloram	1	Kochia & Setaria	100
Picloram	2	Volunteer oats healthy	100
Picloram	3	Volunteer oats	100
Picloram	4	W. Wheatgrass	100
2,3,6 TBA	20	Fair grass	95
Benzabor	1½ lb/sq. rd.	Bare	95
Dicamba	5	Good grass stand	90
Treated 10/11/63		Evaluated 7/7/64	

Plains larkspur (**Delphinium geyeri**), common milkweed (**Asclepias speciosa**), plains pricklypear (**Opuntia polycantha**) and Rocky Mountain juniper (**Juniperus scopulorum**) have all been effectively controlled with relatively low rates of picloram.

An application rate of 1 lb/A has resulted in 100 percent control of plains larkspur with no damage to the associated native grass species at rates of 2 lb/A or less. The 1 lb/A treatment is too expensive for vast areas of infested rangeland; however, extensive plots were established in 1964 to evaluate lower rates of application.

Square rod plots established in 1963 on plains pricklypear show that picloram at 1 and 2 lb/A resulted in 80-90 percent control one year after treatment.

In June, 1963, three new herbicides were evaluated for control of Rocky Mountain juniper in Wyoming. Only picloram, showed activity and the results were very striking. It was equally effective in the pellet form or as the emulsifiable concentrate. Evaluations one year after application indicate that 1 lb/A active ingredient is sufficient for a 100 percent kill.

On July 3, 1964, 5 and 10 acre plots were established by use of a helicopter. These are the first aerial plots established in the Western United States for chemical control of juniper. Picloram at ½, 1 and 2lb/A and picloram-101 mixture at 1 and 2 gal/A were applied in a total volume of 5 gal. of water and chemical per acre. All rates seemed to exhibit considerable toxicity to the juniper trees when evaluated in September, 1964. Final determinations as to percent kill will not be made for at least one year after applications.

Limited grass tolerance experiments were conducted. An application of 2 lb/A of picloram was made across established grass nurseries which included chewings fescue, red creeping fescue, Kentucky bluegrass, Colonial and Seaside bentgrass, Western wheatgrass, tall wheatgrass, Buffalograss, blue grama, Russian Wildrye, perennial ryegrass, Mandan bromegrass and orchardgrass. Observations indicate outstanding control of Canada thistle and white-leaved franseria, with no damage to the grass species.

Other areas have been treated with rates ranging from 1 to 4 lb/A for purposes of checking soil residual. These treated areas will be cross-seeded with various crops in 1965.

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NEW MEXICO'S WEED CONTROL DEMONSTRATION PROGRAM

Gordon B. Hoff[1]

The weed control demonstration program in New Mexico is mainly conducted to show farmers and ranchers how they can use chemicals to control various unwanted species of plants.

In planning the program in each county, the extension service works closely with the Agricultural Services Department of New Mexico State University. The county agent is the backbone of the program and occasionally

1. Extension Agronomist, New Mexico State University

will do most of the planning of the program in his county. However, the usual method is for the agent to work with a program planning committee. This committee may be his county program planning committee or a committee specifically set up to help plan this phase of his program. Usually the extension agronomist and a member of the Agricultural Services Department is present and assists with the planning of demonstrations.

The Agricultural Services' role in the program is to assist the extension service in conducting the demonstrations as well as in planning. This department has three men and various types of spray equipment for applying chemicals. They also obtain the chemicals needed either gratis from the company or dealer or by direct purchase.

The Agricultural Services Department furnishes a 3'x5' sign for each demonstration naming the cooperators and the type of demonstration and small signs for each treatment applied.

The farmer demonstrator is a very important man in the program especially where a demonstration is conducted in field crops and requires special handling to get weed control information and yield data. The selection of the cooperator is very important and the planning committee is very valuable to the program in its ability to select reliable cooperators and thus keep the mortality rate of demonstrations at a low level. The county agent must obtain the necessary information in results of demonstrations and his work is made easier by a cooperator that takes proper care of a demonstration and informs him of his harvest plans.

The program has been very successful in speeding up the use of chemicals for weed control in the state. Some specific examples are the general use of Karmex and Treflan in cotton, bindweed control with various materials, and control of rayless goldenrod, mesquite, cactus and cocklebur on rangeland.

In 1964 there were 60 demonstrations conducted under this program. Farmers and ranchers were able to observe the demonstrations throughout the season. The demonstrations were included in various county tours and results of the demonstrations were publicized in news releases and on the radio. An annual report of all demonstrations is prepared each year.

"CLEAN ACRES WEED CONTROL IN GEORGIA"[1]

J. E. Jernigan[2]

Mr. Chairman, fellow coworkers, and friends:

I am especially happy to have this opportunity to meet with you at the 1965 Western Weed Conference here in Albuquerque. You are to be commended for the organization and development of this fine conference where you can share your accomplishments and problems with fellow workers throughout this important agricultural region of our country. I'm sure, not only you, but farmers, landowners, the agricultural chemicals industry and the consuming public benefit greatly from the mutual sharing of information in this meeting.

You are engaged in the very important business of helping farmers, ranchers, and other landowners solve one of their oldest, most troublesome, and costly problems—weed control. Loss in agricultural production due to weeds and cost of their control is estimated to exceed $4 billion annually. Herein lies a challenging opportunity for us to help increase efficiency of production through lower cost weed control methods and techniques. In a recent study made by research and extension State specialists, and leading farmers in the 14 major cotton growing states it's estimated that through adoption and judicious use of presently known technology in weed control, farmers can reduce the cost of producing cotton by an average of .95 cents per pound of lint. This is about $5 per acre. Accomplishing this goal however will take an intensified, well coordinated educational program with all farmers—both large and small.

The tremendous revolution in agricultural technology is familiar to all of you. By the time you have certain facts fairly well fixed in your mind there are a multitude of new ones to be learned to take the place of many of those you already know.

Certainly the field of weed control science and technology is among the leaders in this revolution. A recent "Survey of the Cost and Extent of Weed Control and Specific Weed Problems"—which is in the printing stage at this time—was conducted jointly by the State Cooperative Extension Services, the Federal Extension Service and the Agricultural Research Service of USDA. Many interesting facts are brought out by the 1962 survey when compared to a similar survey made in 1959. Among the significant facts brought out in this study which point up the rapid rate of change in chemical weed control are:

1. In 1962 herbicides were used on approximately 70 million acres of agricultural land at a cost of over $272 million. The treated acreage in 1959 was about 53 million acres at a cost of approximately $128 million. This is a 75% increase in the acreage treated during this 4-year period. I'm sure the acreage treated with herbicides has gone up considerably since the 1962 survey was made.

2. From 1959 to 1962 herbicide usage on some of our major crops was increased by the following percentages: corn 26, cotton 250, soybeans 408, rice 87, peanuts 786, sugarbeets 192, sorghum 27, forage seed 56, vegetables 246, fruits and nuts 5,198, ornamentals 2,218, lawns 1,020, hay 51, pastures 96, rangeland 13, and non-crop land 83. Overall there was a 281 percent increase in use of pre-emergence herbicides and 13 percent in use of post-emergence herbicides.

We have also had a big increase in the number of herbicides available for use. For instance, in 1940 we had only 14 herbicides available for weed control but in 1962 we had over 100 herbicides from which to choose.

Rapid development and improvement in application equipment and in technique of application have taken place. So you see we have truly had a revolution going on in the field of weed control during the last 25 years.

Farmers have accepted this new concept in weed control and from the above figures you can see that they have begun to rely on herbicides as means of reducing cost of control, cutting down on labor requirements, and on improving their chances of having weed free fields during adverse weather conditions. In spite of all the progress we've made, in my opinion, we have only scratched the surface in the field of chemical weed control.

Education has and will continue to play a vital part in getting widespread acceptance and adoption of chemical weed control among our farmers.

The role of the Extension Service in usage of herbicides could be summed up in two words—education and motivation. And in many cases the latter is much more difficult than the former. To be more specific it's the job of adult education and motivation. This makes it different from education per se. For here we are dealing with a group who in many cases are reluctant to change. They are interested in change only as it will help them solve a particular problem. Farmers are a free choice, non-captive audience, and they base their decisions about the use of herbicides on whether or not to do so would be to their advantage. They consider such factors as:

1. Financial advantage—will the use of herbicides lower production costs? Will it increase production? Will it reduce risk of loss of crop to weeds during adverse weather? etc.
2. Reduction in labor requirement.
3. Increase in convenience.

In other words we must prove to the farmer that the recommended practice is both practical and feasible before he is going to adopt it.

1. An invitational paper presented at the Western Weed Conference, March 17-19, 1965, Albuquerque, New Mexico.
2. Agronomist, Federal Extension Service, Washington, D.C.

To conduct such an educational program the Extension Service is a cooperative agency operating at the county, State and federal level.

County agents make the bulk of individual farmer contacts. Therefore, most of the changes brought about among farmers as a result of the Extension educational program is accomplished through the activities of the local county agent.

State Extension specialists are responsible for (1) interpreting research, (2) training county agents, (3) coordinating program activities with other agencies and business organizations, (4) preparing teaching material such as bulletins, news items, slide sets, posters and other visuals, (5) working with research counterparts to coordinate research work with needs in the field, and (6) providing enthusiasm and program leadership in their field.

In the field of herbicide usage we in Extension have two important functions to perform.

First, we are concerned with the effective use of a herbicide. Will it do the job? Is it economical and practical? Is it suitable for the farmer's soil? Will it fit his size of operation. etc?

Second, we must be concerned with the safe use of herbicides. For herein lies the source of many of our present-day risks and problems with the use of any agricultural chemical. We are all familiar with regulations set by the Pesticide Regulations Division, ARS, of USDA, by the Food and Drug Administration and by the Public Health Service. Many of our misinformed citizens are alarmed about the use of agricultural chemicals and they are constantly bringing pressure on their congressional representatives to do "something" about controlling use of the "terrible chemicals" which they think are contaminating our food, feed and fiber crops as well as our total environment.

Here we have a challenging educational job to do. For what the general public thinks is important because they influence congressional action which affects the use of herbicides as well as other agricultural chemicals.

I feel that our educational program on the safe use of pesticides must be designed to do two things. First, it should be aimed at educating the public on the importance of and the need for using herbicides. We need to point up the need for using these materials as economic tools of production. Here, I think, has been the weakest part of our educational program. And second, we also must carry on an effective educational program on the safe use of herbicides. Farmers must understand that safety in the use of herbicides is important and that misuse can result in financial loss through crop injury or through seizure due to excessive residue on raw agricultural products.

Our educational program on the safe use of herbicides should be entered into with enthusiasm. Farmers should not be led to believe that we practice safety simply because regulations demand it, but because hazards to human health, crops and livestock can result from misuse of herbicides.

I think Georgia's Clean Acres Weed Control Program is an excellent example of an Extension educational program designed to take advantage of available resources to accomplish these above objectives.

James F. Miller, Extension weed control specialist and J. R. Johnson, Head, Extension Agronomy Department started the program in July 1962.

Previous experience in other intensified programs in Soil Fertility, Master Corn, Big M Pasture, Profit Picking Cotton, and Bonus Seed served as a basis for organizing and conducting the Clean Acres Weed Control Program.

In January 1963 a meeting was held with representatives of herbicides and equipment companies, food processors, nurserymen, State Department of Agriculture, Georgia Plant Food Educational Society, Independent Plant Food Manufactures Association, Georgia Cotton Producers Association and other selected people. At this meeting Extension personnel outlined the proposed weed control program. They reviewed results of other emphasis program and presented data on the cost of weeds to Georgia farmers. Loss to weeds in crops and pastures was estimated at 34% of total loss to all causes or about $70 million annually.

To stimulate interest in the weed control program, the specialists outlined the potential for use of herbicides in Georgia. They estimated that an additional 6.3 million acres could be treated for weed control, requiring 11.2 million pounds of herbicides at a cost of almost $20 million annually.

Support was gained for the "Clean Acres Weed Control Program" and at a subsequent meeting in March 1963 the Georgia Weed Control Society was formed. Officers were elected, committees appointed, a constitution and by-laws adopted, dues set and the program was under way. By October 1963 membership in the Society was 123 and one year later it had grown to 190.

After formal organization of the Georgia Weed Control Society in March of 1963 detail work was begun on preparation of material to be used in the intensified educational program. Funds collected from dues were used to prepare educational aids such as radio tapes, news articles, newspaper mats, slides, posters and a series of post cards. With an industry representative, extension specialist, and agronomy staff artist working together these materials were completed by July of 1963.

The proposal for the weed control program was discussed with the Extension administrative staff and with county agents. Agents interested in initiating the program volunteered and the program was begun in 24 counties in August 1963.

Each participating county received:

1. A set of color slides with script.
2. Brochures and a series of five post cards to be mailed at timely intervals.
3. Fifty-one news articles.
4. A set of newspaper mats.
5. Radio tapes.
6. TV aids.
7. Publications.
8. Demonstration outlines and an outline for the program consisting of objectives, goals, program plans, assistance to agents from specialists, execution, and evaluation.

The next step consisted of a series of training meetings for county agents and setting dates for the county kick-off meetings. Agents were given training in use of educational materials and in the development of local data for use in individual county campaigns.

Members of the Georgia Weed Control Society were invited to the county kick-off meetings and they assisted with the program.

James Miller and Harold Gurley, Extension Agronomists along with their colleagues prepared a weed identification and control bulletin in 1963. District meetings were held with county agents to give them training in the use of the publication during the summer.

In February 1964 the first annual meeting of the Georgia Weed Control Society was held. At this time the weed control program was reviewed and progress reported.

A two-day tour for Society members was held during July 1964 at the Georgia Coastal Plain Experiment Station and the Midville Branch Experiment Station to review weed control work at the stations and to visit Extension result demonstrations on weed control in Terrell County, Georgia. This tour was attended by 160 people.

Last July result demonstrations were set up in participating counties for the 1965 Society tour.

Objectives of the Georgia program are:

1. To demonstrate the value of weed control and its potential importance to Georgia's agricultural economy.
2. To cause farmers and business leaders in each county to become more conscious of the effect that

better methods of weed control can have on county and farm income.

3. To increase efficiency of crop production and thereby reduce the cost of production.
4. To help farmers and businessmen understand that weed control requires specific technical information, and that the county agent is the connecting link between the Cooperative Extension Service, the College of Agriculture and the farmers of Georgia.

The "Clean Acres Weed Control Program" has been a big success from the beginning. During its first year almost 3,000 visitors stopped to see weed control results of 427 herbicide demonstrations in 32 selected counties of the State. Miller reports that county agents had an inexhaustible supply of information for news articles, radio topics, slide sets, post cards, banners and other educational material from their own local county.

Members of the Georgia Weed Control Society contributed time, money and herbicides to support the Extension educational program on weed control. They're aiming at showing Georgia farmers how to reduce the annual $70 million loss to weed competition.

This, I believe, is proof that this is one way to carry on an excellent weed control program that gets results.

Thank you.

HERBICIDE USES AND RESIDUE HAZAZRDS AFFECTING REGULATORY AND EDUCATIONAL ASPECTS OF WEED CONTROL

A. J. Culver[1]

Mr. Culver read portions of a letter from Mr. Ward to clarify position on crop land, ditchbanks, irrigation ditches, etc., as follows:

"Weed control on ditchbanks or in irrigation ditches is presently in a most unsatisfactory situation from the viewpoint of residue data adequate to justify such uses. Our registrations in most cases actually warn against contaminating of irrigation water, since data are lacking to prove at what level of contamination of the water there is danger of causing illegal residues in crops grown under the treated system.

"Until some facts are established, we have no basis for removing our current restrictions. Data on persistence in soils, irrigated from the treated system of ditches, is also of growing importance, since some herbicides will carry over and cause trouble in a succeeding crop.

"This means that 'crop land' must be considered land used in the production of crops whether those crops are pasture, agronomic or horticultural crops or forests, range lands utilized by livestock, ditchbank grazed by animals, or any other similar areas.

"There are technical problems relating to residues in meat or dairy products from any herbicide, until the facts have been determined. Of course, there are conditions where rationalization is appropriate to give the user some reassurance, but absolute certainty will come only after well planned studies are completed to prove that the valuable uses of pesticides (herbicides in particular) will not leave illegal residues. So far, food protection people have been willing to overlook some of the technical problems since they have not been deemed of vital importance to the health of the Nation. Until they are solved by extensive chemical residue work or tolerances or exemptions for herbicides needed in irrigation systems have been set, this usage will remain as a potential danger point."

Mr. Culver said there is a lack of supporting data on residues. Current restrictions can't be removed without data. This data is hard to get. Information on persistence in soil and water is needed. Data is lacking on residues in meat and dairy products. Registrations are based on data supplied by the registrant. The Pesticide Regulation Division cannot get data.

Residues still create a potentially dangerous problem. Some hormone type herbicides are carcinogenic.

Restrictions are maintained because we must protect ourselves.

Sometimes rationalization is important.

1. Pesticide Regulation Division, U.S. Department of Agriculture, Corvallis, Oregon

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THE MODEL WEED LAW

James W. Koehler[1]

The Western Weed Control Conference at its meeting in Portland, Oregon on March 22, 1963, directed a resolution to the Weed Society of America requesting it "to make a study of the possibility of a uniform model weed law for weed control which the various state legislatures can draw upon as a pattern".

Following this, the National Association of State Departments of Agriculture meeting at Winston-Salem, North Carolina, in September 1963, adopted a resolution instructing its executive secretary "to form a committee of specialists from among the states and the United States Department of Agriculture to cooperate with the Weed Society of America to draft a suggested uniform state weed law and companion federal weed law designed primarily to control unwanted growth and dissemination of noxious weeds".

The Weed Society of America at its Chicago meeting in February 1964 formally adopted the NASDA resolution and named its committee to work with the committee of specialists from the states and the USDA. I was named to this committete as vice-chairman of the Weed Society of American regulatory committee. Charles V. Dick, Chief Deputy Director of the California Department of Agriculture was named to the committee from NASDA to represent the administrative level. This "pairing" occurred in other state departments of agriculture and seemed to facilitate the work of the committee. It was the consensus of the committee, and I quote Byron G. Allen, Assistant to the Secretary of Agriculture, "that the proposed law should be drafted with three principal objectives: (1) to make it mandatory that every entity owning or controlling land be required to control and eradicate the noxious weeds thereon; (2) that the administration of the law should be placed in local authorities to the extent possible, but with authority in the state to see it is being enforced, and (3) that the law should be kept as uncomplicated as possible."

The committee first met in Washington, D.C. on May 20, 1964 to review a draft of the proposed model law. Later on revised drafts were sent to each committee member for further consideration.

Late in November the suggested uniform state weed control law was submitted to all commissioners, directors and secretaries of agriculture with the following comments from Mr. Allen:

"As you are no doubt aware, some states do not have a regulatory weed control program and other states by reason of the structure of their programs as presently authorized are encountering difficulties in achieving effective statewide control. In addition there is a great deal to be said for uniformity among state laws, particularly for the purpose of cooperation with other states and with the federal government. I believe I express the opinion of the committee in saying that enactment of the suggested uniform law should be of benefit to your state and the other 49 states and the federal government".

MODEL NOXIOUS WEED LAW

[Title should conform to state requirements. The following is a suggestion: "An act to enable the control of noxious weeds and for other purposes."]

(Be it enacted, etc.)

Sec. 1: **Control and Eradication of Noxious Weeds.**

It shall be the duty of every person to control the

1. Chief, Weed and Vertebrate Pest Control, California Department of Agriculture

spread of and to eradicate noxious weeds on lands owned or controlled by him and to use such methods for that purpose and at such times as are approved and adopted by the State Commissioner of Agriculture[1] (hereinafter referred to as the "Commissioner").

Sec. 2: **Definitions.**

(1) **"Person"** means any individual, partnership, firm, corporation, company, society, association, the State or any department, agency, or subdivision thereof, or any other entity.[2]

(2) **"Control", "controlled"** or **"controlling"**, includes being in charge of or being in possession, whether as owner, lessee, renter, tenant, under statutory authority, or otherwise.[2]

(3) **"Noxious Weed"** means any plant which is determined by the Commissioner[3] to be injurious to public health, crops, livestock, land, or other property.

(4) **"Control Authority"** means the chief executive or governing body of each county,[4] city of   or more inhabitants, and townships except townships specifically exempted by the Commissioner.[5]

(5) **"Applicable fund"** means the fund current at the time the work is performed or the money is received.

Sec. 3: **Administration.**

(1) **State Authority.**

(a) The duty of enforcing this act and carrying out its provisions is vested in the Commissioner, and the authorities designated in this act acting under the supervision and direction of the Commissioner. The Commissioner shall determine what weeds are noxious for the purposes of this act, and shall compile and keep current a list of such noxious weeds, which list shall be published and incorporated in the rules and regulations of the Commissioner. The Commissioner shall, from time to time, adopt and publish methods as official for control and eradication of noxious weeds and make and publish such rules and regulations as in his judgment are necessary to carry out the provisions of this act.

(b) The Commissioner is authorized to investigate the subject of noxious weeds; to require information and reports from any Control Authority as to the presence of noxious weeds and other information relative to noxious weeds and the control and eradication thereof in localities where such Control Authority has jurisdiction; to cooperate with Control Authorities in carrying out other acts administered by him;[7] to cooperate with agencies of Federal and State Governments[7a] and persons, in carrying out his duties under this act, and, with the consent of the Governor, in the conduct of investigations outside this State in the interest of the protection of the agricultural industry of this State from noxious weeds not generally distributed therein; with the consent of the Federal agency involved, to control and eradicate noxious weeds on Federal lands within this State, with or without reimbursement, when deemed by him to be necessary to an effective weed control and eradication program; to advise and confer as to the extent of noxious weed infestations and the methods determined best suited to the control and eradication thereof; to call and attend meetings and conferences dealing with the subject of noxious weeds; to disseminate information and conduct educational campaigns with respect to control and eradication of noxious weeds; to procure materials and equipment and employ personnel necessary to carry out his duties and responsibilities; and to perform such other acts as may be necessary or appropriate to the administration of this act.

(c) When determined by the Commissioner that a Control Authority has failed to carry out any of its duties and responsibilities as a Control Authority, the Commissioner shall perform such duties and responsibilities in the same manner and under the same conditions except that any monies collected as provided in sections 4(2) and 4(3) and the Control Authority's share of costs under section 4(3) shall be for deposit to the applicable fund of the Commissioner.

(d) When determined by the Commissioner that a Control Authority has failed to control or eradicate noxious weeds on land owned or controlled by it or to comply with the provisions of section 5 as to any article owned or controlled by it, the Commissioner shall have proper control and eradication measures taken and may hold or prevent the movement of any such article, and the cost of such control and eradication work shall be a charge against the Noxious Weed Control Fund of such Control Authority and shall be deposited to the applicable fund of the Commissioner.

(2) **Control Authorities.**

(a) Each Control Authority shall carry out the duties and responsibilities vested in it under this act with respect to land under its jurisdiction,[8] in accordance with rules and regulations prescribed by the Commissioner. Such duties shall include the establishment, under the general direction of the County Control Authority, of a coordinated program for control and eradication of noxious weeds within such county.

(b) A Control Authority may cooperate with any person in carrying out its duties and responsibilities under this act, and may cooperate with the Commissioner in carrying out other acts administered by him.[7]

(3) **Weed Control Superintendents.**

(a) **Appointment.** Each Control Authority shall employ one or more Weed Control Superintendents who shall be certified by the Commissioner to be qualified to detect and treat noxious weeds. The same person may be a Weed Control Superintendent for more than one Control Authority. Townships and city Weed Control Superintendents may be members of the employing township or city Control Authority. Such employment may be for such tenure, and at such rates of compensation and reimbursement for travel expenses, as the Control Authority may prescribe, and without regard to any provisions of law relating to age or dual compensation.[9]

(b) **Duties.** Under the direction of the employing Control Authority, it shall be the duty of every Weed Control Superintendent to examine all land under the jurisdiction of the Control Authority for the purpose of determining whether the provisions of this act and the regulations of the Commissioner have been complied with; he shall compile such data on infested areas and areas eradicated and such other reports as the Commissioner or Control Authority may require; consult and advise upon matters pertaining to the best and most practical methods of noxious weed control and eradication, and render assistance and direction for the most effective control and eradication; investigate or aid in the investigation and prosecution of any violation of this act; assist the County Assessor[10] as provided in section 7 hereof; and perform such other duties as required by the Control Authority in

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1. Insert appropriate state authority.
2. Paragraphs 1 and 2 of this section are intended to cover all entities owning or controlling lands and should be amplified if necessary.
3. See footnote 6.
4. Language should be adopted to local governmental structure, particularly where there may be both a chief executive and a governing body.
5. Throughout this draft the designations of "county", "city" and "township" have been used. States should conform these designations to the appropriate local entities.
6. As a substitute for the language of this sentence preceeding this footnote, the following language is suggested for States where question of constitutionality of delegations of this type of authority exists: "The State Commissioner shall adopt methods as official for the control and eradification of weeds declared noxious by the legislature."
7. This clause would permit the Commissioner to cooperate with Control Authorities in administration of acts not related to weed control. If controversial, it could be omitted without affecting this act.

7a. States should examine their Constitutions to determine whether such cooperation is prohibited. Such cooperative arrangements with other States, even if viewed as interstate compacts, would not seem to require Federal consent under Article 1, Sec. 10, Clause 3 of the Constitution of the United States, **Virginia** v. **Tennessee,** 148 U.S. 503 1893); **McCready** v. **Byrd,** 73 A. 2d 8 (1950).

8. States may deem it advisable to describe the geographical area over which the jurisdiction of a Control Authority extends.
9. Consideration should be given to whether any other provision of law in this area should be waived.

the performance of its duties. Weed Control Superintendents shall cooperate and assist one another to the extent practicable. County Weed Control Superintendents shall supervise the carrying out of the coordinated control and eradication program within the county.

Sec. 4: **Destroying weeds; notices; expenses.**

(1) **Notices.** Notices for control and eradication of noxious weeds shall consist of two kinds: general notices and individual notices, of a form prescribed by the Commissioner. Failure to publish general weed notices or to serve individual notices herein provided does not relieve any person from the necessity of full compliance with this act and regulations thereunder. In all cases said published notice shall be deemed legal and sufficient notice.[11]

(a) **General Notice.** General notice shall be published by each Control Authority, or any combination of Control Authorities within a county, in one or more legal newspapers of general circulation throughout the area, or areas, over which the Control Authority, or Control Authorities, has jurisdiction, on or before ? ? ? ? of each year and at such other times as the Commissioner may direct or the Control Authority may determine.

(b) **Individual Notice.** Whenever any Control Authority finds it necessary to secure more prompt or definite control or eradication of noxious weeds than is accomplished by the general published notice, it shall cause to be served individual notices upon the person owning and the person controlling such land, and give notification of such notice to the record owner of any encumbrance thereon,[12] giving specific instructions and methods when and how certain named weeds are to be controlled or eradicated. Such methods may include definite systems of tillage, cropping, management and use of livestock.

(2) **Destruction by Control Authority; expenses.** Whenever the owner or person in control of the land on which noxious weeds are present has neglected or failed to control or eradicate them as required pursuant to this act and any notice given pursuant to section 4(1), the Control Authority having jurisdiction shall have proper control and eradication methods used on such land, including necessary destruction of growing crops, and shall advise the owner, person in control, and record holder of any encumbrance[12] of the cost incurred in connection with such operation. The cost of any such control or eradication shall be at the expense of the owner. If unpaid for ? ? ? months, or longer, the amount of such expense shall become a lien[13] upon the property and shall be subject to collection by the Control Authority by sale of the property in the same manner as for delinquent taxes. Nothing contained in this section shall be construed to require satisfaction of the obligation imposed hereby in whole or in part from the sale of the property or to bar the application of any other or additional remedy otherwise available. Amounts collected under this section shall be deposited to the Noxious Weed Control Fund of the Control Authority.[14]

(3) **Quarantine; expenses.** When it appears to a Control Authority that upon any tract of land under its jurisdiction there is an infestation of noxious weeds beyond the ability of the owner and the person in control of such land to eradicate[15], the Control Authority, with the approval of the Commissioner, may quarantine such land and put into immediate operation the necessary means for the eradication of such noxious weeds including necessary destruction of growing crops. The Control Authority shall, prior to the entry upon such land, serve individual notices on the owner and the person in control thereof and the record owner of any encumbrance thereon[12] of such quarantine and entry, and shall also advise the same persons of the completion of the eradication operation, and the cost thereof.

The expense of such quarantine and eradication shall be borne as follows: ⅓ from any funds available to the Commissioner for the administration of this act; ⅓ from the Noxious Weed Control Fund of the Control Authority; ⅓ from the person owning such land, which may be collected and deposited as provided in section 4(2).

Sec. 5: **Cost.**

(1) **Land owned or controlled by State.** The cost of controlling and eradicating noxious weeds on all land, including highways, roadways, streets, alleys and rights-of-way, owned or controlled by a State department, agency, commission or board[16] shall be paid by the State department, agency, commission or board in control thereof out of funds appropriated to its use.

(2) **Land owned or controlled by Control Authorities and townships and cities not Control Authorities.** The cost of controlling and eradicating noxious weeds on all land including highways, roadways, streets, alleys and rights-of-way, owned or controlled by a Control Authority shall be paid by the Control Authority in control thereof out of the Noxious Weed Control Fund, and until the establishment of such Fund, out of the general funds[17] of such Control Authority.

Until the establishment of the Noxious Weed Control Fund of a County Control Authority, the cost of controlling and eradicating noxious weeds on all land, including highways, roadways, streets, alleys and rights-of-way, owned or controlled by a township or city which is not a Control Authority shall be paid by the township or city in control thereof out of the general funds[18] of such township or city. After the establishment of the Noxious Weed Control Fund of the county in which such township or city is located, such cost shall be paid from the Noxious Weed Control Fund of such county.

(3) **Lands owned or controlled by other persons.**[18a] Funds available to any person may be used for the control and eradication of noxious weeds on land owned or controlled by him.

(4) **Costs borne by Control Authority.**[19] Not withstanding any other provisions of this act relating to payment of cost, when determined by a Control Authority to be justified in the interest of an effective weed control program, such Control Authority may cause the control and eradication of noxious weeds on land under its jurisdiction, without cost to the owner or person in control thereof, and a County Control Authority, with the consent of any other Control Authority in such county, may for like cause, cause the control and eradication of noxious weeds on land under the jurisdiction of such other Control Authority, without cost to the owner or person in control thereof. Such justification shall be in writing and shall be open to inspection by any person owning or controlling land under the jurisdiction of such Control Authority.

Sec. 6: **Prevention of dissemination of noxious weeds through articles.**[20]

10. "Auditor" or other appropriate authority.
11. Each State should examine its own Constitution to determine whether general notice is sufficient to permit a Control Authority to enter and perform work, including destruction of growing crops. If such notice is deemed insufficient, paragraph (b) of this subsection should be rewritten to provide for individual notices where such entry and work is contemplated.
12. Notification to owner of encumbrance might be omitted.
13. As an alternative the amount might be collected in the same manner as a mechanic lien or by civil action. A different manner of collection will be necessary where entities such as railroads or others own tax exempt lands.
14. In this draft references are made to the Noxious Weed Control Fund, authorized under section 7. If a State does not desire to authorize such Funds, the references should be to the general fund or other fund intended to bear the costs.
15. States may desire to extend provision to include "control".
16. This subsection is intended to cover all State agencies owning or controlling lands and may need to be altered to include any entity not falling within terms used here.
17. Consideration may need to be given to an authorization for borrowing where general funds may be insufficient.
18. Or other appropriate funds.
18a. This subsection is intended to permit use of otherwise restricted funds of such entities as school districts, etc. Each State should examine its own Constitution in this area.
19. This subsection is intended to permit Control Authorities to bear the cost of work on abandoned, tax-forfeited, marginal and similar lands, or where the work can be performed at nominal cost in connection with other control or eradication work being done by a Control Authority. States may desire to make this a charge against funds of the Commissioner.
20. States should examine other laws in this area, such as screening and nursery, for possible conflict.

To prevent the dissemination of noxious weeds through any article, including machinery, equipment, plants, materials and other things, the Commissioner shall, from time to time, publish a list of noxious weeds which may be disseminated through articles and a list of articles capable of disseminating such weeds, and designate treatment of such articles as, in his opinion, would prevent such dissemination. Until such article is treated in accordance with the applicable regulations, it shall not be moved from such premises except under and in accordance with the written permission of the Control Authority having jurisdiction of the area in which such article is located, and the Control Authority may hold or prevent its movement from such premises. The movement of any such article which has not been so decontaminated, except in accordance with such written permission, may be stopped by the Control Authority having jurisdiction over the place in which such movement is taking place and further movement and disposition shall only be in accordance with such Control Authority's direction.

Sec. 7: **Establishment of Noxious Weed Control Fund; Tax Levy.**[21]

There is hereby authorized to be established a Noxious Weed Control Fund for each Control Authority, without fiscal year limitation, which shall be available for expenses authorized to be paid from such Fund including necessary expenses of the Control Authority in carrying out its duties and responsibilities under this act. The County Assessor[10] of each county shall, with the assistance of the Weed Control Superintendents within the county, ascertain each year the approximate amount of land infested with noxious weeds and its location in his county, and transmit such information tabulated by Control Authorities not later than ? ? ? ? ? of each year to the Commissioner and to each Control Authority in such county. On the basis of such information, the tax levying body of each Control Authority shall make a tax levy each year for the purpose of paying the expenses authorized to be paid from the Noxious Weed Control Fund. Funds so collected shall be deposited to such Noxious Weed Control Fund.

Sec. 8: **Equipment and Materials of Control Authority; charges; records.**

Control Authorities, independently or in combination, may purchase or provide for needed or necessary equipment and materials for the control and eradication of weeds, whether or not declared noxious,[22] on land under their jurisdiction and may sell such materials to persons owning or controlling land under their jurisdiction and may make available the use of machinery and other equipment and operators at such cost as may be deemed sufficient to cover the actual cost of such materials and the cost of operations, including depreciation, of such machinery and equipment.[23] All funds so received shall be deposited to the Noxious Weed Control Fund. Each Control Authority shall keep a record showing the procurement, sale and rental of materials and equipment, which record shall be open to inspection by citizens of this State. A Control Authority may use any equipment or material procured as provided for in this section upon lands owned or controlled by it, or owned or controlled by a township or city which is not a Control Authority, for the treatment and eradication of weeds which have not been declared noxious.

Sec. 9: **Filing of protest; hearing; appeal.**

If any person shall be dissatisfied with the amount of any charge made against it by a Control Authority for control or eradication work or for the purchase of materials or use of equipment, it may, within ? ? ? ? days after being advised of the amount of the charge, file a protest with the Commissioner. The Commissioner shall hold a hearing thereon and shall have the power to adjust or affirm such charge. If any person is dissatisfied with the decision of the Commissioner, or with charges made by the Commissioner for control or eradication work performed by him, such person may, within ? ? ? days from the date of such decision, or notification of the amount of such charge, file a written notice of appeal with the Clerk of the ______________ Court and thereupon an action shall be docketed in said court and tried the same as other actions.

Sec. 10: **Entry upon land.**

The Commissioner, any Control Authority, Weed Control Superintendent, or anyone authorized thereby, may enter upon all land under their jurisdiction for the purpose of performing their duties and exercising their powers under this act, including the taking of specimens of weeds or other materials, without the consent of the person owning or controlling such land and without being subject to any action for trespass or damages, including damages for destruction of growing crops, if reasonable care is exercised.

Sec. 11: **Notices.**

All individual notices, service of which is provided for in this act, shall be in writing. Service of such notices shall be in the same manner as service of a summons in a civil action in the ______________ court or by certified mail to the last known address to be ascertained, if necessary, from the last tax list.

Sec. 12: **Penalties.**

(1) Any person knowing of the existence of any noxious weeds on lands owned or controlled by him, who fails to control or eradicate such weeds in accordance with this act and rules and regulations prescribed thereunder, and any person who intrudes upon any land under quarantine or who moves or causes to be moved any article covered by section 6 hereof except as provided therein, or who prevents or threatens to prevent entry upon land as provided in section 10, or who interferes with the carrying out of the provisions of the act, shall be subject to a fine not to exceed $______________ on account of each violation.

(2) [24]Any Control Authority, and where such Control Authority is composed of more than one person, each member of such Control Authority, and any Weed Control Superintendent, who shall fail and refuse to perform the duties required of him by this act and rules and regulations thereunder shall be subject to a fine not to exceed $______________ on account of each violation.

Sec. 13: (Separability clause, if deemed necessary)

21. Conform to particular tax structure of State.
22. If a State does not wish to furnish materials and equipment for non-noxious weeds, the words "whether or not declared noxious" should be omitted and the word "noxious" inserted prior to the word "weeds" in this sentence.
23. States may wish to consider charging less than full amount.
24. Optional.

CHEMICAL CONTROL OF TALL LARKSPUR AND RESPONSE OF THE PLANT COMMUNITY

E. H. Cronin and N. K. Roberts[1]

Abstract: On the Wasatch Plateau in Central Utah **Delphinium barbeyi** (tall larkspur) is associated with deep persistent snowdrifts. These drifts do not melt until June or July. Rapid development produces plants in many stages of growth within a relatively short distance because of the receding snowdrifts. Since stage of growth at treatment time is critical ,single treatments of up to 8 lb/A of the propylene glycol butyl ether esters of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) or 2-(2,4,5-trichlorophenoxy) propionic acid (silvex) failed to control tall larkspur on these sites. Repeated annual treatments of 4 lb/A the first year and 8 lb/A the following year or treatments of 2 lb/A the first year, 4 lb/A the following year, and 4 lb/A the third year with either 2,4,5-T or silvex reduced the density of tall larkspur from as high as 30 percent aerial cover to 2 percent or less. Repeated treatments either reduced the density of other weedy species or did not affect them. One

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forage plant (**Ligusticum filicinum**) was nearly eradicated from the plots. Treatments increased the aerial cover of the grass species as much as 5 times. Increase of the grasses on plots grazed by livestock was largely due to **Stipa lettermani.** On plots protected from grazing livestock most of the increase in grass cover was due to **Bromus carinatus.** Crops Research Division, ARS, U. S. Department of Agriculture and Utah State University, Logan, Cooperating.

A TRIAL OF PICLORAM FOR CONTROLLING CHAPARRAL SPECIES IN SOUTHERN CALIFORNIA

Lisle R. Green and Joe R. Goodin[1]

Picloram (4,amino-3,5,6-trichloropicolinic acid), Trademark Tordon, is one of the latest and most promising herbicides to challenge 2,4-D and 2,4,5-T in woody plant control. We got our first small samples of the product in the spring of 1963, along with reports by the producer that Tordon should control or kill a variety of California woody plants. We have some tests underway, but before reviewing our experience, I'd like to tell something about the brush control problems in southern California, and why we are interested in Tordon.

Large fires still occur in southern California in spite of the best efforts of modern firefighting organizations. In 1960, three 20,000-acre fires burned on the Angeles National Forest simultaneously. You all heard of the Bel Air-Brentwood fire which burned 14,000 acres and 480 homes in November 1961. In 1964, major fires occurred around Glendale and Burbank on March 16 and at Santa Barbara in late September.

Such disastrous fires occur because of critically dry and windy weather, steep rough terrain, and almost unbroken expanses of brush fuels—about 5,000,000 acres in southern California.

1. Range Conservationist, Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture, and Assistant Agronomist, University of California, Riverside,

Firefighting agencies for many years have been clearing this brush from narrow firebreaks on ridgetops, valley bottoms, and along roads. During the past few years brush has been hand cut, bulldozed, or burned to make wide cleared strips called fuel-breaks. Fuel-breaks total nearly 300 miles in southern California, and perhaps a thousand miles statewide. Much of the work is only partially completed because sprouting brush has not yet been eliminated.

The most difficult plant to eliminate is scrub oak (**Quercus dumosa**). It is hard to kill by grubbing, with mechanical equipment, or with herbicides. Broadcast sprays with a mixture of 2,4-D and 2,4,5-T (brushkiller) have usually killed leaves, but not many stems. Repeated hand sprays have been necessary to eliminate the sprouting oak plants.

If Tordon killed plants that resist 2,4-D and 2,4,5-T, or killed them quicker, it could be of tremendous help. So it was with great hope that we started spraying plants with our first small sample. There has been insufficient time for final evaluation, and what I say today is of necessity subject to change as more experience accumulates.

Foliage tests.—We sprayed Tordon 22K onto scrub oak plants in May 1963, and in July 1964 at 3 widely spaced locations. Spray was applied, with a power sprayer and hand-held wand, to individual plants on the Glendora Ridge fuel-break. A pressure-type backpack sprayer was used at two other locations, North Mountain and Palomar Mountain. Each plant was sprayed until all foliage was wet. Tordon 22K was added to 100 gallons of water at rates of ½ to 8 pounds to form the spray solution. Our standard brushkiller recommendation—2 pounds each of 2,4-D and 2,4,5-T in 1 gallon of diesel oil and 98 gallons of water—was used as a comparison treatment.

At this time, Tordon does not appear to be highly effective against scrub oak, and is probably less effective than brushkiller. Data collected on Glendora Ridge nearly two years after treatment (table 1) indicate poor control with ½ to 2 pounds of Tordon in 100 gallons of solution. However ,observations on Palomar Mountain plots, treated in July 1964, indicate that at rates of 4 or 8 pounds Tordon may be as effective against oak as brushkiller. Abundant

Table 1. Effects of Tordon 22K (T) and of brushkiller (BK)[1] on Quercus dumosa[2]

Location	Rate/ 100 gal.	Plants treated	Partial topkill, sprouting	Partial topkill, no sprouting	Top-killed, sprouting	Top-killed	Apparently dead
	lbs.	No.			Percent		
Glendora	½ (T)	30	50	—	30	—	20
Ridge	1 (T)	30	70	—	10	—	20
	2 (T)	30	40	—	40	—	20
	4 (BK)	45	15	—	—	50	35
North	1 (T)	10	100	—	—	—	—
Mt.	2 (T)	10	100	—	—	—	—
	4 (T)	10	40	60	—	—	—
	8 (T)	10	10	90	—	—	—
	4 (BK)	10	—	20	10	—	70
Palomar	1 (T)	25	—	100	—	—	—
Mt.	2 (T)	25	—	100	—	—	—
	4 (T)	25	—	100	—	—	—
	8 (T)	25	—	92	—	—	8
	4 (BK)	25	4	96	—	—	—

1. 2 pounds each of 2,4-D and 2,4,5-T in I gallon of diesel oil and 98 gallons of water.
2. Plants were treated on Glendora Ridge in May 1963, on North Mountain and Palomar Mountain in July 1964. The most recent observations were in March 1965.

sprouting was the rule in the earlier test; sprouting may still occur on plants sprayed in the summer of 1964.

Sprouting manzanita (**Arctostaphylos glandulosa**) has been another plant resistant to herbicides on most spray jobs. Again, Tordon would be a valuable addition to our herbicide arsenal if it gave positive control of this shrub species.

Tentative results indicate that at rates of 4 to 8 pounds per 100 gallons of emulsion, and perhaps at lighter rates, Tordon will kill manzanita. In the test on Glendora Ridge, plants were killed at both the 1- and 2-pound rates, with no sprouting (table 2). On the two areas sprayed last summer, Tordon at these rates has not yet caused serious damage. At rates of 4 and 8 pounds some plants apparently have been killed and most of the others seriously damaged. We expect that many of these will die.

Chamise (**Adenostoma fasciculata**), the most abundant shrub in southern California, is a vigorous resprouter and a problem when trying to convert brushland to grass. However, chamise has been quite susceptible to 2,4-D or 2,4,5-T. One broadcast application has killed as much as 95 percent of sprouting chamise on some projects, but on others kill has been variable and much less. Hand spraying has nearly always eliminated it. Although not as dif-

Table 2. Effects of Tordon 22K (T) and of brushkiller (BK)[1] on Arctostaphylos glandulosa[2]

Location	Rate/ 100 gal.	Plants treated	Partial topkill, sprouting	Partial topkill, no sprouting	Apparently dead
	Lbs.	No.		Percent	
Glendora	½ (T)	5	40	60	—
Ridge	1 (T)	5	—	—	100
	2 (T)	5	—	—	100
North	1 (T)	10	100	—	—
Mt.	2 (T)	10	80	20	—
	4 (T)	10	—	80	20
	4 (BK)[1]	10	—	—	100
Palomar	1 (T)	25	—	96	4
Mt.	2 (T)	25	—	100	—
	4 (T)	25	—	88	12
	8 (T)	25	—	88	12
	4 (BK)	25	—	80	20

1. 2 pounds each of 2,4-D and 2,4,5-T in 1 gallon of diesel oil and 98 gallons of water.
2. The Glendora Ridge plots were treated in May 1963, the others July 1964. The most recent observations were made in March 1965.

Table 3. Effects of Tordon 22K (T) and of brushkiller (BK)[1] on Chamise (Adenostoma fasciculata)[2]

Location	Rate/ 100 gal.	Plants treated	Partial topkill, sprouting	Partial topkill, no sprouting	Top-killed, sprouting	Top-killed, no sprouting	Apparently dead
	Lbs.	No.			Percent		
Glendora	½ (T)	5	—	—	—	—	100
Ridge	1 (T)	5	—	—	—	—	100
	2 (T)	5	—	—	—	—	100
	4 (BK)	5	—	—	—	—	100
North	1 (T)	10	10	40	—	—	50
Mt.	2 (T)	10	—	—	—	—	100
	4 (T)	10	—	—	—	—	100
	4 (BK)	10	—	—	10	—	90
Palomar	1 (T)	25	—	60	—	—	40
Mt.	2 (T)	25	—	24	—	—	76
	4 (T)	25	—	20	—	—	80
	8 (T)	25	—	24	—	—	76
	4 (BK)	25	—	—	4	4	92

1. 2 pounds each of 2,4-D and 2,4,5-T in 1 gallon of diesel oil and 98 gallons of water.
2. The Glendora Ridge treatment date was May 1963; the other two locations were treated during July 1964. Observations were made during March 1965.

ficult as scrub oak, it is a serious problem because of its abundance. Any herbicide giving consistent, economical control would be useful.

In our first test, a few plants were hand sprayed in May 1963 at ½, 1, and 2 pounds of Tordon 22K per 100 gallons of emulsion, and all rapidly died (table 3). Chamise plants sprayed July 1964 at 4 or 8 pounds per 100 gallons are all dead. At the 2-pound rate all chamise were killed at one location, but some of the lower stems are still green at another. At the 1-pound rate about half the treated plants still have green stems, and some have green leaves as well.

Tordon appears to be just as effective on chamise as brushkiller, although its action is somewhat slower. Tordon at the 2-pound rate, and probably at the 1-pound as well, will probably kill all chamise sprouts. Four pounds appears to be as effective as 8 pounds and somewhat faster acting than 2 pounds.

Other plants resistant to brushkiller include the sumacs (**Rhus.** spp.) and toyon (**Heteromeles arbutifolia**). Only a limited number of these species occurred on our spray areas, and larger tests need to be made. Laurel sumac (**R. laurina**), sprayed in May 1963, was killed by Tordon at 1- and 2-pound rates, but crown sprouted at the ½-pound rate (table 4). Toyon, sprayed in July 1964 at 2- and 4-pound rates, suffered quite complete topkill, but most plants crown sprouted.

Red shank (**Adenostoma sparsifolium**) is not a serious problem, except on local areas. On one fuel-break test the 2-pound rate destroyed all plants.

Soil test.—Tordon 10K is a pelleted herbicide intended for soil application and entry into the brush plant through the roots. In the past we have used considerable Fenuron in efforts to control sprouting brush in this manner. Results during the recent dry years have been less successful than was obtained using Tordon.

In September 1963, Tordon 10K was applied in a ring at rates of ¼ to 4 ounces close to the crowns of individual sprouting red shank plants. All rates were effective, destroying 90 percent or more of the treated plants (table 4). Tordon 10K was also broadcasted over replicated plots at two locations (table 4) at rates of 50, 100, and 150 pounds per acre. Within a year all chamise, sage (**Salvia**), California sagebrush (**Artemisia californica**), California buckwheat (**Eriogonum fasciculatum**), Mission manzanita (**Xylococcus bicolor**), and laurel sumac on the plots was dead. Some chamise and California buckwheat sprouted on plots treated with 2,4-D.

Tordon applied to the soil is promising, but needs to be tested on more of the resistant shrub species.

In summary.—Because Tordon herbicide is new to agencies working in the field of plant control, we receive many inquiries as to its effectiveness, availability, and cost. At this time we answer that it appears to be promising for control of certain sprouting chaparral shrubs, but we are not ready to recommend it strongly at this time. We haven't demonstrated that it is more effective than the cheaper brushkiller on many shrub species. Further testing will be necessary to determine the place of Tordon in woody plant control.

Table 4. Effect of Tordon 10K pellets on brush sprouts in San Diego County, California

Location	Rate	Date of treatment	Date of obser.	Partial topkill, no sprouting	Apparently dead
RED SHANK (ADENOSTOMA SPARSIFOLIUM)					
Oak	¼ oz.	9/63	2/65	10	90
Grove	½ oz.	Do.	Do.	10	90
	1 oz.	Do.	Do.	—	100
	2 oz.	Do.	Do.	10	90
	4 oz.	Do.	Do.	10	90
CHAMISE (ADENOSTOMA FASCICULATA)					
San	50 lbs/A	5/63	5/64	—	100
Ysabel	100 lbs/A	Do.	Do.	—	100
	150 lbs/A	Do.	Do.	—	100
CHAMISE, SAGE, CALIFORNIA SAGEBRUSH, LAUREL SUMAC, BUCKWHEAT					
Lakeside	50 lbs/A	1/64	10/64	—	100
	100 lbs/A	Do.	Do.	—	100
	150 lbs/A	Do.	Do.	—	100

CHEMICAL CONTROL OF GREEN RABBITBRUSH (CHRYSOTHAMNUS VISCIDIFLORUS (HOOK.) NUTT). BY 2,4-D AND PICLORAM

Paul T. Tueller and Raymond A. Evans[1]

Several range seedings in eastern Nevada have become infested with green rabbitbrush (**Chrysothamnus viscidiflorus** subsp. **puberulus** (D. C. Eaton) H & C). Root excavations of this species indicate a direct competition with the following seeded and native grasses: crested wheatgrass (**Agropyron desertorum** (Fisch.) Schutt); Indian ricegrass (**Oryzopsis hymenoides** (Roem. & Schutt) Ricker); squirreltail (**Sitanion hystrix** (Nutt.) J. G. Smith): Sandberg bluegrass (**Poa secunda** (Presl); bluebunch wheatgrass (**Agropyron spicatum** (Pursh) Scribn. & Smith); and streambank wheatgrass (**Agropyron riparium** (Scribn. & Smith).

In December, 1962, the Bureau of Land Management established a 5-acre exclosure in a homogeneous portion of a 514-acre crested wheatgrass seeding which had been planted in 1958. Initially, brush was removed from this site with a Service brush cutter and then seeded with standard crested wheatgrass at 4 lb/A. Root-sprouting rabbitbrush now forms an overstory to the grasses and forbs. Rabbitbrush covers 7 percent while big sagebrush

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covers 1.5 percent. The site is at an elevation of 6,200 ft. and the surface soil is a loam with gravely clay at 11 inches. The entire profile is highly calcareous from limestone.

We evaluated 2,4-D at 1, 2, and 3 lb/A and 4-amino-3,5,6-trichloropicolinic acid (picloram) at ¼, ½ and 1 lb/A for control of rabbitbrush and big sagebrush in this seeding. We applied herbicides on May 15, June 6, and June 22, 1963. The surfactant X-77 at 0.1% v/v was used with both herbicides. Herbicides were applied in water at 10 gpa and 30 psi. Plot size was 20 x 20 feet and 4 replications were used. On the May 15 spray date, **Poa secunda** had about 2 inches of new growth and the soil was moist throughout the profile. On the June 6 spray date **Poa secunda** was 6-8 inches high and was in the dough stage. Soil moisture was present throughout the profile. On June 22, 1963, the soil was dry, **Poa secunda** was in bloom and 15 inches high. Results of the 1963 studies, but not those of 1964-65, are reported here.

We obtained excellent kills of rabbitbrush by applying ½ and 1 lb/A of picloram (Table 1). These rates did not satisfactorily control big sagebrush (Table 2). The application of 2,4-D did not control either species successfully. Picloram exhibited definite selectivity between big sagebrush and rabbitbrush. On the plots sprayed June 6, 1963, at ½ lb/A, 98 percent of the rabbitbrush was killed while big sagebrush had a mortality of only 20%. For the June 22 spray date, mortality of the two species was 100 and 21%, respectively.

Table 1. Control of green rabbitbrush by 4-amino-3,5,6-trichloropicolinic acid (picloram) and 2,4-D (percent kill).[1]

Herbicide	Spray dates		
	May 15, 1963	June 6, 1963	June 22, 1963
2,4-D			
1 lb/A	14	19	23
2 lb/A	51	45	63
3 lb/A	44	56	81
Picloram			
¼ lb/A	43	90	71
½ lb/A	88	98	100
1 lb/A	97	100	100

1. Both green rabbitbrush and big sagebrush were sprayed on the same plots.

Table 2. Control of big sagebrush by 4-amino-3,5,6-trichloropicolinic acid (picloram) and 2,4-D (percent kill).[1]

Herbicide	Spray dates		
	May 15, 1963	June 6, 1963	June 22, 1963
2,4-D			
1 lb/A	36	26	51
2 lb/A	87	60	77
3 lb/A	93	87	88
Picloram			
¼ lb/A	0	11	8
½ lb/A	12	20	21
1 lb/A	54	40	23

1. Both green rabbitbrush and big sagebrush were sprayed on the same plots.

We clipped grasses on two 9.6 square foot quadrats in each plot. Yield data show no obvious trends in relation to treatments. The average yield values were 62 lb/A for 1963 and 286 lb/A for 1964. This variation might be attributed to differences in precipitation or to continued protection.

WEED CONTROL STUDIES IN CALIFORNIA DECIDUOUS FRUIT CROPS

A. H. Lange[1]

The value of herbicides for the control of annual weeds in tree fruits in California and other states has been demonstrated. A 5' to 10' weed free strip down the tree row offers many advantages to the orchardist. Some of these include: better access to the orchard during the winter time, reduced disease, rodent, and mechanical injury around the base of the tree, reduced soil compaction from mechanical cultivation and permanent locations for orchard heaters, sprinkler heads, etc. Hedge row planting with disking or mowing of the centers necessitates chemical weed control down the tree row as does various other new orchard practices.

This years registration of simazine for a number of tree fruits and the current labor situation have resulted in a great deal of interest in orchard weed control in California. A recent survey of the California deciduous orchards estimated 10,000 acres treated this year with pre-emergence herbicides for annual weed control. The California research work in this area might be termed a three phase approach. The first involves screening new herbicides applied to greenhouse grown tree fruit seedlings in nutrient-fed sand culture. The second phase involves an application of more promising herbicides over dormant planted seeds and cuttings in the nursery row. The third phase is the testing of the most promising herbicides in young established orchards. The following is a brief summary of this work.

The seedling work in the greenhouse has demonstrated species differences, for example Black walnut appeared to be the most resistant of the species tested to simazine, diuron, prometryne, and most susceptible to bromacil. Bartlett pear seedlings were more resistant to diuron and simazine than to isocil and bromacil. Stone fruits were quite similar in response to herbicides with some differences. Peaches, plums, cherries, and almonds appeared to be more sensitive to prometryne than simazine.

Simazine and diuron were further compared with isocil, bromacil, duPont 732 (5-chloro-3-**tert.** butyl-6-methyluracil), and duPont 733 (5-bromo-3-**tert.** methyluracil). DuPont 733 showed greater safety on peaches, almonds, and plums than simazine, diuron, or the other three uracils but not on cherries.

In nursery trials simazine, diuron, bromacil, isocil, and prometryne gave excellent **early** weed control. Most of these herbicides gave residual weed control with the exception of prometryne which lost its activity early. Diphenamid gave fair weed control at 2 months, poor at 3 months, but appeared to improve somewhat by 4 months. The phytotoxicity from diphenamid could not be readily determined because of the extreme effect of early weed competition on young nursery plants. Diuron appeared to have the greatest margin of safety for young nursery plants of all species with the exception of young grafted apples where simazine and diuron were about equal. Bromacil was generally too phytotoxic with the possible exception of peach rootstocks. Isocil showed more selective advantage than bromacil but less than diuron. Isocil showed considerable safety on peach rootstocks.

To date only simazine and diuron have been widely tested in uniform trials for weed control in orchards. Simazine has given consistently better weed control on a pound for pound basis; however, diuron has shown fewer instances of phytotoxicity. Some phytotoxicity was noted on young almonds treated with as low as 2 pounds of simazine per acre in sandy soils. Diuron showed greater safety on peach trees with no injury up to and including 8 lb/A. Some injury on peaches was apparent at 8 lb/A with simazine. Prunes showed some injury from 4 lb. of simazine and 8 lb. of diuron. Pears and walnuts showed no

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injury up to and including 8 lb/A of diuron but some phytotoxicity was noted with 8 lb. of simazine applied to young pear trees.

Diuron and simazine are now recommended for weed control in California walnuts up to 3.2 and 4 lb. respectively in split or single application. Both herbicides are registered for use in apples and pears but are not yet recommended by the University of California. Simazine is registered on most of the California orchard crops with the exception of apricots, nectarines, and figs. Diuron is registered for apples, pears, and walnuts. A series of 5 year uniform trials are now underway in forty orchards for further evaluation of simazine and diuron under California conditions.

PREPLANTING, SOIL-INCORPORATED APPLICATIONS AND PREEMERGENCE APPLICATIONS OF HERBICIDES IN FURROW-IRRIGATED ONIONS

R. M. Menges and J. L. Hubbard

Abstract: Soil surface and soil-incorporated applications of herbicides were compared for weed control in onions grown on furrow-irrigated sandy clay loam. Soil surface applications of 2-chloroallyl diethyldithiocarbamate (CDEC) and dimethyl 2,3,5,6-tetrachloroterephthalic acid (DCPA) were compared with and without a white petroleum mulch.

A powered rotary tiller with L-shaped cutting teeth was used to incorporate the herbicides with the surface in. of warm, air-dry soil. 'White Crauex' onions were seeded just before pre-emergence applications and just after and 10 days after soil-incorporated applications. During the first 4 weeks, all plots were furrow-irrigated 1 and 16 days after treatment; during the same period, 0.09, 0.04, 0.09, and 0.09 in. of rain fell 1, 5, 6, and 18 days after treatment. Predominant weeds were Palmer amaranth (**Amaranthus palmeri** S. Wats) and common purslane (**Portulaca oleracea** L.)

DCPA, 4 or 8 lb/A, provided selective weed control in soil surface applications. Soil-incorporated applications of the herbicide failed to perform as efficiently as soil surface applications, but they injured onions at the 8-lb rate, regardless of the time of application. White petroleum mulch reduced weed control with soil surface applications of DCPA but had no effect on herbicidal selectivity in onions.

CEDC controlled weeds at the 6-lb rate regardless of incorporation but performed less efficiently at the 3-lb rate. White petroleum mulch enhanced the activity of soil surface applications of the herbicide but increased herbicidal injury in onions; untreated white mulch reduced the stand and yield of onions. CDEC injured onions when soil-incorporated at seeding and tended to do so at the 6-lb rate when incorporated 10 days before seeding. Time lapse was thus insufficient for selectivity in onions.

Ethyl N-ethyl-N-cyclohexylthiolcarbamate (R-2063) controlled weeds more efficiently with soil incorporation but caused excessive injury in onions with all applications.

Rainfall undoubtedly enhanced the performance of soil surface applications of herbicides.

Thermistor radiometer data and thermocouple data showed that temperatures of the surface and soil layers just below the white mulch were considerably lower than those in the respective areas in bare soil; temperature decreased with increasing depth in bare soil. The soil surface applications of herbicides were therefore exposed to higher temperatures than applications incorporatd with soil or covered with white mulch. (Crops Research Division, ARS, U. S. Department of Agriculture in cooperation with the Texas Agricultural Experiment Station, Weslaco)

PRE-EMERGENCE AND PREPLANTING SOIL-INCORPORATED APPLICATIONS OF HERBICIDES IN FURROW-IRRIGATED TOMATOES FOR PROCESSING

Alvin R. Hamson[1]

These studies were conducted at the Farmington Field Station in Utah for 9 years from 1956 to 1964 inclusive. All herbicide treatments before 1961 were applied pre-emergent on direct seeded tomatoes or post-plant on the transplanted crop. Studies with incorporation 3 inches deep with a power-driven, hooded rotary tiller with L-shaped teeth were conducted from 1961 to 1964.

Results from pre-emergent and post-plant treatments were erratic between replicates in an experiment, between experiments in a given year, and particularly between years. The most promising herbicides in these trials were CDEC (Vegadex) 6 lbs/A, CDAA (Randox) granular 6 lbs/A, neburon 4 lbs/A, CIPC 6 lbs/A, Amiben 2 lbs/A, and Tillam 4 lbs/A.

Weed control in later experiments was much improved by incorporation of herbicides and by use of newer herbicides with good activity on weed species present and with specific tolerance by tomatoes. The promising newer herbicides were diphenamid at 4 to 6 lbs/A with the formulations Enide and Dymid being about equally effective, and Stauffer R 4461 (Prefar) at 10 lbs/A.

Replicated yield trials were conducted in 1963 and 1964. The weed control ratings for predominant weed species, possible injury to tomatoes as observed by relative growth of tomato plants and hours of labor required to weed the plots converted to hours per acre are indicated in Table 1. Tillam and Diphenamid were the best herbicides both from the standpoint of weed control and

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Table I. 1963 Weed Control Evaluation on Tomato Transplants With Incorporation 3" Deep
Weed Control Ratings

Herbicide and Rate	Handweeding Hrs/Acre	Mallow	Nightshade	Lambsquarter	Redroot	Purslane	Stinkgrass	Combined Weed Control	Tomato Growth
Tillam 4 lbs/Acre	19.7[1]	10[2]	8.75	9.75	9.50	10	9.50	9.75	9.75[3]
Diphenamid 6 lbs/Acre	39.8	10	6.75	10	10	10	9.75	8	9.75
R-4461 10 lbs/Acre	46.4	8.75	5.50	10	9.75	10	9.75	7	9
Vegadex 6 lbs/Acre	62.3	9.5	5	8.5	8.75	9.25	8.25	6	8.5
Solan 4 lbs/Acre	74.1	9.25	6.25	7	9	10	6.75	7.75	5.75
Amiben 2 lbs/Acre	32.3	8.75	7	9.5	9	10	6.75	7.75	5.75
Check	86.0	7.5	4.25	6.25	5.5	7.5	5.75	2.25	7

1. Hours/acre required for hand weeding after normal cultivation.
2. Subjective rating of weed control: 1 = no control of weeds, 10 = complete control.
3. Subjective rating of injury to tomatoes: 1 = severe injury, 10 = no injury.

Table 2. 1964 Tomato Weed Control Experiment—Farmington
Subjective Ratings of Weed Control and Tomato Injury

Herbicide	Rate/A	Weed Control[1] Mallow	Night-Shade	Lambs Quarter	Red Root	Purslane	Annual Grass	Overall Rating Weed Control	Tomato Injury[2]	Hrs/A for Hand Weeding
1. Tillam Incorporated	4 lbs/A	10	9.8	7.8	8.8	8.8	9.2	8.2	10.0	108.3
2. Dymid Incorporated	6 lbs/A	10	7.8	9.2	10.0	9.8	9.8	8.8	10.0	66.7
3. Enide Incorporated	6 lbs/A	10	7.5	9.8	9.8	9.8	10.0	8.8	9.8	73.5
4. Dymid Post Plant	6 lbs/A	10	8.0	9.2	10.0	10.0	10.0	8.8	10.0	65.9
5. Enide Post Plant	6 lbs/A	10	8.2	9.5	9.8	10.0	10.0	8.8	9.2	56.7
6. Check		3.2	3.8	1.2	1.2	2.0	1.0	1.2	8.5	227.4

1. Subjective rating of weed control: 1 = no control of weeds, 10 = complete control.
2. Subjective rating of injury to tomatoes: 1 = severe injury, 10 = no injury.

Table 3. Effect of Herbicides on Yield and Average Size of U.S. No. 1 Fruits

Herbicides	Yield T/A[1]	Average Fruit Size
Enide Post Plant	10.27a	0.44 lbs.
Dymid Post Plant	8.89ab	0.43 lbs.
Enide Incorporated	8.48abc	0.45 lbs.
Dymid Incorporated	8.44abcd	0.43 lbs.
Tillam Incorporated	6.41bcde	0.45 lbs.
Check	3.54 e	0.43 lbs.

1. Yields from herbicide treatments with common letters following are not significantly different at odds of 19:1 and 99:1 by Duncan's Multiple Range Test.

Table 4. Effect of Herbicides on Yield and Average Size of U.S. No. 2 Fruits

Herbicides	Yield T/A[1]	Average Fruit Size
Enide Post Plant	5.69a	0.46 lbs.
Enide Incorporated	4.57ab	0.46 lbs.
Dymid Incorporated	4.41ab	0.44 lbs.
Dymid Post Plant	3.87ab	0.41 lbs.
Tillam Incorporated	3.62ab	0.46 lbs.
Check	2.68 b	0.46 lbs.

1. Yields from herbicide treatments with common letters following are not significantly different at odds of 99:1 by Duncan's Multiple Range Test.

Table 5. Yield of Marketable Fruits (Total of U.S. No. 1 and U.S. No. 2 Fruits) For Herbicide Treatments

Herbicide	Yields T/A[1] .05	.01	Average Fruit Size
Enide Post Plant	15.95a	a	0.45 lbs.
Enide Incorporated	13.06ab	ab	0.45 lbs.
Dymid Incorporated	12.85abc	abc	0.44 lbs.
Dymid Post Plant	12.76abc	abc	0.43 lbs.
Tillman Incorporated	10.04 bcd	bcd	0.45 lbs.
Check	6.22	d	0.44 lbs.

1. Yields from herbicide treatments with common letters following are not significantly different at adds of 99:1 by Duncan's Multiple Range Test.

tomato plant growth. Stauffer R-4461, Vegadex, and Solan were intermediate in weed control and plant growth and Amiben, though an excellent herbicide for all weeds but nightshade and stinkgrass, caused significant injury to tomato plants.

In 1964 both formulations of Diphenamid, Dymid, and Enide were applied with pre-plant incorporation and post-plant at 6 lbs/A and Tillam was applied with pre-plant incorporation. Subjective ratings of weed control, hand labor required for weeding, and tomato injury are indicated in Table 2. It is interesting to note that hand weeding was reduced by herbicides to one half or even one fourth of the time required for the check plots without herbicides.

The first indications of reduction in yield of plots treated with Tillam as compared to Diphenamid are indicated for U. S. No. 1, U. S. No. 2, and total yield of marketable fruits including No. 1 and No. 2 in Tables 3, 4, and 5 respectively. Significant differences are indicated by Duncan's Multiple Range test. These differences in yield may have resulted from greater weed competition caused by slight differences in weed control as evidenced by considerably reduced yields of the check plots or the Tillam may have been slightly toxic to the tomatoes because of a heavy rain just after transplanting into the incorporated plots. This reduction in yield was not observed previously, so it very likely was peculiar to the conditions of this experiment. Because the spectrum of weed control is quite different between Tillam and Diphenamid, this consideration is likely more important than possible differences in yield.

NEW DU PONT HERBICIDES FOR SELECTIVE WEED CONTROL

D. L. Burgoyne[1]

Linuron (Lorox) weed killer, a 50 per cent wettable powder formulation, has been approved for selective weed control in carrots, Irish potatoes, and cotton.

"Linuron" is a unique substituted urea herbicide. It is more active than "Karmex" diuron weed killer as a post-emergence contact material on many weeds, and when used with certain surfactants it becomes an outstanding contact herbicide. In addition, it gives good residual control of seedling weeds for up to 10 weeks, and dissipates from most soils in four months. This reduces residual effects on many rotation crops.

"Linuron," applied as a layby treatment in cotton at rates of two to three pounds per acre with surfactant, has shown outstanding selective weed control. Irrigation should

1. Development and Service Representative, Industrial and Biochemicals Department, E.I. Du Pont de Nemours & Company.

be applied as soon as practical following treatment, and recent results indicate that sprinkler irrigation generally gives better weed control than furrow irrigation.

"Linuron" is recommended for pre-emergence use on Irish potato fields at rates of two to four pounds per acre depending on soil type. It is recommended for both pre-emergence and post-emergence treatment in carrots. Recommended rates for pre-emergence use in carrots are one to four pounds per acre, depending on soil types. Rates for post-emergence application range from 1.5 to 4 pounds per acre, depending on weed height.

Testing of bromacil "Hyvar" X weed killer for control of Bermudagrass, puncture vine, and for general annual weed control in citrus groves was continued through 1964 under an experimental permit.

Applications of bromacil at rates of 4 to 8 pounds per acre applied during the rainy season continue to show good results. If additional test results are favorable, full label clearance of this practice may be possible in the future.

The label directions for using diuron "Karmex" weed killer in established stands of alfalfa have been revised and approved to allow lower dosages on alfalfa grown for hay. Application of 1½ to 3 pounds per acre on established dormant or semi-dormant alfalfa, during the rainy season, will give good control of most broadleaves and grasses, especially during the first spring cuttings when these weeds are a severe problem. However, to control volunteer alfalfa seedlings in addition to annual weeds in alfalfa for seed, the recommended dosage of "diuron" continues to be 4 pounds per acre.

SUPPRESSION OF FIELD DODDER (CUSCUTA CAMPESTRIS) BY SHADE

J. H. Dawson

Abstract: Field dodder (**Cuscuta campestris**) is a parasite and derives its organic food materials from the host plant. It therefore does not require light for photosynthesis, as green plants do. However, dodder does respond to light and shade suppresses it.

Shade from alfalfa did not reduce emergence of dodder seedlings, but did reduce the numbers that attached to host plants by more than 90% and delayed attachment 7 to 10 days. Attached dodder shaded by alfalfa did not develop its characteristic golden color, grew very slowly, and was delayed in maturity 3 to 4 weeks.

Shade from a uniform stand of alfalfa of normal vigor can suppress dodder sufficiently to provide a significant measure of dodder control. If dodder is controlled by other means when alfalfa does not shade the soil, the suppression that occurs after the alfalfa has attained a height of 2 feet or more can provide an important part of a full-season control program. (Crops Research Division, ARS, U. S. Department of Agriculture and Washington Irrigation Experiments Station Cooperating, Prosser)

LONGEVITY OF DODDER SEEDS IN SOIL AS A NEW APPROACH TO CONTROL

D. C. Tingey[1]

Experiments conducted at the Utah Agricultural Experiment Station from 1958 to 1964 have supplied data to indicate that seeds of the three species of dodder found in alfalfa seed fields in Utah are of short duration in the soil (from 3 to 4 years). Seeds used in the studies were of large seeded alfalfa dodder (**Cuscuta indecora** Choisy var. neuropetala Engelm Hitch.), field dodder (**Cuscuta Campestris Yuncker**), and small seeded alfalfa dodder (**Cuscuta Approximata** var. urceolata (Kuntze) Yuncker).

1. Agronomist, Utah State University, Logan

The fact that dodder is not a problem in alfalfa grown for hay is additional evidence that the seeds of the 3 species are of short duration in the soil. Otherwise the seed would survive in the soil from one planting of alfalfa to the next and perpetuate the dodder.

Since dodder seeds seem to be of short duration in the soil, this provides a basis for control. A short crop rotation using non-host crops and preventing dodder from producing seeds on weedy host plants in these crops for 3 or 4 years is one method of dodder control.

A new approach to the control of dodder in alfalfa seed crops, based on a short period of seed dormancy in soil, coupled with the perennial crop such as alfalfa, is being explored at the station. The method consists of plowing, which will require a special plow or some attachment to the present plow, and turning the top soil containing the viable dodder seeds over and putting them on the bottom of the furrow and covering them with 6 inches or more of soil. This will put all the viable seeds down so deep into the soil that the seedlings cannot reach the surface and create a problem. Dodder seeds in the soil when the alfalfa was planted should have germinated or rotted, provided the crop has occupied the soil for 3 or 4 years.

Thus, one plowing done with the right kind of plow that would turn the furrow completely over, should solve the dodder problem on a field badly infested with dodder seed, provided the alfalfa has occupied the land for 3 or 4 years. After the plowing the surface soil should not be worked deeper than 2 or 3 inches for 3 or 4 years to avoid bringing the seeds back to the surface where they can germinate and cause trouble. A newly plowed field could have the soil worked shallow into a seed bed and planted to a small grain crop. The small grain crop should not be furrowed for irrigation. When the crop was harvested, alfalfa could be planted into the grain stubble followed by an irrigation. The next year the farmer would be back in seed production and dodder should not be a problem provided precautions were taken to prevent re-infestation through seed, water, manure, animals, machinery, etc.

This same procedure suggested for dodder control would appear to have application in other weed problems whose seeds are of short duration in the soil and where a perennial crop is grown.

The plow method may have a place also in the control of weeds whose seeds are of long duration in the soil. Where the surface soil suddenly becomes heavily infested with such seeds then considerable may be accomplished **in** control by plowing them under and avoiding deep working of the soil for a number of years.

With soils which crack badly or where mice are a problem, the effectiveness of the method may be reduced some because of the annual movement of seeds into the soil.

The plow method of weed control may have wide application, but it needs further exploration and studies on longevity of seeds in the soil and factors influencing the longevity to determine its place in weed control.

EFFECTS OF SOIL INCORPORATION ON THE ACTIVITY OF PYRAZON

Gary A. Lee[1]

The study was initiated to determine the effects of four methods of mechanical incorporation on the activity of pyrazon. The objectives were (1) to find the most effective method of soil incorporation for pyrazon, (2) to determine the effects of four methods of soil incorporation of pyrazon on the control of broadleaved and grass species of weeds common to sugar beet fields, (3) to determine the effect of methods of incorporation of pyrazon on the stand of sugar beets, and (4) to determine the effect of methods of incorporation of pyrazon on sugar beet yields and sucrose content of the sugar beets.

The field was prebedded with Eversman bedding units.

1. Graduate Student in Weed Control, University of Wyoming, Laramie

The four methods of mechanical incorporation were: (1) finger-weeder, (2) roto-tiller, (3) sinner-weeder, and (4) rotary-hoe. Chemical treatments consisted of pyrazon at 5 lb/A, pyrazon at 3 lb/A, PEBC at 3 lb/A, and check. The herbicides were applied in a seven inch band over the center of the sugar beet row. Each treatment consisted of four rows, 100 feet long. Treatments were replicated 12 times for a more realistic statistical analysis.

Weed and sugar beet counts were taken from an area ten feet long and three inches wide, one and one-half inches on either side of the beet row. The plant population was classified as to (1) sugar beets, (2) broadleaved weeds, and (3) grass species. Broadleaved weeds most commonly found in the experimental areas were: rough pigweed (**Amaranthus retroflexus** L.), lamb's quarters (**Chenopodium album** L.), black nightshade (**Solanum nigrum** L.), buffalo bur (**Solanum rostratum** Dunal.), and Kochia (**Kochia scoparia** L.). Grasses most commonly found in the experimental area were: green foxtail (**Setaria viridis** (L.) Beauv.) and barnyardgrass (**Echinochloa crusgalli** (L.) Beauv.). The weeds between the rows were controlled with conventional inter-row cultivation. The weeds within the sugar beet row were removed by hand weeding. Sugar beet stand was thinned to approximately one beet per eight inches of row. Plots were kept relatively weed free for the remainder of the growing season.

Sugar beet yields were determined by randomly selecting ten feet of row in the middle of the plot.

The sinner-weeder method of incorporation resulted in a significant better control of grass than the other three methods. The finger-weeder method of incorporation resulted in significantly less control of broadleaved weeds. The use of the roto-tiller and sinner-weeder resulted in a significant reduction in sugar beet stand when comparing all methods of incorporation. The sinner-weeder resulted in a significant reduction in tonnage yields of sugar beet roots. Pyrazon at 5 lb/A and PEBC at 3 lb/A gave significantly better control of broadleaved and grass species than the other treatments. Pyrazon at 3 lb/A, when compared to the check, significantly reduced the broadleaved weed population, although it had less control than Pyrazon at 5 lb/A and PEBC at 3 lb/A. Sugar beet stands were significantly reduced by the pyrazon at 5 lb/A and PEBC at 3 lb/A treatments, but were not significantly reduced by the pyrazon at 3 lb/A treatment.

There was an interaction between incorporation methods and chemical treatments in the sugar beet yield data. Even though pyrazon at 5 lb/A and PEBC at 3 lb/A reduced the stand of sugar beets, the yields were higher than the pyrazon at 3 lb/A and check treatments. There were no significant differences in sucrose content of the four incorporation methods or chemical treatments.

The principle results from this study are:

(1) For the control of the grass species, the sinner-weeder was the most effective method of chemical incorporation, and Pyrazon at 5 lb/A or PEBC at 3 lb/A were the best chemical treatments.

(2) The roto-tiller, sinner-weeder and rotary-hoe were significantly better than the finger-weeder as a method of incorporation in controlling broadleaved weeds. PEBC at 3 lb/A and Pyrazon at 5 lb/A were the best chemical treatment for broadleaved weed control.

(3) The sinner-weeder and roto-tiller caused a significant reduction in sugar beet seedling stand, but only the sinner-weeder incorporation resulted in a reduction in sugar beet yield. Pyrazon at 5 lb/A and PEBC at 3 lb/A caused a significant reduction in sugar beet seedling stands, but both treatments had slightly higher sugar beet yields than the check.

(4) In this study, pyrazon at 3 lb/A was too light a rate for satisfactory weed control.

(5) With all factors taken into consideration, the most effective of the four mechanical incorporation methods for incorporating pyrazon was the power driven roto-tiller.

ANNUAL WEED COMPETITION IN SUGAR BEETS

Harold P. Alley[1]

Although striking advances have been made in all phases of sugar beet production, the immediate concern is weed control.

With hand labor becoming limited, and the cost of thinning and weeding sugar beets continuing to rise, it is of necessity that herbicides now available be used by the sugar beet grower for him to obtain maximum production. Many sugar beet growers do not fully realize what weed infestations may do to the crop yield. With a limited amount of labor available in 1965 we are undoubtedly going to see some heavily infested fields and especially in those areas where the sugar beet grower is hesitant to use herbicides.

This study was conducted to determine the competitive effects of different densities of rough pigweed (**Amaranthus retroflexus** L.) and green foxtail (**Setaria viridis** L. Beauv.) on sugar beet yield in relation to weed-free sugar beets.

Weed densities consisted of one weed per 8 sugar beets, one weed per 4 sugar beets, one weed per 2 sugar beets, one weed per 1 sugar beet and two weeds per 1 sugar beet for the individual pigweed and foxtail treatments.

Where pigweed and foxtail were combined in the same treatment the densities were one pigweed and one foxtail per 8 sugar beets, one pigweed and one foxtail per 4 sugar beets, one pigweed and one foxtail per 2 sugar beets, one pigweed and one foxtail per 1 sugar beet, and two pigweed and two foxtail per 1 sugar beet. In addition there was one check (weed-free) treatment. Weeds were hand thinned and maintained to the desired density.

In addition, the data obtained from the 1963-1964 studies were analyzed from an economic standpoint. The yield per acre and value of the sugar beet crop is presented in the following table:

Weed density/beet	Yield T/A	Beet value/A[a]
2 pigweed 2 green foxtail	3.38	$ 56.10
2 pigweed	4.31	71.54
2 green foxtail	14.38	235.38
Weed-free	22.53	373.99

a. Beet value per acre figures at $16.60/T.

Valuing sugar beets at $16.60/T, a green foxtail infestation of 2 plants per sugar beet could assumingly cost the sugar beet grower $138.61/A, whereas the heaviest infestation of pigweed and pigweed plus green foxtail could cause a loss of $302.45 and $317.89/A respectively when compared to the yield from the weed-free plots.

These figures were derived from the highest infestations evaluated in this study. The infestations common to many beet fields would be intermediate to the heaviest infestations used in the above table.

Sugar beet production costs and practices[2] just published by the Wyoming Agricultural Experiment Station, Division of Economics show that break-even yields of sugar beets in Wyoming in 1964 were between 12 and 13 tons/A.

From the information obtained from the competition study, it is evident that every method at the disposal of the sugar beet grower must be used to make sugar beet growing an economical venture.

The effects of the various densities of pigweed, foxtail, and the combination pigweed and foxtail on the yields of sugar beet roots, sugar beet tops, weeds and total vegetation are summarized in the following table.

1. Weed Scientist, University of Wyoming, Laramie, Wyoming.
2. Sugar Beet Production Costs and Practices. Wyoming Agr. Exp. Sta. Mimeo Circ. No. 206. January 1965.

DENSITY OF WEEDS PER SUGAR BEET	TONS PER ACRE Beet roots	Beet tops	Weeds	TOTAL VEGETATION
Check (weed-free)	22.53[a]	23.74 a	.00 a	46.27 a
Green foxtail 1/8	21.70 a	23.03 a-b	.35 a-b	45.08 a-b
Green foxtail 1/4	20.32 a-b	21.69 a-c	.65 a-b	42.66 a-b
Green foxtail 1/2	20.35 a-b	20.91 a-c	1.28 a-c	42.54 a-b
Green foxtail 1/1	16.57 c-e	20.44 a-c	2.17 b-c	39.18 b-c
Green foxtail 2/1	14.18 e	17.07 c-e	3.08 c	34.33 c-d
Rough pigweed 1/8	18.80 b-c	22.13 a-b	1.96 b-c	42.89 a-b
Rough pigweed 1/4	17.81 b-d	15.38 d-e	4.95 d	38.14 b-c
Rough pigweed 1/2	10.63 f	12.69 e-f	5.47 d-e	28.79 d-e
Rough pigweed 1/1	6.81 g	9.49 f-g	8.65 f-g	24.95 e-f
Rough pigweed 2/1	4.31 g-h	7.43 g	9.14 f-g	20.88 f
Pigweed & foxtail 1:1/8	17.86 b-d	18.56 b-d	2.79 c	39.21 b-c
Pigweed & foxtail 1:1/4	15.16 d-e	18.34 b-d	5.06 d	38.56 b-c
Pigweed & foxtail 1:1/2	10.75 f	13.28 e	5.98 d-e	30.01 d-e
Pigweed & foxtail 1:1/1	6.84 g	9.84 f-g	7.31 e-f	23.99 e-f
Pigweed & foxtail 2:2/1	3.38 h	6.60 g	10.02 g	20.00 f

a. Means in the same column which have the same letter are not significantly different at the .05 level.

FACTORS INFLUENCING PYRAZON EFFECTIVENESS FOR WEED CONTROL IN SUGAR BEETS

K. W. Dunster[1]

Time of Treatment

Pyrazon has been reported herbicidally active as a post-emergent treatment in sugar beet production areas of Europe and the humid, high rainfall areas of the United States. Post-emergence trials in many areas of our semi-arid west have failed to provide consistent results. Good results were obtained only when rainfall was received after application. This indicates that root rather than foliage absorption is the primary consideration.

Promising post-emergent results were obtained by Sullivan (7), Andersen (1), and Alley (3) when pyrazon was applied with wetting agents and/or contact herbicides. In general, beet damage was greater and herbicidal effectiveness somewhat inferior to the response obtained with pre-plant treatments. Such treatments would be considered to be of a remedial nature and will not receive further consideration in this paper.

A greenhouse trial conducted at the Amchem Research Farm demonstrated the advantage of pyrazon incorporation over surface applied treatments when sub-irrigated. Data presented in Table 1 indicates that the root rather than epicotyl or shoot represents the primary organ of absorption.

Table 1. Influence of soil placement on weed reduction from pyrazon treatment at two rates.

Application	Setaria 2 lb/A	Setaria 4 lb/A	Lambsquarter 2 lb/A	Lambsquarter 4 lb/A
Surface appl.	0%	37%	20%	33%
Incorp. (1 in)	40%	80%	57%	97%

1. Herbicide Development, Amchem Products, Inc., Ambler, Penna.

A similar observation has been made in many field trials. Stewart (6) working near Missoula, Montana, showed pyrazon to be most effective as a pre-plant incorporation treatment in the absence of rainfall. Pre- and post-emergent treatments in the same trial were relatively ineffective.

Incorporation Techniques

With root uptake the primary consideration, steps must be taken to place pyrazon in contact with the root system of germinating weed seeds. In areas where natural rainfall cannot be predicated wtih any degree of success, this is achieved by mechanical incorporation.

Extensive studies by Lee (5) of the Univ. of Wyoming and Eckroth (4) of Holly Sugar Co. indicate proper soil placement of pyrazon is essential if maximum beet selectivity and herbicidal activity is to be assured. This is evident in Eckroth's field data presented in Table 2.

Table 2. Effect of incorporation equipment on beets and weeds treated with pyrazon.

Method of incorp.	stand reductions* Beets	Grass	Brdlvs.
Beyl (chisel)	14%	41%	74%
Bye-Hoe (power)	19	58	77
Russ-Ken (layering)	33	68	85
K. J. (harrow-tine)	15	51	73

* Ave. of 36 trials in Rocky Mountain area (1964).

A loss of sugar beet stand has been observed in the field in some instances where pyrazon was incorporated with a layering type device such as the Russ-Ken sinner weeder. Injury appeared to be aggravated by poor beet-growing conditions and light, coarse textured soil conditions.

Shallow incorporation with the chisel, harrow-tine or Howery-Berg equipment has generally not produced weed control comparable to that obtained with the Russ-Ken or power driven rotary tiller type.

Power driven rotary tiller equipment such as the Eversman or Bye-Hoe has tended to minimize beet injury and produce consistent weed control.

Sugar beet injury caused by method of incorporation has usually been in the form of reduced stands. Surviving beets have good vigor and apparent stimulation has been reported by some researchers (3).

Beet injury observed during the past season may have been partly due to the nature of the 50% active formulation available during the 1964 testing season. The 50% material was initially more phytotoxic to beets than the 80% material in a late summer trial in New York, but the injury was outgrown. A recent greenhouse trial in Ambler, Pa. confirmed this observation.

A recent study was conducted at the Amchem Research Farm to determine the relative effect on beet selectivity and herbicidal activity of pyrazon placement in the soil. Comparisons were made between surface, concentrated band adjacent to seed, 1 inch incorporation and 2 inch incorporation treatments. Applications were made to sandy and clay loam soils at 2 and 4 lb/A. The results are reported in Table 3.

Beet damage was most pronounced where pyrazon had been incorporated throughout the soil profile. Apparently continued exposure of the root system to pyrazon more than offsets the physical dilution brought about by soil incorporation. It is speculated that vigorous sugar beet seedlings are capable of growing out of the treated area before toxic concentrations are accumulated under field conditions.

Table 3. Sugar beet and weed response to pyrazon application sites.

		stand and vigor reduction					
Treatment rate		Clay loam			Sandy loam		
		Beets	Lambsqtr.	Setaria	Beets	Lambsqtr.	Setaria
Surface	2 lb/A	10%	20%	0%	25%	97%	30%
	4	5	33	37	42	93	75
Seed layer 1/2"	2	7	37	23	5	93	60
	4	12	90	77	26	100	87
1" incorp.	2	0	57	40	13	83	83
	4	0	97	80	17	100	85
2" incorp.	2	0	63	57	12	100	77
	4	53	100	87	67	100	95

Table 4. Chronological response of weeds to pyrazon treatment.

Treatment	Torrington				Worland			
	May 26		July 26		June 2		June 30	
	Brdlv.	Grass	Brdlv.	Grass	Brdlv.	Grass	Brdlv.	Grass
Pyrazon 5 lb/A	81	42	85	87	92	75	95	74
Pyrazon 3 lb/A	56	29	97	89	69	2	90	31
Check	48	19	80[a]	83[a]	11	-6	-6	-33

a. Mechanical treatment - Bezzerides Weeders

Table 5. Weed response to herbicide combinations and their components.

			Control			
Treatment	Rate	Beet stand[a]	Nightshade	Pigweed	Foxtail	Yield
Pyrazon	5 lb/A	72.4	72.4%	77.5%	17.8%	15.9 ton/A
Pyrazon +	3	64.1	95.2	91.7	56.9	20.6
PEBC	3					
Pyrazon +	3					
TCA	5	64.9	62.5	72.4	82.2	16.0
Pyrazon +	3					
TD 282	2	68.3	87.2	75.9	59.4	18.0
Pyrazon	4	59.2	86.5	88.1	54.5	17.7

a. Beet injury accentuated by Chemical concentration in a narrow band due to the method of irrigation.

Persistence of Pyrazon's Effectiveness

Processes including vaporization, leaching, photochemical alteration and degradation or detoxification by soil micro-organisms are known to influence the persistence of herbicides in the soil. These factors must be considered in explaining the season-long weed control observed on many pyrazon-treated areas.

Work by Alley (2) indicates that Pyrazon has no appreciable activity in the vapor phase. Since this is the case and, further, since the chemical is incorporated, we can speculate that loss of herbicidal activity as a result of volatility or photodecomposition is minor.

Pyrazon has a water solubility of 300 ppm. Sprinkler irrigation or rainfall appears to be an adequate substitute for mechanical incorporation. From this we can assume that pyrazon is somewhat subject to leaching.

A preliminary leaching study was conducted to determine the effect of different amounts of overhead irrigation on pyrazon leachability in three different soil types. A plant bioassay indicated that in a clay loam soil pyrazon was leached approximately 1½, 2¼, 3½ and 6 inches with ½, 1, 2 and 4 inches of water respectively. The leaching pattern was not appreciably different for silt and sandy loam soils. More critical investigations must be made as to the influence of organic matter and absorption on leaching patterns.

Some researchers report improved weed control with pyrazon as the growing season progresses. Work conducted by the Univ. of Wyoming (3) and reported in Table 4 indicates that improved weed control may be a function of time.

Chemical Combinations

Pyrazon, although effective on some grasses at higher rates, is known primarily as a broadleaf weed killer. Broad spectrum weed control is provided by combining pyrazon with grass herbicides or other effective on weeds not controlled satisfactorily by pyrazon alone.

Detailed studies conducted by the Great Western Sugar Co. (7) and the Univ. of Wyoming (3) demonstrate the success of any given combination to be a function of the weed complex present. Combination specificity is evident in the work by the Univ. of Wyoming as reported in Table 5.

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2. Alley, H. P. 1964. Unpublished data — Ph.D. thesis, Univ. Wyoming.
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EVALUATION OF SELECTIVE HERBICIDES FOR THE CONTROL OF ANNUAL BROAD-LEAVED WEEDS IN SMALL GRAIN IN MONTANA[1]

H. R. Guenthner, D. E. Baldridge, G. P. Hartman and V. R. Stewart[2]

Summary

The yield data presented has shown that 2,4-D can not be safely applied at an early growth stage in spring grains for the control of early germinating weeds or in the fall in winter wheat for the control of fall-germinated annual broadleaf weeds. When the rate of 2,4-D was increased to control the 2,4-D tolerant weeds, yield reductions were evident even when the treatment was made at the proper growth stage.

Several of the herbicides evaluated effectively controlled annual broadleaf weeds which are tolerant to 2,4-D.

Ioxynil. Spring wheat, winter wheat and barley were found to have excellent tolerance to ioxynil. Rates as high as two pounds per acre has had little effect on grain yields. Oats, however, did not exhibit any tolerance to ioxynil. Applications of ioxynil were most effective when applied early on rapidly growing young weeds and when the grain was in the three to five-leaf stage. A combination of four ounces of ioxynil plus four to six ounces per acre of 2,4-D appears to be the most effective combination and will provide a broader spectrum of weed control than ioxynil alone. Ioxynil did not effectively control tansy mustard, knotweed and kochia at rates up to twelve ounces per acre. It can be safely applied in the fall for the control of fall-germinating weeds in winter wheat. The addition of a surfactant may increase the effective of ioxynil. Present data indicates that volume may be an important factor in the performance of ioxynil.

Dicamba. Spring wheat and winter wheat have shown good tolerance to dicamba. Barley, however was found to be more sensitive to this herbicide. Oats appears to be more tolerant than barley to dicamba based on one season's observations. A combination of dicamba at two ounces per acre and 2,4-D at four to six ounces per acre applied on wheat at the five-leaf stage or early tillering stage was an effective treatment. This treatment was effective in controlling most annual broadleaved weeds except tansy mustard and knotweed. A height reduction of the grain was noticed at this rate but apparently did not result in a reduction in grain yield.

Picloram. Spring wheat, winter wheat, barley and oats were found to be tolerant to picloram up to rates of one ounce per acre in tests conducted at Moccasin. At Sidney a test conducted in spring wheat showed a tolerance of one-half ounce per acre of picloram. Oats have been found to be the most tolerant of the small grains evaluated. Rates as low as one-fourth ounce per acre did cause some shortening in height of barley and wheat; however, no yield reduction resulted. Picloram was safely applied at the three leaf stage at one-half ounce per acre in winter wheat and barley. A combination of picloram at one-fourth to one-half ounce per acre with 2,4-D at four to six ounces per acre was applied from the five-leaf stage to the tillering stage without damage to the grain. Picloram has been effective on wild buckwheat, cow cockle and Russian thistle but is not effective on knotweed, tansy mustard, roundleaf mallow or kochia. A combination treatment provided a broader spectrum of weed control.

Dacamine was not found to be more effective than 2,4-D and TD-440 (evaluated one season) performed similar to other 2,4-D treatments.

1. Contribution from the Montana Agricultural Experiment Station, Bozeman, Montana. Summary of paper presented at the Western Weed Control Conference at Albuquerque, New Mexico, March 17-19, 1965.
2. Agronomists, Montana Agricultural Experiment Station located at Moccasin, Huntley, Sidney, and Kalispell; respectively.

WINTER APPLICATIONS OF 2,4-D AND MCPA FOR CONTROL OF TANSY MUSTARD IN ALFALFA

Merrill A. Ross[1]

Fall germinating Tansy mustard has caused considerable reduction in the quality of first cutting alfalfa hay in eastern and southeastern Colorado during recent years.

Chemicals were tested in the 1962, 1963, and 1964 seasons at Rocky Ford for the control of this weed in established alfalfa. In 1962 and 1964 chemicals were applied both as dormant and post-dormant winter (with respect to alfalfa) and spring applications. In 1963 dormant sprays only were used. Chemicals tested in the 1962 winter season included diuron, simazine, CIPC, EPTC, and the phenoxy compounds MCPA, 2-4-DB and 2,4-D. The spring applications included MCPA, 2,4-D and 2,4-DB. The 1963 trials included MCPA, 2,4-D and Hyvar. Both the spring and winter 1964 trials were limited to 2,4-D and MCPA. Diuron, simazine, EPTC and CIPC tried in the 1962 winter tests were applied too late to control Tansy mustard.

The outstanding control of Tansy mustard with 2,4-D and MCPA in the winter applied treatment with no damage to the alfalfa was somewhat unexpected. The 2,4-DB proved to be relatively ineffective against Tansy mustard. Diuron, simazine, EPTC and CIPC were not tested further because the phenoxy compounds would be considerably cheaper and more convenient to use. Hyvar in the 1962 test showed considerable promise but was toxic to the alfalfa at the rates used. It still merits further testing.

Winter applied chemicals were sprayed on established alfalfa following early winter storms. At the time chemicals were applied the Tansy mustard was green and showing signs of life (attributed to the warm weather). The alfalfa had remained dormant. In general the phenoxy compounds, 2,4-D and MCPA gave excellent control of Tansy mustard without any damage to the alfalfa. Outstanding results were noted in the 1962 and 1964 seasons. Somewhat poorer results were obtained under the drier conditions of the 1963 season.

The winter application of phenoxy compounds has several possible advantages. First, they are applied at a time

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CONTROL OF TANSY MUSTARD IN ALFALFA WITH 2,4-D AND MCPA (1964)

Treatment Chemical	lbs/A	Percent Stand Reduction of Tansy Mustard in Alfalfa		Yield of Forage Expressed As Percent of Check: 1st Cutting		2nd Cutting		3rd Cutting	
		Winter applied	Spring Applied	Winter applied	Spring Applied	Winter applied	Spring Applied	Winter applied	Spring Applied
2,4-D	1	96	—	105	—	100	—	101	—
2,4-D	½	93	84	121	50	101	84	106	103
2,4-D	¼	88	70	110	60	106	94	100	96
MCPA	1	97	85	110	60	100	82	105	100
MCPA	¼	95	89	115	70	104	72	107	96
MCPA	¼	83	75	110	69	103	102	107	102

of the year when the farm work is slack; secondly, they can be applied with low cost sprayers usually on hand; and thirdly, the cost of the chemical is about a dollar per acre. Another advantage is lack of damage to the alfalfa.

There was considerable damage to the alfalfa when these compounds were applied in the spring after it had broken dormancy. Damage was most evident on the first cutting. The alfalfa seemed to recover fairly well later in the season.

2,4-D and MCPA are practical and effective under eastern Colorado conditions for control of Tansy mustard in established alfalfa. Typically open winters are characterized by cold periods in early winter followed by warm periods. The cold causes the alfalfa to go dormant and it remains in this condition while the Tansy mustard grows during warm days. In our tests the chemicals were applied during these warm periods. 2,4-D and MCPA should definitely be applied before the alfalfa greens up in the spring. Probably any time before the alfalfa breaks dormancy would be effective.

TORDON — DISAPPEARANCE FROM SOILS

C. A. I. Goring, C. R. Youngson, and J. W. Hamaker[1]

Tordon[2] (4-amino-3,5,6-trichloropicolinic acid) has shown outstanding promise for control of brush (5, 6), woody rangeland species (1), and deep-rooted perennial herbaceous weeds (3, 4).

Not only is it highly active via foliar application (1, 3, 4, 5), but because of its persistence in soil and susceptibility to leaching (2), it has been extremely effective on deep-rooted plants via soil application (6). In this respect, its method of action is similar in principle to the benzoic acid herbicides. However, it is considerably more active than 2,3,6-trichlorobenzoic acid (3); and, therefore, is being recommended and used at correspondingly lower dosages.

The persistence of Tordon in soil, although a vital, necessary, and integral part of its herbicidal activity, will (together with the tolerance of the crop to be planted) determine the interval between herbicidal treatment and the successful planting and growth of a normal crop.

Many field plots have been treated with Tordon in the last few years. A number of these plots have been sampled to various depths at various times and assayed for Tordon. The results of this continuing program obtained to date are presented in this report.

EXPERIMENTAL

The location of the plots, the rates of application of Tordon, the weed-cover treated, and the properties of the soils (0-6 inches deep) are shown in Table 1.

The plots were sampled to depths of 2½ to 6 feet. The assistance of E. R. Laning, Jr., R. L. Warden, and J. W. Gibson, in obtaining and submitting the soil samples for analysis, is gratefully acknowledged. For the most part, each soil did not vary greatly in mechanical analysis and pH throughout the depth sampled; but organic matter gradually decreased with increasing depth. 1 to 4 cores (usually 3) were sampled per plot, divided up into 6-inch increments, and composited for analysis. 3 to 4 plots were sampled per treatment with Tordon.

The soil samples were air-dried, crushed, mixed, and diluted with a sandy loam soil to give a 3-fold dilution series varying from 1:3 to 1:2187. Two replicates of each dilution were prepared for each sample. A standard series was also prepared, starting with an 0.5 ppm concentration (1 pound per acre 6 inches) of Tordon in the soil.

The diluted soil samples were placed in small containers and planted to safflower (4 seeds per container). Safflower was used as an indicator plant, because it gives a good range of symptoms over a range of Tordon herbicide concentrations in soil and because it is one of the important crops most sensitive to Tordon. The plants were grown under greenhouse conditions for a few weeks and then graded for severity of symptoms by the following system:

Numerical grade	Description of symptoms
0	No symptoms.
1	True leaf formed; very slight onion leaf or spindly.
2	True leaf formed; pronounced onion leaf or spindly.
3	Very small spindly true leaf primordia.
4	Cotyledons open; no true leaf primordia produced.
5	Cotyledons unopened.
6	No emergence or plants dead.

The numerical grades of the plants in each pair of duplicate jars for the check-series were averaged and plotted against concentrations on tricyclic semi-log paper and best-fitting straight lines drawn.

The numerical grades for the various experimental soil samples were also averaged, and estimates for the concentrations of Tordon in the original soil samples obtained by multiplying together the concentrations of Tordon in the original soil samples obtained by multiplying together the concentrations of Tordon equivalent to these average grades (obtained from the standard curve) and the dilution factor involved. Estimated concentrations of Tordon for the various dilutions and replicate plots were then averaged to give an estimated concentration of Tordon to the nearest one-thousandth of a part-per-million for each soil depth in each experiment. These results are shown in Table 2.

It is evident from Table 2 that the concentrations of Tordon at any depth in the various plots were below 0.001 ppm in 4 instances with sampling intervals ranging from 24 to 42 months, 0.001 to 0.125 ppm in 7 instances with sampling intervals ranging from 5 to 28 months, and above 0.125 ppm in 5 instances with sampling intervals ranging from 5 to 22 months. Furthermore, except for the California 6-plot, the highest concentrations of Tordon were in the top 12 inches of soil. Measurable amounts of Tordon were found in only 2 of the plots at a depth of

1. Bioproducts Research, The Dow Chemical Company, Walnut Creek, California
2. Registered trademark of the Dow Chemical Company, designated picloram by WSA nomenclature committee.

Table 1. Location of Plots, Rates of Application ot Tordon, Weed Cover When Treated, and Properties of the Soils.

Location of Plots	Rate Lbs/Acre	Weed Cover	Properties of Soils (0-6") Sand %	Silt %	Clay %	Organic Matter %	pH
Kansas—1	1.68	Field Bindweed	15	55	30	1.5	4.8
Kansas—2	3.36	Field Bindweed	15	55	30	1.5	4.8
South Dakota—1	1.68	Field Bindweed	41	45	14	2.8	7.2
Minnesota—1	4.2	Brome Grass	17	69	14	4.4	5.5
Minnesota—2	1.5	Canada Thistle	24	51	25	9.0	7.5
California—1	4.0	Morning Glory	11	60	29	2.0	7.3
California—2	4.0	Morning Glory	43	40	17	1.0	6.1
California—3	1.5	Morning Glory	46	35	19	1.3	6.1
California—4	3.0	Morning Glory	46	35	19	1.3	6.1
California—5	2.0	Morning Glory	6	53	41	1.1	7.8
California—6	4.0	Morning Glory	6	53	41	1.1	7.8
California—7	1.68	Morning Glory	2	61	37	2.2	7.3
California—8	1.68	Morning Glory	2	61	37	2.2	7.3

Table 2. Location of Plots, Sampling Interval, Rainfall or Irrigation, and Concentrations of Tordon in the Soil Profiles

Location of Plots	Interval Between Treatment and Sampling	(1) Rainfall or Irrigation Inches	Concentrations of Tordon Herbicide in the Soil Profiles in Parts Per Million 0-6	6-12	12-18	18-24	24-30	30-36	36-42	42-48	48-54
Kansas—1	May 1962-Oct. 1962	19	0.007	0.011	0.008	0.004	0	0	0	0	—
	May 1962-July 1964	54	0	0	0	0	0	0	0	0	—
Kansas—2	Sept. 1962-July 1964	36	0.221	0	0	0	0	0	0	0	—
South Dakota—1	May 1962-Oct. 1962	13	0.053	0.024	0.004	0.001	0	—	—	—	—
	May 1962-Nov. 1963	40	0.018	0.017	0.006	0	0	—	—	—	—
Minnesota—1	June 1962-Nov. 1962	11	0.329	0.085	0.007	0	0	—	—	—	—
	June 1962-Nov. 1963	33	0.177	0.008	0.002	0	0	—	—	—	—
Minnesota—2	Sept. 1962-Nov. 1963	22	0.137	0.070	0.009	0	—	—	—	—	—
California—1	Nov. 1961-Oct. 1963	43	0.001	0	0	0	0	0	0	0	0
California—2	Nov. 1961-Mar. 1964	43	0	0	0	0	0	0	0	—	—
California—3	Aug. 1960-Feb. 1964	65	0	0	0	0	0	0	0	0	0
California—4	Aug. 1960-Feb. 1964	65	0	0	0	0	0	0	0	0	0
California—5	Nov. 1961-Mar. 1964	49	0.011	0.061	0.047	0.025	0.020	0.001	0	0	0
California—6	Nov. 1961-Mar. 1964	49	0.016	0.052	0.104	0.085	0.051	0.061	0.056	0.010	0
California—7	Aug. 1962-April 1963	5	0.327	0.010	0.007	0.005	0.001	0	0	0	—
California—8	May 1961-Aug. 1963	38	0.025	0.005	0.009	0.004	0.004	0.006	0.007	0.009	—

(1) The figures shown represent rainfall exclusively except for the California-8 experiment, in which the area was flooded with 25 inches of water in July, 1962.

48 inches (California 6 and 8). The California 8-plot was flooded with 25 inches of water and was expected to have Tordon present to a considerable depth in the soil. The California 6-plot did not have any Tordon below the 48-inch depth.

The parts-per-million of Tordon at each soil depth were added together and converted to pounds of Tordon recovered per acre by multiplying by 0.002 (an acre 6 inches was assumed to be 2,000,000 pounds of soil; and, therefore, 0.001 ppm equals 0.002 pounds). These results were subtracted from the pounds-per-acre of Tordon applied, to give pounds of Tordon that had been lost. The percent loss of Tordon was also calculated. Actual losses and percent losses of Tordon are shown in Table 3.

Losses of Tordon ranged from 58 to 98 percent within 1 year after application and from 78 to 100 percent within 2 years after application. For 2 of the 3-plot locations where Tordon was applied at 2 different rates, (Kansas 1 and 2 and California 5 and 6), a greater percentage of Tordon was lost at the lower than at the higher rate of application for similar time periods. At the third location, (California 3 and 4), Tordon could not be detected in any of the plots.

Half-lives for Tordon for the various locations were estimated by assuming that the rate of disappearance of Tordon was directly proportional to its concentration in the soil ($\frac{dc}{dt} = -kC$ where C is the concentration of Tordon in the soil—that is, first order kinetics). The estimates of half-lives were rounded off to the nearest month. When Tordon could not be detected in the soil, the half-life was estimated by assuming 99.9 percent loss of Tordon since the bio-assay method was capable of detecting as little as 0.002 pounds of Tordon per acre 6 inches.

The estimates shown in Table 3 indicate half-lives for Tordon in the soil for the field plots tested of from 1 to 13 months.

SUMMARY

Field plots in California, South Dakota, Kansas, and Minnesota to which Tordon had been applied at rates of from 1.44 to 4.2 pounds per acre were sampled and bio-assayed for Tordon at various intervals.

Losses of Tordon ranged from 58 to 96 percent within 1 year after application, and from 78 to 100 percent within 2 years after application. Estimated half-lives for Tordon at the various locations ranged from 1 to 13 months. A greater percentage loss of Tordon occurred at the lower than at the higher dosage of Tordon at the only 2 locations where an appropriate comparison was possible.

For all of the locations except 1, the highest concentrations of Tordon were found in the top 12 inches of soil. Measurable amounts of Tordon were found at only 2 of the locations to a depth of 48 inches. One of these plots had been flood-irrigated with 25 inches of water 13 months prior to sampling.

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Table 3. Loss of Tordon from the Experimental Locations Sampled

Location of Plots	Interval Between Treatment and Sampling—Months	Rate Lbs./Acre	Loss Lbs./Acre	Loss %	Estimated Half-Life of Tordon—Months
Kansas—1	5	1.68	1.62	96	1
	25	1.68	1.68	100	<3
Kansas—2	22	3.36	2.92	87	8
South Dakota—1	5	1.68	1.52	91	1
	17	1.68	1.60	95	4
Minnesota—1	4	4.2	3.36	80	2
	16	4.2	3.83	91	5
Minnesota—2	13	1.5	1.07	71	7
California—1	23	4	4.00	100	<2
California—2	28	4	4.00	100	<3
California—3	41	1.5	1.50	100	<5
California—4	41	3	3.00	100	<5
California—5	28	2	1.67	83	11
California—6	28	4	3.13	78	13
California—7	8	1.68	0.98	58	6
California—8	23	1.68	1.54	92	3

COMBINED APPLICATION OF HERBICIDES WITH DUST CONTROL PRODUCTS

V. W. Woestemeyer, J. D. Stone, and R. H. Cooper[1]

Dust creates a serious problem in many areas such as industrial yards, playgrounds, certain military installations, etc. Many of these same areas have weed problems, and it is often desirable to apply a soil sterilant type of weed killer at the same time the dust control chemicals are applied. The objective of this test was to evaluate the performance of certain herbicide-dust control formulations.

PROCEDURE

A series of experimental treatments was applied as a fall application using several herbicides in combination with a petroleum resin product, Coherex. This is a dust control material manufactured by Golden Bear Oil Company. The herbicides used were as follows:

C. All treatments were applied as sprays with the total volume being 11¼ gallons per 100 square feet. This volume conforms to the standard recommendation for applying Coherex to assure penetration to the desired depth in the soil.

The Coherex forms a stable emulsion with water. The Maintain which emulsifies with water and borate-chlorate formulations which dissolve in the water phase were added to the emulsion before spraying. The size of the individual plots was 400 square feet.

1. U.S. Borax Research Corporation, Anaheim, California

The vegetation at the time of application consisted of a moderate growth of Australian saltbush, Bermuda grass, wild barley, and filaree, an annual broadleaf weed. The combination treatments and results are listed in the table following.

RESULTS

Evaluations were made the following year in March and July. All herbicide treatments controlled 99% to 100% of the vegetation through March. In July control from the borate-chlorate treatments ranged from 85% to 95% with white horse nettle the only remaining specie. Vegetation control data are given in the following table:

Vegetation Control

Herbicide	Rate*	Per Cent Control March	July
Coherex + Polybor-Chlorate	4 lbs./100 sq. Ft.	100	95**
Coherex + Polybor-Chlorate	2 lbs./100 sq. Ft.	99	85**
Coherex+Monobor-Chlorate Granular	2 lbs./100 sq. ft.	99	85
Coherex + Maintain	3 Gals./Acre	99	100
Coherex		0	0

* All treatments were applied with 2¼ gallons Coherex and 9 gallons water per 100 square feet.

** White horse nettle.

All treatments effectively controlled dust movement during the observation period.

CONCLUSIONS

Applications of Coherex/water emulsions containing MAINTAIN, POLYBOR-CHLORATE or MONOBOR-CHLORATE Granular adequately controlled dust and vegetative growth throughout the duration of the test.

COMPARATIVE EFFICIENCIES OF SEVERAL HERBICIDES FOR CRABGRASS IN LAWNS

Lambert C. Erickson[1]

Crabgrass (Digitaria sanguinalis Scop.), the emigrant, has been present in lawns in the United States for probably more than 200 years, but it is only within the past 50 years that it has become a severe lawn problem; to the extent that it is the most abhorred lawn weed today. Duane Isley, in his book Weed Identification and Control, uses crabgrass as a near classic sample of a universal weed. The Velsicol Company report of December, 1964 shows that crabgrass got more 1st place votes as a "most important" lawn weed than any other weed. In 1914 Ada Georgia wrote, "In the southern states this is regarded as a good thing, for the spontaneous growth of the grass in grain fields after harvest often yields a heavy crop of nutritious hay and good pasture after that". The yield part of that sentence I can defend. Crabgrass, on our check plots, has outyielded Kentucky bluegrass at a ratio of approximately 3:1, July to September inclusive for the past three seasons.

Crabgrass has rather specific base temperature requirements. In Idaho its distribution or its potential adaptation can be quite accurately determined by constructing a scale of mean monthly temperatures obtained by the U. S. Weather Bureau for the growing season. Isolated protected environments will deviate widely in temperature

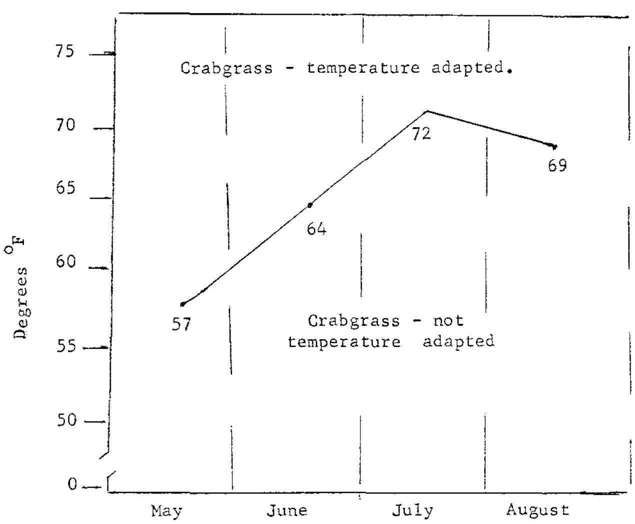

Figure 1. Mean monthly temperatures required for crabgrass adaptataion in Idaho.

from the official Weather Bureau recordings and crabgrass will be found in limited quantities in such situations. Figure 1 illustrates the mean minimum temperatures for the persistence of large crabgrass. Mean minimums lower than those indicated prevail only in limited areas in the northern States or at only higher elevations elsewhere.

1. Agronomist, University of Idaho, Moscow

The plot area on which our studies are conducted is located at Lewiston, at an elevation of about 900 feet where crabgrass consistently produces luxuriant growth. It does not prevail in Moscow 30 miles away where the mean temperature is about 10 degrees lower. Consequently, it serves us not as an example of universality of the species; instead it serves to illustrate its precise ecologic requirements.

The plot area is a complex of weed species growing in competition with Kentucky bluegrass. The dominating weed species are stitchwort **Stellaria graminea** and large crabgrass. These two species form an extremely compatable association because of their differing thermal growth requirements. These inter-species growth compatabilities are illustrated in Figure 2.

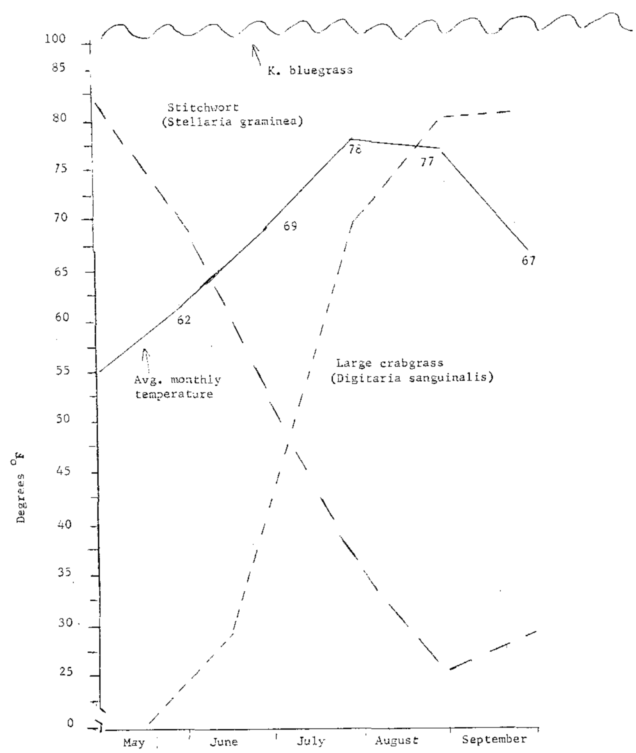

Figure 2. Relative growth performance of Stitchwort and crabgrass (% density stand) 1960 to 1964 inclusive. Lewiston, Idaho.

It is my opinion that practically all original thoughts and discoveries are lost in either antiquity or advertising. So it must also be with respect to selective weed control in turf. Certainly there must have been an era of "folklore lawn medicine", or is organic gardening a recent invention? Where is the record of perhaps the Model T mechanic, who dumped his dirty petroleum solvent on the lawn and discovered that the dandelions died, while the grasses battered and burned survived. Or was it the "wild catter" bringing in a wild oil well who discovered the selectivity in petroleum.

Practically all that is certain is that we had the $FeSO_4$ era, the H_2SO_4, and the $CuSO_4$ eras. Then we had the era when progressive folk surface drenched their lawns with kerosene, gasoline, stove oils, and various unidentifiable petroleum waste fractions. Then there was the era of the flame thrower when certain individuals discovered the heat wilt technique. Others had some sizzling experiences.

Then someone rediscovered that the arsenicals were toxic. This followed the second go-around of the film "Arsenic and Old Lace". The era of arsenic for lawns really never died. It was merely punctuated with mercury particles. The Mercury era was really a diversion in posture exercise whereby instead of spudding you sprayed each Sunday morning.

In scientific reality each of the preceding products mentioned and the dedicated individuals who labored in their development have contributed immeasurably to recent, present and future developments.

In retrospect, it now appears that the present era began when it was found that chlordane applied pregermination controlled crabgrass. Since that date perhaps a dozen materials have been developed all of which would have been very satisfactory 10 years ago. Today, however, the public is more discriminating.

Our screening program has been in progress since 1960. Table 1 shows the relative performance of nine materials in 1964. Note that there was no deficiency of crabgrass. Every plot was paired with a check and the check averaged a crabgrass density of 99.9 per cent.

Table I. Average performance of herbicides for crabgrass (Digitaria sanguinalis) control, Lewiston, Idaho 1964

Company and product		Lbs/A a.i	Respective % crabgrass remaining 9-964	Turf injury
Diamond Alkali				
Dacthal	(wp)	8,10,12,14	1,1,0.2,0.1	None
Dow Chemical				
Zytron	(liq)	8,10,12,14	12,8,3,0.7	"
DuPont				
Tupersan	(")	8,10,12,14	53,45,33,15	"
Elanco				
Trifluralin	(")	2,2½,3,3½	16,14,9,3	"
Hercules				
Azak	(wp)	8,10,12,14	35,28,26,24	"
Stauffer				
Betassan	(liq)	14,18,22,26	40,32,12,9	"
"	(gran)	14,18,22,26	62,53,55,38	"
Union Carbide				
UC 22463	(gran)	4,6,8,10	99,96,96,90	Severe
Velsicol Corp.				
ACS 22	(liq)	7,15,22,40	98,60,15,2	Minor
"	(gran)	7,15,22,40	92,24,3,0.7	"
OCS 21944	(liq)	5,7,9,20	55,29,15,0.7	None
"	(gran)	5,7,9,20	97,96,84,26	"
Non-treated		99.9 avg.		

THE EFFECT OF DISODIUM METHANEARSONATE (DSMA) SOIL RESIDUES ON COTTON AND OTHER CROPS GROWN IN ROTATION WITH COTTON

E. E. Schweizer

Abstract: The use of disodium methanearsonate (DSMA) in the Midsouth as a directed postemergence spray to control weeds in cotton has execeeded even the most liberal acreage estimates. Because information on the persistence of DSMA was limited, seven greenhouse experiments were conducted to determine: (1) the initial and residual toxicity of DSMA in Bosket silt loam: (2) whether increased increments of soil-applied phosphorus would prevent DSMA toxicity; and (3) the effects of several concentrations of DSMA on cotton and other crops grown in rotation with cotton.

DSMA and phosphorus were thoroughly incorporated into air-dried soil before planting the test crop. Plant height and fresh weights were recorded four to six weeks later.

Initially, cotton grew in Bosket silt loam containing 60 ppmw of DSMA without the occurence of a significant reduction in height or fresh weight, but it was injured by DSMA concentrations of 80 ppmw and greater. After 20 weeks, cotton replanted in the same concentration series grew uninjured in 80 ppmw of DSMA and after 36 weeks in 120 ppmw of DSMA without a significant effect on growth. After 36 weeks DSMA concentrations of 160, 240, 320, and 480 were still injurious to cotton.

The addition of phosphorus to Bosket silt loam low (28 lb. P_2O_5 per acre) in phosphorus increased the phytotoxicity of DSMA to cotton. This was observable in a combination treatment with 50 ppmw concentration of DSMA and 32 ppmw of phosphorus, and at all four phosphorus concentrations (4,8,16, and 32 ppmw) with 100 ppmw of DSMA. The addition of phosphorus to Dubbs silt loam, also low (76 lb. P_2O_5 per acre) in phosphorus, did not increase the phytotoxicity of DSMA to cotton.

The incorporation of 50 ppmw of DSMA to Bosket silt loam reduced rice height by 75%; soybeans by 39%; oats by 12%; corn and cotton by 10%; and wheat by 3%. Rice growth was not affected in Dubbs silt loam or Sharkey clay at DSMA concentrations as high as 100 ppmw. (Crops Research Division, ARS, U. S. Department of Agriculture in Cooperation with the Mississippi Agricultural Experiment Station, Stoneville)

A STUDY OF HERBICIDES FOR USE UNDER ASPHALT

V. W. Woestemeyer and J. D. Stone[1]

The application of herbicides to soil prior to application of an asphalt surface has long been recognized as good practice. The objective is to prolong the life of the asphalt surface by preventing emergence and growth of vegetation through the asphalt. Several herbicides and formulations were tested for this purpose and results were reported to this Conference in 1960.

A more recent investigation was conducted under greenhouse conditions. The objective was threefold: (1) To devise a method for greenhouse evaluation; (2) to determine the possibility of correlating greenhouse and field plots; and (3) to evaluate additional herbicides as prepaving treatments.

PROCEDURE

The field tests previously reported were conducted on mixed vegetation with Bermuda grass predominant. Top growth and litter were completely removed by shallow scalping. Herbicides, including borate (Concentrated Borascu), borate-chlorate (Polybor-Chlorate), simazine, and monuron (alone and with borax as Ureabor) were applied and watered in. A "single course armor coat" of hot asphalt and crushed rock was applied to provide the asphalt surface. Periodic evaluations of herbicidal action were made.

Herbicides tested in the greenhouse were Polybor-Chlorate, Concentrated Borascu, and bromacil. The test procedure was as follows: Galvanized iron pans (8" x 12") were perforated in the bottom and covered with a mixture of soil, sand, and vermiculite. On this growing medium, five Bermuda grass rhizomes and Johnson grass, bindweed and millet seeds were planted. The rhizomes and seeds were then covered with one inch of soil. The herbicide treatments were applied dry and watered in. A one-inch layer of slow-curing, 800, cold grade asphalt was then hand packed on the pans. Treatments were run in triplicate. The pans were watered by subirrigation. The herbicidal activity was evaluated for 30 days with respect to seedling and Bermuda grass rhizome control.

RESULTS AND DISCUSSION

Herbicidal performance in the field plots, 30 days and one year after treatment, was as follows:

1. U. S. Borax Research Corporation, Anaheim, California

Table 1

Herbicide	Rate	Per Cent Vegetation Control After Treatment 30 Days	One Year
Polybor-Chlorate	4 Lbs./100 Sq. Ft.	90	100
	6 Lbs./100 Sq. Ft.	100	100
Concentrated Borascu	6 Lbs./100 Sq. Ft.	90*	90*
Ureabor	1 Lb./100 Sq. Ft.	20	40
Monuron (Active)	17.4 Lbs./Acre	30	50
Simazine (Active)	17.4 Lbs./Acre	20	20

* Some Bermuda grass emerged in one of three replicates.

Table 2

Treatment	Rate/A.	Number of Bermuda Grass Rhizomes Emerged and Surviving After 30 Days	Seedlings Emerged
Control		15.0	Yes
Polybor-Chlorate	250 Lbs.	0.0	No
Polybor-Chlorate	500 lbs.	0.0	No
Concentrated Borascu	750 Lbs.	0.3	No
Bromacil	1 Lb.	3.3*	Yes**

* Twelve rhizome buds ruptured the asphalt and most of the rhizomes died during the 30-day test.

** Seedlings ruptured the asphalt and emerged within 12 days, but died within 30 days.

It was determined that a satisfactory herbicide for prepaving use should possess the following characteristics:

Nonselectivity to assure control of all species.

Quick initial action, with sufficient solubility in the soil solution and sufficient speed herbicidally to kill vegetation before asphalt swells or is ruptured by growth.

Persistent enough to assure prolonged protection; not subject to rapid leaching or decomposition by soil organisms.

The following data are from greenhouse tests:

CONCLUSIONS

Greenhouse tests can be useful for evaluating the performance of herbicides under asphalt.

Such characteristics as speed of action and selectivity of an herbicide under asphalt can be observed in such greenhouse studies. There would appear to be a qualitative correlation between field and greenhouse tests; the absolute rates of herbicide per acre are of course different.

Longer observation periods would be necessary to fully evaluate herbicidal persistence.

CASORON — A PROGRESS REPORT

James H. Hughes[1]

Dichlobenil or Casoron[2], 2,6-dichlorobenzonitrile, is a herbicide which has shown broad activity for control of many annual and perennial weeds.

Casoron's mode of action is not entirely known but it has been observed to affect the meristematic areas of germinating weeds. There are exceptions; however, since Casoron has shown excellent control of many perennial weeds, some of which heretofore have been very difficult or impossible to control. This report will deal with registered uses of Casoron and other important developments underway which would appear to warrant registration.

In most instances, Casoron appears to be a rather specific herbicide for control of many specific weeds for specific uses. Selectivity is mostly dependent on the insoluble nature of Casoron controlling germinating weeds in the upper soil horizon in established plantings. This is not the case in all observations, for which an explanation has not been determined.

Cranberries

Casoron has been granted full registration for use in cranberry bogs. Cranberries are an important crop in several localized coastal areas of Washington and Oregon. Horsetail, rushes (**Juncus** spp.), onion-grass, loosestrife, crabgrass, sorrel, velvetgrass, knotweed and smartweed are a few of the weeds which Casoron selectivity controls in cranberries.

For the Pacific Northwest two equal granular applications containing 4% active ingredient is registered for use in the spring at an interval of 3 to 6 weeks between each treatment. Total application is 100 pounds of granules per acre or two 50 pound applications per season. Fall applications have not been cleared since a broader spectrum of perennial and annual broadleaf weeds generally have been controlled in the spring as compared to fall treatments.

Special ground application equipment has been developed for use by growers to apply Casoron G-4 granules accurately. Weeds are one of the highest costs to a cranberry grower and Casoron is probably the most effective herbicide developed to date for control of weeds in this crop.

Dodder Control in Established Alfalfa Grown for Seed

Field trials conducted for the past three years in Washington, Oregon and Idaho have indicated Casoron will control germinating dodder in established alfalfa grown for seed. Not only does Casoron control dodder itself, but other annual weeds such as lambsquarters, pigweed, and annual grassy weeds such as foxtail are controlled. Dodder will oftentimes attach itself to annual weeds prior to attaching to the ultimate host, alfalfa; therefore, control of annual weeds is important.

Expanded field trials are contemplated this spring in the important seed growing areas, applying Casoron as a split application or two treatments per season.

First applications of Casoron either as a 4% granule or as the 50% wettable powder should be applied just prior to the last cultivation, followed by incorporation. Sprinkler or furrow irrigation is needed as soon as practical to activate the herbicide. If second crop seed is harvested, a second application of Casoron is made in the alfalfa stubble just prior to the second irrigation. If hay is not harvested, applications are made with the G-4 formulation through the standing forage. Split or two applications per season have insured Casoron remains in the soil at a high enough rate to control dodder until July 31st. If dodder germinates after July 31st most observers have concluded dodder has not resulted in contamination of harvested alfalfa seed.

A total of 100 pounds of Casoron G-4 or 50 pounds of the 4% granules is applied each treatment per applied acre. Applications for full registration have been made.

Nursery Stock, Shelterbelts and Forest Plantings

Full registration has been granted for use of Casoron G-4 or W-50 in many established woody ornamentals. A wide range of selectivity has been noted in ornamentals and exaggerated rates of application in many cases have not injured ornamentals sensitive to many other herbicides. Commercial nurserymen as well as the homeowner have had need of a broad spectrum herbicide of a highly selective nature. The buildup of soil residue has not been a problem, which is a desirable feature for many commercial stock and container nurseries. Additional registrations are being sought and the list of ornamentals should be expanded materially as results are received.

In the areas of the West where young shelterbelts or forest plantings are important, Casoron has shown excellent selective control of many annual weeds. Additional

1. Thompson Hayward Chemical Company, Fresno, California
2. A research discovery of N. V. Phillips-Duphar of the Netherlands, given the trade name of Casoron by Thompson Hayward Chemical Company.

research is being continued in Washington, Idaho, Oregon and Montana.

Approval has been granted for a 2% granule for use by the homeowner. A broad spectrum selective herbicide with low mammalian toxicity has been needed by the homeowner for many years. We expect Casoron G-2 to be readily accepted by the homeowner market because of these properties.

Fruit Trees—Non-bearing and Fruit Tree Nurseries

Casoron has been approved for use on non-bearing apple, peach, plum and cherry trees. Attempts to obtain full registration are now underway on these trees of bearing age. It is expected other deciduous fruit trees soon will be added to the approved list.

Aquatic Weed Control

As a pond or reservoir treatment, Casoron has been very effective for control of various aquatic weeds such as **Potamogeton nodosus, Potamogeton pectinatus** and **Potamogeton diversifolius, Elodea** and **Naiads.** Applications of 5 to 20 pounds per acre have been effective in controlling **Chara.**

Breakdown of Casoron has been fairly rapid after aquatic weed control, which is desirable in most cases. Fish toxicity studies on bluegill and sunfish have determined the TLm after 48 hours to be 15 to 35 ppm. Other studies are continuing on fish and marine animals. If field results continue to look encouraging during 1965, registration for aquatic uses will be requested in 1966.

Small Fruits

Quackgrass and other hard-to-control weeds have been selectively controlled in blueberries, blackberries and raspberries. Additional field trials are continuing in the Pacific Northwest where growers have a particularly difficult weed problem.

Specific Weeds

Horsetail. In cranberry bogs, one of the most important weeds is horsetail, which is effectively controlled with Casoron. In other agricultural crops, ornamentals and along state highways and railroads this perennial weed has been very difficult to control. Rates of 2 to 8 pounds per acre have given outstanding results. Casoron has selectively controlled horsetail in ivy, azaleas and Rhododendrons.

Quackgrass. Selective control of quackgrass has been noted in established ornamentals such as Forsythia and Nandina and many deciduous tree fruits. Fall or early spring treatments at rates of 5 to not more than 8 pounds per acre have given the best control.

Nutsedge. Nutsedge has been controlled in Southern California by incorporating rates of 3 to 6 pounds per acre followed by irrigation. Selective trials are continuing in ornamentals and in other deciduous tree fruits.

Bracken fern. Due to the fire hazard associated with this weed in the early spring, railroads are particularly interested in controlling Bracken fern in forestry areas. Results to date look very encouraging. Applications of 5 to 10 pounds on and off railroad trackage are continuing this year in hopes of determining the exact rates of application needed.

Skeletonweed (Chondrilla juncea L.). Skeletonweed is becoming a problem in many wheat fields near Spokane. Washington. Skeletonweed has become the most important and hardest to control weed in the wheat growing areas of Australia.

Encouraging field trials near Spokane, Washington, last year have shown Casoron may be effective at rates of 6 to 8 pounds per acre. Expanded field trials are continuing this year on a larger scale conducted by Washington State University at Pullman, Washington.

INDUSTRIAL WEED CONTROL WITH A TRUE SOLUTION OF SODIUM METABORATE, SODIUM CHLORATE AND BROMACIL

R. F. Crawford, R. H. Cooper, and V. W. Woestemeyer[1]

A universal, or all-purpose herbicide would offer a simple solution to the problem of nonselective weed control. In the absence of a universal herbicide, one of the tools at our disposal today is the principle that sometimes combinations of herbicides can achieve more effective weed control than any one compound alone. An exceptional herbicidal composition is (Hibor) a combination of sodium metaborate, sodium chlorate, and bromacil.

Hibor is a ready-to-spray liquid herbicide containing 70 pounds of sodium chlorate, 100 pounds of sodium metaborate, and 3 pounds of bromacil per 100 gallons of solution.

Chemical Composition:

	Per Cent	lbs./Gal.
Sodium Metaborate, Anhydrous ($Na_2O.BO_3$)	10.00	1.00
Sodium Chlorate ($NaC10_3$)	7.00	0.70
Bromacil (5-Bromo-3-s-butyl-6-methyluracil)	0.30	0.03

Physical State: A clear, colorless, true solution

Specific Gravity: 1.179 at 20° C.

Pounds per gallon: 9.82

pH: 11.80

This combination of chemicals makes a true solution that is adapted to use in any conventional spray equipment.

It effects a rapid knockdown of existing vegetation at application time. Kill of perennial root systems in the soil and residual control of seedlings is achieved from this formulation.

Wettable powders, such as ureas, triazines, and uracils, when used alone or with a borate-chlorate solution must be under continuous agitation to maintain homogeneity. Agglomeration and sedimentation of the wettable powder is so serious that tank car quantities of such a formulation are impractical where they cannot be kept under continuous agitation.

A fortuitous property of bromacil was, therefore, its solubility in alkaline solutions. The high solubility of bromacil in an alkaline aqueous solution coincided with the maximum solubility of a borate solution; that is, as sodium metaborate which has a pH of about 11.8. From the standpoint of **physical** properties, bromacil and metaborate chlorate was a very compatible combination of herbicides.

The hazards of sodium chlorate are well recognized because of its chemical property of being a strong oxidizing agent.

The ability of borates to retard the fire hazard associated with chlorate was illustrated dramatically in the tests reported this year at the Southern Weed Conference (E. M. Mitchell, Fire Retardant Properties of Borates in Sodium Chlorate Herbicidal Sprays, Proceedings of Southern Weed Conference, 1965, pp. 338-341). From the **chemical** standpoint then, Hibor represents a very complimentary combination of herbicides.

Borate-chlorates were most effective on Johnson grass at the heading stage of growth and thereafter, which is a late season application as seen from the data below when borate-chlorates were applied at three intervals during the growing season.

Bromacil was most effective as an early season application—at the pre-emergence or seedling stage of growth, which is also apparent from this data where bromacil was applied at 3 intervals during the growing season.

The combination of borate-chlorates and bromacil was very complimentary from the standpoint of herbicidal activity in that satisfactory weed control was achieved with an application made at virtually any time of the season:

1. U. S. Borax Research Corporation, Anaheim, California

The Effect of Date of Treatment on Johnson grass Control in Late September

Treatment	Rate lb./A.	Applied:	Per Cent Control of Johnson Grass in Late September, 1964		
			Late April	Mid May	Late June
Borate-Chlorate[1]	962		34	55	77
Bromacil[2]	12		74	34	45
Borate-Chlorate + Bromacil	962 + 12		100	94	98

1. Sodium metaborate, anhydrous 1 572 Pounds
   Sodium Chlorate - 390
2. 5-Bromo-3-sec-butyl-6-methyluracil, active

It is well recognized that sodium chlorate has severe initial action that is depleted rapidly.

As seen from this data, equal quantities of chlorate were applied with and without borate, and borate increased the residual action of chlorate:

Treatment	Lbs./A	Per Cent Control
Chlorate + Borate	105 + 150	55
Chlorate	105	13

Borates increased the residual action of bromacil, as seen from this study where bromacil was applied in the presence and absence of borates.

Compound	Per Cent Control Days To 120	150	180
Bromacil	100	60	0
Borate	0	9	0
Borate + Bromacil	100	100	100

The combination of herbicides described above has achieved chemical, physical, and herbicidal properties that are more effective than any one compound alone. This combination of herbicides offers a tool for the nonselective control of a broad spectrum of weed species with a maximum of residual herbicidal action.

A NEW WEED AND GRASS HERBICIDE

E. R. Laning, Jr.[1]

A new herbicide has been discovered by the plant science research group of The Dow Chemical Company. Formulations of this new herbicide are known under the tradeamrk "daxtron."*

The herbicide is known chemically as 2,3,5-trichloro-4-pyridinol. It is a white solid highly stable material with the following properties:

1. Melting point—approximately 216°C
2. Solubility—grams per 100 grams solvent at 23°C

Water	.057
Acetone	4.0
Benzene	.071
Ethanol (95%)	4.21
Xylene	.30
NaOH (1%)	5.35

3. Vapor pressure:
   5.50 x 10-6mm Hg. at 26°C
   1.39 x 10-4mm Hg. at 50°C

Daxtron herbicide is a highly active weed killer and is absorbed and translocated by both roots and foliage of most plants. In addition, contact activity usually is apparent following foliar applications. Dechlorophyllation may occur on many plant species following either foliar or soil application. The dechlorophyllation is reversible when plants are treated at sublethal concentrations.

Daxtron herbicide is especially effective for the control of grasses, but also will control many broadleaf weeds.

Experiments have been conducted by Dow personnel in various areas. The purpose of this paper is to present some of the field research data which have been collected to date—with particular emphasis on results obtained on non-agricultural situations in California, but also with reference to work done in other areas. Daxtron herbicide as formulations such as the potassium salt were used in these experiments. The indicated dosages were calculated on the pyridinol equivalent basis.

Near Davis, California, herbicide was applied to a vigorously growing 12 inch tall stand of water grass, purslane and chickweed. Application was made in September when the temperature was high and the days following treatment were hazy. The data shown in Table 1 indicate the good "knockdown" activity of Daxtron and also the continuing action through the foliage and the roots.

Table 1. Short Term Response of Three Annual Weed Species to Daxtron* applied in California
Percent Foliar Necrosis

	lb/A.	4 days all weeds	18 days Grass	18 days BL	35 days Grass	35 days BL
Daxtron	0.5	12	53	30	65	25
Daxtron	1	36	65	53	88	25
Daxtron	2	68	93	81	98	88
Daxtron	4	72	94	80	100	86

1. Plant Science Research and Development, The Dow Chemical Company, Davis, California

* Registered trademark of The Dow Chemical Company for herbicides containing 4-amino-3,5,6-trichloropicolinic acids.

Two experiments were established near Sacramento to evaluate the effectiveness of Daxtron herbicide and of Daxtron plus Tcrdon, herbicides on vegetation at different stages of growth. In early March, applications were made to a variety of annual broadleaved weeds in the 4 to 8 leaf stage and grasses 3 to 5 inches tall (the area had been rototilled to provide this early stage of growth at that time of year). In the second experiment, which was applied at the same time, the broadleaved weeds were flowering and the grasses were approaching the boot stage of growth. The soil in the experimental areas dried out during the hot summer months and untreated vegetation made vigorous regrowth following Setpember and October rains. Results collected the following February are presented in Table 2.

Table 2. Percent Vegetation Control Eleven Months After Application

	lb./A.	Early Post-emerg. Grass	Early Post-emerg. B.L.	Late Post-emerg. Grass	Late Post-emerg. B.L.
Daxtron	$1\frac{1}{4}$	90	92	78	55
Daxtron	$2\frac{1}{2}$	95	88	94	89
Daxtron	5	99	97	97	95
Daxtron+Toidon*	$1\frac{1}{4}+\frac{5}{8}$	92	95	77	88
Daxtron+Tordon*	$2\frac{1}{2}+1\frac{1}{4}$	98	99	88	99
	$5+2\frac{1}{2}$	97	99	93	97

*Registered Trademark of the Dow Chemical Company for herbicides containing 4-amino-3,,56-trichloro-picolin acids.

As an early post-emergence application, Daxtron herbicide alone, even at 1¼ lb. per acre, provided excellent one season control. However, it was suggested that at the lowest dosage tested against more mature vegetation, the addition of Tordon added significantly to the degree of broadleaf weed control obtained.

In a similar experiment near Woodland, California, a variety of annual broadleaf weeds and grasses were treated in January. These weeds had germinated in September and were about 6 inches tall in a thick stand. The data collected the following month and the following year (Table 3) provide a good illustration of the advantages of the combination treatment—Daxtron plus Tordon herbicides.

Table 3. Percent Vegetation Control Following January Application Near Woodland, California

	lb./A	1 month Grass	1 month B.L.	13 months Grass	13 months B.L.
Daxtron	2.5	88	84	75	13
Daxtron	5	92	90	90	27
Daxtron	10	99	98	96	45
Daxtron+Tordon	2.5+1	97	97	67	73
Daxtron+Tordon	5 +2	97	100	87	83
Daxtron+Tordon	10 +2	97	100	96	93

The combination of Daxtron at 2½ lb. per acre and Tordon at 1 lb. per acre provided excellent season long control. Higher rates were needed to maintain this control in the second season following application.

The Woodland experiment was repeated at Fresno, California. January applications were made to 8 to 10 inch tall annual grasses and broadleaved weeds. Again results observed one month and 13 months after treatment are presented (Table 4). It would appear that the slightly higher temperatures in Fresno resulted in a faster knock-down. The lighter rainfall, in comparison to Woodland, may have helped prolong the soil residual activity.

Table 4. Percent Vegetation Control Following January Applications in Fresno, California

	lb./A.	1 month Grass	1 month B.L.	13 months Grass	13 months B.L.
Daxtron	2.5	100	100	83	0
Daxtron	5	100	100	93	5
Daxtron	10	100	100	97	17
Daxtron+Tordon	2.5+1	100	100	78	98
Daxtron+Tordon	5 +2	100	100	83	97
Daxtron+Tordon	10 +2	100	100	88	97

In Michigan, logarithmic dosage tests were applied on established perennial grasses. Daxtron herbicide was applied as a foliar spray in mid-May to a dense, vigorously growing, 12 to 15 inch tall stand of orchard grass and smooth bromegrass. Dosages ranged from 10 to 1 lb. per acre.

Within 10 days after treatment there was 50 percent top-kill at the 9 and 10 lb. per acre dosages and foliar burn was produced at rates as low as 2 lb. per acre of Daxtron. The grass continued to die back and final kill or control was rated in September (Table 5).

Table 5. Orchard Grass and Bromegrass Control with Daxtron

Rate lb./A.	% Control	Comments
9	100	No live vegetation present
8	100	No grasses; few broadleaf seedlings are chlorotic and apparently dying
7	100	Same
6	100	Same
5	90	Chlorotic grasses appearing in plot
4	80	Increase in number of grasses. Broadleaf weeds begin to appear
3	80	Grasses less cholortic
2	70	Orchard grass only; appears chlorotic
1	30	Bromegrass has malformed leaves, no flowering; 20% orchard grass flowering

Later, similar applications were made to an adjacent stand of orchard grass and bromegrass, and to a stand of quackgrass. The areas were mowed and the clippings were removed. When the sprays were applied in early July, the grasses were 6 to 8 inches tall and growing vigorously. Again, the 6 lb. per acre rate killed these perennial grasses (Table 6).

Table 6. Perennial Grass Control with Daxtron Herbicide

		Percent control for indirected rate lbs./A.							
		8	7	6	5	4	3	2	1
Orchard grass and Bromegrass	% control	100	100	100	90	90	90	80	50
Quackgrass	% control	100	100	100	100	100	90	90	10

These experimental areas were observed during the following year; the 100 percent control ratings still were applicable.

Research work conducted in the Southeast also is of interest. In that warm humid climate of extreme vegetative growth pressure, higher dosages generally were required to provide season long control on non-crop situations. Generally, 10 to 20 lb. per acre of Daxtron plus 1 to 2 lb. per acre of Tordon as early post-emergence treatments gave season long control of the annuals and perennials such as dewberries, buckvines and Trumpet creeper and other perennial vines and of most Bermuda grass infestations. Dormant applications of Daxtron at 20 lb. per acre gave 80 to 100 percent control of nutsedge for two seasons.

Several large plot applications to railroad road beds and other industrial sites have substantiated the small plot field experiments. Examples include a railroad right-of-way treated in Virginia. Daxtron at 7½ lb. per acre plus Tordon at ¾ lb. per acre provided excellent vegetation control from early June through the growing season. A foliar spray of Daxtron at 10 lb. per acre plus Tordon at 1 lb. per acre applied on June 3rd gave essentially complete control of a very heavy stand of grass and some broadleaf weeds in Pennsylvania. The same treatment in another area of Pennsylvania gave over 95% control of weeds and grasses from early June through July of the next year.

Combinations of Daxtron and Tordon applied as dry granules also are effective. As would be expected, pre-emergence treatments with granules are more effective than post-emergence applications, because of the reduced foliar activity. However, excellent results have been obtained when rain has occurred within a reasonable time after application to existing vegetation. Daxtron plus Tordon at 5 plus ½ lb. per acre applied in April in Michigan, resulted in at least 80 to 90 percent control of annual and perennial vegetation through the growing season. The 10 plus 1 lb. per acre and the 15 plus 1½ lb. per acre applications were completely effective over the same period of time.

In addition to the non-crop situations already discussed, exploratory experiments have been conducted to evaluate Daxtron herbicide for weed control in crops. Pre-emergence treatments in sugar cane have shown promise at ¾ to 2 lb. per acre. Post-emergence directed sprays at ½ to 2 lb. per acre in sugar cane and at ¼ to ¾ lb. per acre in corn have given promising results. Come-up stage treatments also have been highly effective. In a limited number of experiments, peanuts have been tolerant to come-up sprays of Daxtron herbicide.

Daxtron also has been shown to be an outstanding regrowth inhibitor for cotton when used in combination with a defoliant.

INDUSTRIAL WEED CONTROL WITH, MAINTAIN, AN EMULSIFIABLE CONCENTRATE OF 2,3,6-TRICHLOROBENZYLOXYPROPANOL BROMACIL, 2-ETHYLHEXYL-2, 4-DICHLOROPHENOXYACETATE

R. F. Crawford, R. H. Cooper, and V. W. Woestemeyer[1]

It has been our observation, as well as many others, that there are a number of weed species that actually become a greater problem when the more susceptible species are controlled by means of chemical weed control and, in some cases, by mechanical weed control.

For example, Kochia will flourish when annual weed and perennial grasses are controlled or reduced.

Woody vines, such as trumpet vine, will soon form a complete ground cover when perennial grasses, such as

1. U.S. Borax Research Corporation, Anaheim, California.

Johnson grass and Bermuda grass, are controlled.

Russian thistle will grow more vigorously when annual weeds are controlled than when forced to compete for light, nutrients and water.

Undoubtedly this phenomenon can be accounted for under the catchall category, "competition." A number of mechanisms have been elucidated to describe the specific factors involved in plant competition. Real progress is being made in the pursuit of this problem as a fundamental study.

However, looking at this problem in the eyes of a man who has used one of our modern and wonderful chemical weed killing tools, this man is unhappy. His desire is for control of all weeds and the control of one species to be replaced by another species is obviously unsatisfactory.

One approach to this problem was to find or develop combinations of existing herbicides that would control a broader spectrum of plant species.

A liquid emulsifiable concentrate containing 2 pounds of 2,3,6-trichlorobenzyloxypropanol, 1 pound of bromacil, and 0.2 pound of 2,4-dichlorophenoxyacetic acid equivalent per gallon, Maintain, has this ability. When diluted with water it forms a stable emulsion that can be sprayed with conventional equipment.

Typical Chemical Analysis:

Active Ingredients:
- 2,3,6-Trichlorobenzyloxypropanol (TRITAC ... 21.30%
- 2-Ethylhexyl Ester of 2,4-Dichlorophenoxyacetic Acid ... 3.21%
  - (2,4-Dichlorophenoxyacetic Acid Equivalent 2.07%)
- Bromacil (5-Bromo-3-sec-butyl-6-methyluracil ... 10.37%

Inert Ingredients ... 65.12%

Contains 2 pounds of 2,3,6-trichlorobenzyloxypropanol, 0.2 pound of 2,4-dichlorophenoxyacetic acid equivalent, and 1 pound of bromacil per gallon.

Specific Gravity: 1.16 at 70° F.

Physical State: Brown liquid
Emulsifiable concentrate

For a vegetation control problem where Kochia was in association with annual grass and broadleaf species, or perennial grasses, the following data were obtained:

Kochia Control—Great Falls, Montana

Treatment and Rate Per Acre	Per Cent Kochia Control Initial	Final	Per Cent Control All Weeds—Final
Maintain 2 Gal.	95	88	70
Maintain 3 Gal.	95	100	87
Maintain 4 Gal.	95	99	94
Tritac D 2 Gal.	89	93	38
Tritac D 3 Gal.	89	100	60
Tritac D 4 Gal.	98	95	80
2,4-D 2 Lb.	80	5	0
2,4-D 4 Lb.	85	8	0
Bromacil 2 Lb.	85	5	10
Bromacil 4 Lb.	85	45	35

It would appear from this data that some initial control of Kochia was obtained from 2,4-D but not season-long.

Tritac + 2,4-D achieved season-long control of Kochia, but not of grasses.

Bromacil at these low rates killed some of the Kochia initially, but did not persist for the season. As expected, bromacil controlled the susceptible annual grass and broadleaf species nicely, but the over-all final control was less than satisfactory because the Kochia had been released from competition and succeeded nicely in covering the treated area.

Satisfactory nonselective control of all weed species present in this vegetation problem was obtained with Maintain.

In some instances, it is desired to leave the grasses for erosion control, in which case Tritac D has been found to be semiselective—that is, many established perennial grasses are tolerant.

Mixed vegetation containing grasses and woody vines, i.e., trumpet vine is another vegetation problem where Maintain was found to be effective.

Control of Mixed Perennial Grasses and Vines with MAINTAIN

Treatment Appleid in Spring	Rate/Acre	Per Cent Control in Fall: Perennial Grass	Vines	Over-all
Tritac D	4.0 Gal.	15	85	20
	6.0 Gal.	13	90	20
	8.0 Gal.	30	97	15
Bromacil	3.2 Lbs.	95	8	50
	6.4 Lbs.	98	25	58
	8.7 Lbs.	99	45	75
Maintain	4.0 Gal.	95	80	83
	6.0 Gal.	95	88	90
	8.0 Gal.	99	95	95

The Tritac D killed the vines and then the grasses took over; the bromacil killed the grasses and then the vines took over. Maintain controlled all species in this vegetation problem.

This combination of herbicides found in Maintain has been found to offer a tool for satisfactory nonselective weed control in numerous vegetation problems wherein the individual components did not achieve season-long control of all of the weed species present.

MINUTES OF THE BUSINESS MEETING OF THE WESTERN WEED CONTROL CONFERENCE HELD AT THE HILTON HOTEL, ALBUQUERQUE, NEW MEXICO, MARCH 19, 1965

The President called for the Secretary to read the minutes of the Portland Business Meeting of March 19, 1963, the Executive Committee Meeting in Salt Lake City, March 25, 1964, the Executive Committee Meetings in Albuquerque, March 17 and 18, 1965. The minutes were approved as read.

The matter of an annual meeting that was proposed by the Executive Committee was discussed at some length. It was suggested that an annual meeting would strengthen the Conference by combining all phases of western weed control into annual meeting. Wayne Whitworth moved that Conference meet on an annual basis starting with the 1967 meeting. Eugene Heikes seconded the motion and the ensuing vote by the members was 49 in favor of the motion and 12 against. Motion carried.

President Hodgson discussed the invitations for the Conference to meet in Arizona and Hawaii. President Hodgson pointed out that it is the responsibility of the Executive Committee to select the time and place of the Conference but felt the Executive Committee would welcome expressions from the floor. A lively discussion ensued with a majority of those present favoring the Hawaiian suggestion. Comments regarding the possibility of additional expense to members in comparison to Mainland meetings were made particularly to those living inland from the Pacific Coast ports. President Hodgson said that all the discussion would be helpful to the Executive Committee in arriving at a decision.

S. W. Strew gave the Treasurer's Report indicating that the Conference was solvent. The Treasurer's Report will be a part of the proceedings.

Richard Fosse reported for himself and David Bayer as the Auditing Committee. This report covered the financial activity of the Conference since the Las Vegas meeting in March 1962. Considerable time and effort went into this report and it was suggested that it be included in the Proceedings. Mr. Fosse moved and it was seconded that the Financial Reports be accepted as read. It was seconded and passed by the Conference.

Research Committee Report, Robert Schieferstein, Chairman

The chairman reported that the next meeting of the Research Committee would be held in Reno, Nevada in 1966. The committee elected the following for 1966:

Robert Schieferstein, Chairman
Harold Alley, Vice-Chairman
David Bayer, Program Chairman
Howard Cords, Local Arrangements Chairman

The following Research Project Committee reports were made:

Project I: **Perennial Herbaceous Weeds**—Ken Dunster indicated this sub-committee would like to see more emphasis placed on cultural control research. David E. Bayer was elected new chairman.

Project II: **Herbaceous Range Weeds**—W. C. Robocker reported Coburn Williams will be chairman next year.

Project III: **Undesirable Woody Species**—New chairman for 1966, Mike Newton.

Project IV: **Weeds in Horticulture**—Don Dye announced that R. Romanowski will assume chairmanship.

Project V: **Weeds in Agronomic Crops** — Chairman Arnold Appleby reported that the next chairman of this sub-committee would be W. E. Albeke.

Project VI: **Aquatic and Ditchbank Weeds**—Don Seaman brought up for discussion the possibility of separating this project into two parts—aquatic and ditchbank weeds. Following several comments from the floor, it was agreed the sub-committee shall remain as is. Don Seaman will chair this sub-committee with E. J. Bowles as vice-chairman.

Project VII: **Chemical and Physiological Studies**—Reed Gray reported that Lowell Jordan, Chairman, had to leave the meeting early. Reed Gray will be the new chairman.

Project VIII: **Economic Studies**—E. E. Heikes suggested even though he had no formal report due to committee inactivation, that economic study be stepped up within the Research Project involved. (Action was taken in the Research Committee Meeting disbanding this committee. However, studies in this areas should be reported in any other applicable committee.)

Education Committee Report — Robert E. Higgins, Chairman. This conference recognizes the importance of education in the total program of weed control, and that good research and effective education should go hand in hand.

Continued emphasis on improving educational efforts and reports of progress and results will help us secure the full value of research by its application by those needing this help.

In the proceedings of the 1963 meeting held in Portland, there is listed 13 points on what is good about our weed program; 17 items on what should be done in the near future to improve our weed program; and nine suggestions for action. Most of these are of concern to everyone and not just the education people. We should review these items.

Actually, we have not done much as a committee or conference organization to implement some of the suggestions made. However, we have had some discussion and observed some of the individual contributions made.

Montana is developing an educational film on Dalmatian toadflax and leafy spurge. It will soon be available. Contact Leslie Sonders, extension weed specialist, for this.

Contributions have been made on economics of weed control as presented by Harold Alley of Wyoming, yesterday.

James Koehler of California, presented and discussed the model weed law. This is presented to be included in the proceedings.

Some states—Idaho and Colorado as examples—have made some progress in developing materials for use by 4-H club members. We think we need a more coordinated effort here.

Louis Jensen and Eugene Hughes have helped to have good equipment and visual presentation at this meeting.

While education and regulatory people provided only one quarter day of program at this meeting, we think we should have more program of this nature both as separate sessions and in the general program. Industry, government agencies, and others can be asked to participate and contribute their ideas.

Visuals to help in the educational effort are limited. Each state has prepared some good materials. We think a clearing house for these materials could be developed so that more of us can take advantage of the ideas and get greater mileage. Gene Heikes of Colorado, discussed and showed slides and colored leaflets which have been developed in state. These can be purchased through or from him. Others have slides or materials which have greater use than just in their own state.

The education committee can help promote some of these ideas. More interest, participation, and ideas are welcome.

Regulatory Committee Report—James Koehler, Acting Chairman. He reported that the committee recommends that the Education and Regulatory Section of the program be expanded to one-half day because of the great interest in this portion of the program as evidenced by a large attendance.

The committee requests its next chairman to contact appropriate persons in the eleven western states in an effort to encourage the attendance of additional regulatory personnel.

The committee further requests its next chairman to set up a correspondence and roster file to pass from chairman to chairman.

In addition, the committee regrets, for obvious reasons the discontinuance, by the Research Committee, of Project 8 "Economic Studies".

Comments following these reports indicated the possibility of expansion based on the increasing interest on the part of those now involved.

Resolutions Committee—Lambert Erickson, Chairman. The Committee moved the adoption of the following resolutions and further moved that the Conference Secretary send copies of each to the appropriate agencies and/or individuals concerned.

Resolution No. 1

Whereas, our officers during the past year, President, J. M. Hodgson; Vice President, L. A. Jensen; Secretary-Treasurer, S. W. Strew; Business Manager, E. J. Bowles; and WSA Representative, R. A. Fosse; have spent much time and effort in connection with the Conference.

Now therefore, be it resolved that we express to them our appreciation and thanks for their service.

Resolution No. 2

Whereas, the Western Weed Control Conference assembled in Albuquerque, New Mexico on March 19, 1965, appreciates the opportunity to meet in Albuquerque and,

Whereas, the local arrangements committee under the chairmanship of Eugene E. Hughes has done an outstanding job.

Now, therefore, be it resolved that we express to them our appreciation and thanks for their service.

Resolution No. 3

Whereas, weeds, conservatively estimated, cost over one billion dollars annually in the 11 western states and,

Whereas, progress in herbicide development has far exceeded the ability of research, extension, and regulatory agencies to properly evaluate and bring into practical application the use of many of these materials and,

Whereas, the herbicide industry is probably in its early developmental stages.

Now, therefore, it is recognized that more manpower is required in basic, applied educational and regulatory phases of weed control than is presently available to properly expedite the program.

Now, therefore, be it resolved that the Western Weed Control Conference hereby urge the respective Director and/or Dean of the, Colleges of Agriculture and Commissioner or Director of the State Departments of Agriculture in the 11 western states to re-evaluate the manpower distribution within their Department or the additional manpower needed to meet the obvious needs for expanded efforts in this field and,

Be it further resolved, that this resolution be sent to the respective governors of the 11 western states.

Resolution No. 4

The members of the Weed Society of America who participated in drafting a model weed control law are to be highly commended for their diligent efforts and early completion of this work and,

Now, therefore, be it resolved that Western Weed Control Conference now in session request the Commissioner or Director of State Departments of Agriculture in the 11 western states to give diligent study to adoption of such a uniform law in their respective state and,

Be it further resolved, that the proposed model weed law be included as a part of the proceedings of this Conference.

Resolution No. 5

Whereas, information on the science and practice of weed control is voluminous and whereas, the problems in weed control are of the greatest economic significance,

Now, therefore, be it resolved that this Western Weed Control Conference assembled this 19th day of March 1961, respectfully request the Secretary of the United States Department of Agriculture to consider publication of a yearbook of Agriculture on the subject of "Weeds and Weed Control" at the earliest possible date.

Resolution No. 6

Whereas, the eventual utility of a weed control practice is determined by its economic benefit and,

Whereas, there is a dearth of information on the crop yield losses caused by weed populations as influenced by species, crops, and environments,

Now, therefore, be it resolved that applicable economic analysis be encouraged wherever possible in weed control research studies.

The motion by Mr. Erickson was seconded and passed by the Conference.

Nominations Committee—Wayne Whitworth, Chairman. The committee placed the following names in nomination:

Louis Jensen, Utah State University, President

S. W. Strew, Colloidal Products Corporation, Vice President

K. C. Hamilton, University of Arizona, Secretary-Treasurer

J. M. Hodgson, ARS, USDA, WSA Representative

There being no further nominations from the floor, subsequent voting by the members, constituting a quorum, elected the above as their officers for 1965-1967 biennium.

It was moved and seconded that the Conference go on record as approving the conduct of the Conference business by the officers for the biennium 1963-1965. Membership vote was unanimous.

S. W. Strew
Secretary

MINUTES OF RESEARCH COMMITTEE MEETING

Albuquerque, New Mexico
March 17, 1965

The meeting was called to order by Bob Schieferstein. The first order of business was the selection of a meeting place for the 1966 Research Section meetings.

Harold Alley stated that the W-77 Regional Technical Committee were meeting in Reno prior to the Research Section and expressed the desire to have the Research group consider Reno for their 1966 meeting place also.

Lewis Jensen reported that facilities and service would be improved over 1964 if the group desired to return to Salt Lake City in 1966.

Howard Cords assured the group that adequate facilities would be available in Reno.

Harold Alley moved and Dean Swan seconded that the Research Section hold their meeting in Reno, Nevada, in 1966. Passed.

Bob Schieferstein read the proposed constitution and By-Laws of the Research Committee of the WWCC. Considerable discussion followed.

A question was raised pertaining to the section on membership which reads "members of the conference actively engaged in Weed Control Research." Bob Schieferstein stated that the membership has not been restrictive but there may be a possibility of such. He explained that anyone who showed interest in weed control should possibly be considered as "actively engaged."

President Hodgson read the section from the WWCC Constitution and By-Laws which reads "actively engaged." Jess explained his interpretation of "actively engaged" in research.

It was moved and seconded that the proposal be accepted as read. Passed.

The Acting Chairman of Project 6, Aquatic and Ditchbank Weeds, raised the question of changing the title as some papers overlap and are reported or could be submitted to other project areas. Dr. Timmons explained that the WSA project is entitled Aquatic and Marginal Weeds and felt that in the Western Region Aquatic and Ditchbank go together. The Research Committee was opposed to separating Project 6 and felt that individuals could report research in the project area where it best fitted.

Gene Heikes, Chairman of Project 8, Economic Studies, stated that there were no research papers submitted, no members to the sectional meetings and suggested that Project 8 be disbanded; however, he encouraged submission of economic studies.

Names of the officers and project chairman are included in the minutes of the conference business meeting.

Meeting adjourned.

Harold Alley,
Secretary

Western Weed Control Conference

Financial Report

INCOME

Bank Balance March 12, 1965	$ 306.83	
Deposit March 23, 1965	1664.00	
Deposit March 26, 1965	9.17	
Deposit March 26, 1965	295.10	$2275.10

DISBURSEMENTS

Check No. 103, E. E. Hughes	25.00	
Check No. 104, N. M. School Supply	12.24	
Check No. 105, J. M. Hodgson	6.00	
Check No. 106, Void		
Check No. 107, Louis Jensen	21.30	
Check No. 108, Cole Hotel	614.22	
Check No. 109, Horace Skipper (OSU)	50.00	
Check No. 110, Peerless Printers	22.36	
Check No. 111, Artcraft Printers	60.00	
Bank Charges, March 24, 1965	.61	811.73
BANK BALANCE, March 31, 1965		$1463.37

LIABILITIES

Printing Proceedings	559.35	
Printing Research Report	450.00	
Local Arrangements	60.00	$1069.35
ESTIMATED SURPLUS March 31, 1965		$ 394.02

S. W. Strew
Secretary-Treasurer

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