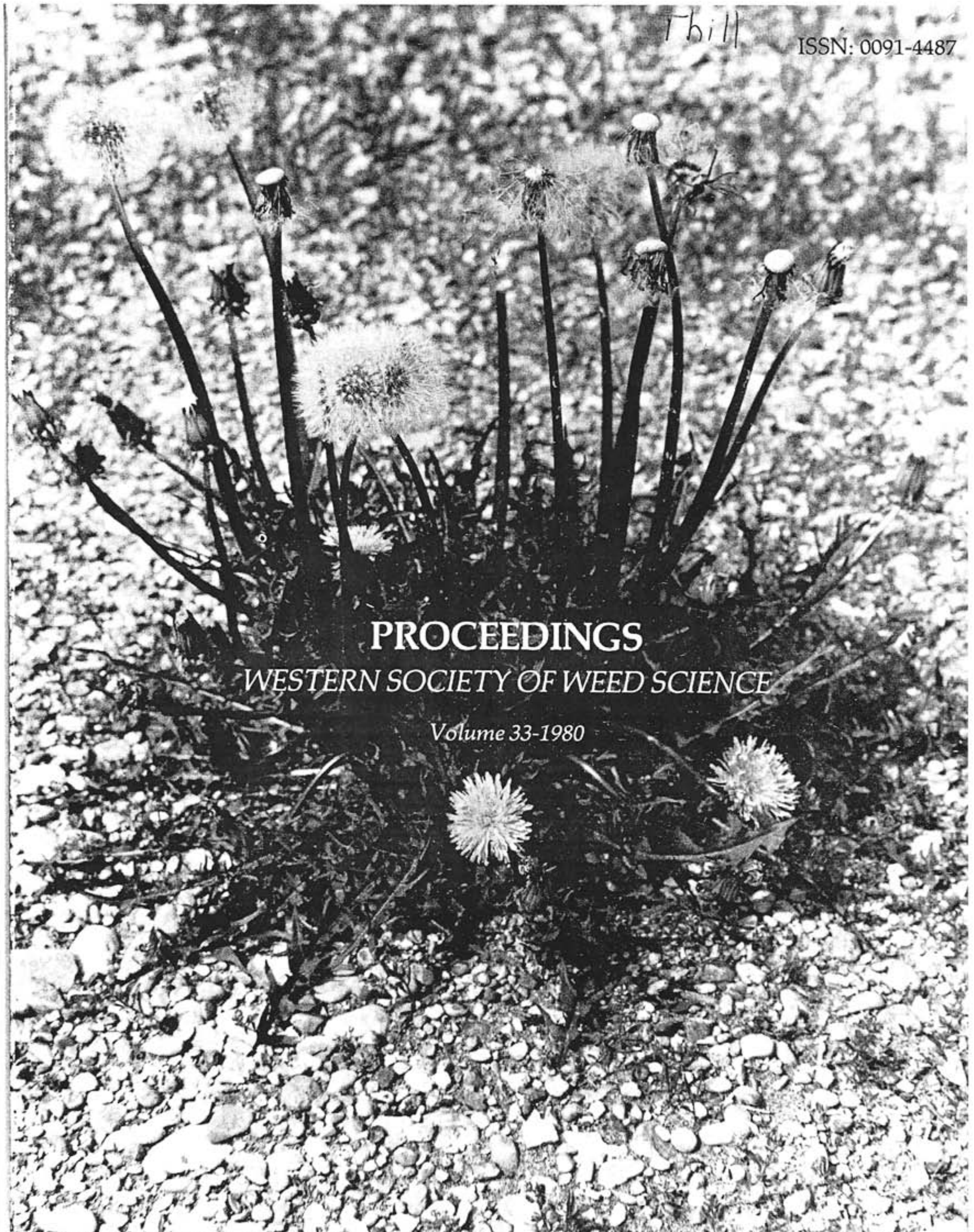

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PROCEEDINGS

WESTERN SOCIETY OF WEED SCIENCE

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1980

PROCEEDINGS

OF

THE WESTERN SOCIETY OF WEED SCIENCE

VOLUME 33

PAPERS PRESENTED AT THE ANNUAL MEETING

MARCH 18, 19, 20, 1980

HOTEL UTAH

SALT LAKE CITY, UTAH

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PRESIDENTIAL ADDRESS

Larry C. Burrill[1]

The Western Society of Weed Science is, in my opinion, a very healthy society. The reason for this is the people who make up the Society. They are very interested in what they are doing. They are interested in making this into a functional organization and their standard answer when asked to participate or to help in some way with Society activities is "Yes." I particularly like the fact that in the Western Society we do not differentiate between members depending upon their occupation. We do not have sustaining members and we do not have graduate student sections. For a society of this size I consider that to be an advantage. I think that there is agreement that one of the reasons this Society is so popular with its members is because the format that we have allows considerable open discussion during the two and one-half day conference. I am a little bit concerned that we will not be able to continue with this style of conference if the number of papers submitted for the research sections continues to grow. This may sound a bit sacrilegious and I'll try to explain what I mean very carefully. The annual conference is held to allow members to exchange information and the presentation of formal papers is one way in which this can be done. However, it is just as important that we allow time for a more informal exchange of information. If the number of papers continues to grow so that we must constantly have three or more concurrent sessions then fewer people are able to attend each of the sessions and consequently fewer people are able to participate and gain from the exchange of information. I think those people who have research data and other information which has reached the stage where it is time to present it to the members should feel free to do so. Those members who need to present papers in order to justify their attendance at the meeting should also feel free to do so. However, I do not think we should actively encourage people to prepare papers just for the sake of having a large number of papers. If those members who are now presenting three or four papers would be content to prepare only one or two very high quality papers I think the membership would benefit by being able to attend more of the papers and still have more time available for informal discussion.

As your President I feel some obligation to inform you of some of the activities that we see happening in weed control on the international level. I would like to do this by discussing briefly some programs, problems, and people relating to weed control on the international level. Under the general heading of problems I would like to introduce you to a weed called *Mimosa pigra*. This weed is native to South America and was introduced into northern Thailand as an erosion control measure. It has now escaped into some of the river systems and is rapidly moving down these systems. *Mimosa pigra* is a semi-aquatic weed which thrives on the river banks, ditch banks and flood plains. This very agressive, rank growing weed has thorns and is almost inpenetrable after it is allowed to grow for a few months. In Thailand there does not seem to be any single control measure which looks promising for control of *Mimosa pigra*. In fact, there does not appear to be any reason why this weed will not continue to move down the river systems into the major rice producing areas of Thailand. There is now some interest in looking at the biological

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control for this weed and there have been a few attempts at screening various chemicals. It is going to take a major collaborative program by the various organizations involved in Thailand if this weed is going to be stopped before developing into a major problem.

Another weed I would like to introduce you to is *Rottboellia exaltata*. This weed is an annual grass which is present on all of the continents where they have tropical areas and is also present in the southern United States. This annual grass has the ability to grow higher than almost any crop with which it is associated. It is a very fast growing, aggressive weed. It is a particular problem in corn because of all of the grass herbicides used on corn only pendimethalin [*N*-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine] can control this weed. Where herbicides such as atrazine [2-chloro-4-(ethylamino)-6-(isopropylamino)-*s*-triazine] or alachlor [2-chloro-2',6'-diethyl-*N*-(methoxymethyl)acetanilide] are used the weed population is soon shifted to nearly a solid stand of *Rottboellia*. People who normally hand weed their crops are very reluctant to hand weed *Rottboellia* because it has many small irritating spines on the stems. This weed is a particular problem because it has the ability to germinate and grow even under shady conditions as you would see in a fairly mature corn crop and will continue then to set seed before the corn is harvested. It is commonly found associated with many of the annual upland crops. *Rottboellia* is spreading rapidly in the tropical areas and it is going to take a carefully planned series of control measures on a continuous basis to get this weed under control in a given area. It does have one weakness in that the seeds last in the soil only about three years.

Aquatic weeds are continuing to be a major problem not only in the tropics, but also in the area covered by the Western Wociety of Weed Science. Dick Comes tells me that he now has fewer chemical tools to work with than when he started working on aquatic weeds many years ago. In Thailand I saw water hyacinth (*Eichhornia crassipes*) build up behind a dam on a major river to the extent that they had to operate a boat twenty four hours a day just to push the water hyacinth through the spillway so that it could move on down stream. In India I saw a group of people who were hired to work all year just to remove water hyacinth from a lake which was popular for sailing.

The above examples were used to illustrate my point that weed problems continue to change and as soon as a problem is controlled there is another problem to take its place. We, as weed scientists, must be aware of this and continually be alert for potential problems which can be stopped before they grow to major proportions. This fact is often overlooked by people working in developing countries.

There has been an awful lot of developmental work aimed at improving the lot of the small farmers of the world. This has also included some work on weed control. However, to a large extent the small farmers have been bypassed by the tremendous developments in weed science over the last 40 years. As an example it might surprise you that even in the Philippines which for the last 20 years has been the home of the International Rice Research Institute only about 10 percent of the rice farmers use herbicides. They still rely largely on mechanical means such as the small rice weeder and hand weeding along with flooding to keep their weeds under control. The upland farmers of the world still rely mostly on hand weeding and to some extent animal traction to control their weeds. In general the small farmers find that herbicides are too expensive for their financial situation and there is the added factor of increased risk as a result of using herbicides. By risk I mean either risk of failure to control the weeds or phytotoxicity to the crop. In either case the small farmers are not in a very good situation to accept more risk. As a result much of the developmental work in weed control that is now going on is aimed at trying to find ways to allow farmers to use herbicides but to reduce the cost and to reduce some of the risk associated with herbicide use. An example of one of the techniques being developed now is herbicides to form mulches. The herbicide is sprayed onto the existing vegetation. The vegetation then dies and forms a mulch through which the seeds are planted. The mulch then serves to discourage an further weed growth. So additional herbicides or weeding often is not necessary. This method greatly reduces risk to the crops from the herbicides since at the time that the herbicide is applied there are no crops growing in the area.

There is also some work being done with living mulch to control weeds or at least discourage weed growth. In general these mulches are low growing vigorous plants and very likely would be nitrogen-fixing plants. If a thick stand of these plants can be formed they are quite effective at preventing weed growth. The same principle is being applied in another system which is being tested around the world under the general heading of multiple cropping. This certainly is not new because the Chinese and other people have been using multiple cropping for hundreds of years. The advantage of course to multiple cropping is that the farmers are able to get a second crop off of the same area in the same time period. The second crop is usually a legume and usually a low growing vigorous plant which gives the advantage of competing with weeds which would normally grow between rows of the first crop. In this way the amount of effort needed to control weeds in the field is greatly reduced.

There is also a lot of good agronomic work being done in relation to weed control such as selecting varieties which are better able to compete with weeds. Agricultural practices such as crop rotation are being promoted. An example would be the control of *Scirpus maritimus* which is a perennial sedge found in aquatic or semi-aquatic situations. This weed has become a serious problem is some of the rice areas of the Philippines. It has been found that in only two years it can be completely eliminated by draining the field and shifting to an upland crop such as corn or beans. Where herbicides are expensive or for other reasons not acceptable to small farmers they are going to have to rely more and more on some of these nonchemical practices to help solve their weed problems.

Training is one of the bright spots in the development of weed control capability in the less developed areas of the world. There are many young people now being asked to be at least partially involved in weed control but who have little or no background in weed science. There are now a number of different organizations getting involved in training and it has been found that an intensive course of three or four weeks will go a long ways in upgrading the weed science capability of these people. A general philosophy has been accepted by most of the organizations involved in weed control training that to a great extent these courses should be designed to allow maximum participation by the trainees themselves. Wherever possible they should be allowed to actually do things being taught rather than to hear about them. Even in the more structured lecture situations student participation should be encouraged. Another activity associated with these training courses which has proven to be very useful is the development and distribution of printed material. This has been found to be one of the most limiting factors and one of the easiest to correct. I predict that more and more members of the Western Society of Weed Science will become involved in such activities in the future.

Mr. Nguyen van Vuong is a young weed scientist whom I was fortunate enough to work with in Indonesia in 1972. He was working there as a junior scientist at the Regional Center for Tropical Biology. Vuong was specializing in the study and control of aquatic weeds and impressed me as an extremely hard working and intelligent young man. I learned later that he returned to Viet Nam to get his family just 20 days before the collapse of the government. He was not able to get out of the country and we corresponded two or three times over the past few years. Last November we received a letter saying that he had escaped from Viet Nam and was in a refugee camp in Malaysia. He had managed to get out with his wife and two sons, but was forced to leave a 10 year old dayghter behind in Viet Nam. The immediate physical needs of Mr. Vuong and his family were met to some extent by another weed scientist, Dr. Chris Teo, who is living and working in Malaysia. Dr. Teo received his Ph.D. in weed science working with Dr. Roy Nishimoto at the University of Hawaii. At this time, March 1980, we have not heard from Mr. Vuong for about two months but at last report there was a good chance that he and his family would be allowed to immigrate to Australia where he hopefully could find employment as a weed scientist. During the first few months of Mr. Vuong's stay in the refugee camp in Malaysia weed scientists in the United States, Malaysia, Australia and England were exchanging letters and working on various ways to get Mr. Vuong and his family into a society where he could function in a useful way.

Sometimes I think the informal weed society as just described is more functional than the formal weed society; however, there is an official International Weed Science Society. This has been in existence for about three years now and quite a few members from WSWS are members of that society. We had a set back last year when the president at that time, Mr. Les Matthews, was injured in an automobile accident and did not work for more than a year. The president now is Dr. Marvin Schreiber from Purdue University and I am encouraged that the Society will be able to make a useful contribution. At this time we are preparing two or three newsletters each year and we are now working on a listing of most of the weed science publications in the world. This will take about a year to finish but I think it will be a useful publication.

Integrated pest management has become a very popular term and there is some activity at the international level in developing international programs. The program under Title XII is at this time being planned by Purdue University and in April of this year four different teams will travel to different regions of the world to explore the need for and possibilities of collaborative research on integrated pest management. In this program IPM will be defined as pure horizontally integrated pest management. That is, they will be studying the relationships between various pests and the particular crops. While there are some excellent samples where we need to study the relationship between the various pests I am somewhat concerned that at this stage of development in many of the tropical countries priority must be given to solving immediate pest problems rather than looking at the integrated pest management programs. As long as the IPM programs do not drain resources away from the more immediate pest problems than I think the activities will make a useful and much needed contribution.

ENERGY RETURNS FROM WEED CONTROL

John D. Nalewaja[1]

The effects of the finite nature of fossil fuels, especially liquid petroleum, are beginning to have a major impact upon the stability of the nation's economic system. The cost of gasoline and the rate of inflation have increased many times since the petroleum crisis of 1973. Finally, the attention of our nation is focused on this serious situation. Conservation of energy and diversification from petroleum to other forms of energy have become a primary objective of the society. Agricultural production practices need to be evaluated for possible improvement in energy usage without reducing productivity which has been important to our high standard of living and towards our balance in foreign trade.

Agricultural production only requires 3% of the United States' total energy needs, not including solar energy (3). However, if a national crisis in energy consumption is to be averted, every person in our society needs to conserve and make changes in the type of energy they consume.

Modern agriculture's high productivity has involved an increased amount of input energy. Primitive agriculture yielded 16 calories of energy output for every calorie of input which was mainly human energy. The energy yield from modern agriculture with high production varies from 1 to 5 calories of output per calorie of input depending on the crop and production practice (7). Effective weed control through the use of herbicides has contributed greatly to the high productivity of modern agriculture. The high productivity of modern agriculture, which has made it possible for one farm worker to provide food for more than 50 other people, is essential to our ability to maintain the present standard of living. Thus, energy usage in all segments of the economy needs to be evaluated along with conducting new research to reduce energy inputs or to develop alternate sources. The objective of this discussion is to evaluated energy usage in the weed control segment of agricultural production.

Weeds growing uncontrolled in crops cause direct yield reduction by using soil moisture and minerals and by intercepting sunlight for crop growth. The energy output to input from weed control in wheat and corn was previously reported by Nalewaja (10). In that report 11,000 kcal/lb. of herbicide was used for all herbicides based upon a report by Pimentel (11). However, since that report, Green and McColloch (5) reported energy values for various herbicides (Table 1). In this report, the energy values used were those reported by Green and McCulloch for the herbicides they included in their report and for herbicides with similar chemistry. Other herbicides were given a value of 15,000 kcal/lb. of which one-half was assumed petroleum in origin. The discussion was related mainly to total energy with reference to liquid petroleum which is of primary concern at present. The proportion of total energy which is from petroleum is given in the fuel oil and naphtha column in Table 1.

The total energy for herbicide manufacture does not precisely reflect petroleum energy input. Paraquat had the highest total energy requirement, but not the highest amount of petroleum energy per pound of herbicide (Table 1).

The energy requirements and returns from the control of various weeds in wheat based upon yield loss data from competition experiments and average

[1]Agronomy Department, North Dakota State University, Fargo, North Dakota.

Table 1. Energy for the manufacture of various herbicides. From Green and McColloch (5).

Herbicide	Naphtha and fuel oil (Kcal/lb)	Steam and electricity (Kcal/lb)	Total (Kcal/lb)
MCPA	8,550	5,450	14,000
Diuron	17,400	11,600	29,000
Atrazine	13,700	7,300	21,000
Trifluralin	8,350	7,650	16,000
Paraquat	15,100	33,900	50,000

wheat yield are presented in Table 2. The highest energy requirement for wild oats (*Avena fatua* L.) control was with hand hoeing at 101,850 kcal/A. Two hand hoeings in wheat required 195 hr/A based on unpublished data from a timed hoeing experiment at North Dakota State University in 1978. The hoeing energy is in close agreement with Rappaport (12) who reported that hand weeding in a garden in New Guinea required 90,168 kcal/A. The energy requirements for weed control in wheat increased with increased mechanical involvement and higher rates of herbicides. Delayed crop seeding with 1.5 extra cultivations for wild oats control required 95,289 kcal/A, triallate [*S*-(2,3,3-trichloroallyl)diisopropylthiocarbamate] at 1 lb/A with harrow incorporation required 31,495, and barban (4-chloro-2-butynyl *m*-chlorocarbanilate) at 1/4 lb/A postemergence required 7,998.

Weed species influence the energy for control as certain weeds may require different rates of a given herbicide or another herbicide with a different energy requirement. The energy for wild mustard (*Brassica kaber* L.) control with 2,4-D [(2,4-dichlorophenoxy)acetic acid] at 1/4 lb/A was similar to that for wild oat control with barban at 1/4 lb/A. The only difference was in the greater estimated energy requirements for barban. Picloram (4-amino-3,5,6-trichloropicolinic acid) at 1/4 oz/A effectively controls wild buckwheat (*Polygonum convolvulus* L.) with an energy requirement of only 4,467 kcal/A of which 4,248 was for labor and mechanical application. Herbicides for weed control in wheat require less energy than mechanical methods. The energy for mechanical operations was the average energy of the gasoline consumed in the operation multiplied by 1.5 for indirect energy (10) and labor energy was 21,770 kcal/40 hr week (11). The indirect machine energy is for construction and maintenance. Transportation of gasoline was not included nor was transportation energy included for the herbicides.

The energy returns in wheat for weed control inputs varied from 11 to 144 depending upon the weed species and control practice assuming a moderate weed infestation of 100 plants/yd^2 (9) and an average wheat yield of 30.5 bu/A (13). Wild buckwheat was less competitive than wild oats or wild mustard so the energy return from controlling wild buckwheat was 87 times the input for picloram (4,467 kcal/A) and controlling wild mustard returned 135 times the input for 2,4-D (7,748 kcal/A).

Herbicides for wild oat control gave a higher energy return per input than mechanical delayed seeding. The petroleum energy alone for the delayed seeding practice was 62,767 kcal/A of gasoline and for herbicides 18,327 kcal/A assuming one-half the energy for the herbicide was petroleum. Dichlfop (2-[4-(2,4-dichlorophenoxy)phenoxy]propanoic acid) and triallate were assumed to require the same energy for herbicide manufacture; but because

Table 2. Energy requirements and returns for various weed control methods in wheat based upon weed competition data.

Weed at 100 plants/ sq. yd.	Weed control	Weed control inputs/A: Chem.[a] (Kcal)	Mech.[b] (Kcal)	Labor[c] (Kcal)	Total (Kcal	Wheat gains[d] (%)	(Bu/A)	(Mcal)	Energy output: input
Wild oats	Triallate 1 lb/A	15,000	16,405	90	31,495	33	10.1	1,150	37
Wild oats	Barban 1/4 lb/A	3,750	4,218	30	7.998	33	10.1	1,150	144
Wild oats	Dichlofop 1 lb/A	15,000	4,218	30	19,248	33	10.1	1,150	60
Wild oats	Delayed seeding 1.5 cultivations	-	95,102	187	95,289	33	10.1	1.150	12
Wild oats	Hoeing 2x (195 hr/A)	-	-	101,850	101,850	33	10.1	1,150	11
Wild mustard	2,4-D 1/4 lb/A	3,500	4,218	30	7,748	30	9.2	1,047	135
Wild buckwheat	Picloram 1/4 oz/A	2.9	4,218	30	4,467	11	3.4	387	87

[a]Herbicide energy at 15,000 kcal/lb except for 2,4-D and picloram which were assumed similar to MCPA which was given a value of 14,000 kcal by Green and McCulloch (5).

[b]Mechanical energy was average gasoline (31,248 kcal/gal) consumption (10) times 1.5 to account for indirect machine costs based upon average machine cost for corn production (11).

[c]Labor energy was time involved in the weed control practice and 21,700 kcal/40 hr week.

[d]Wheat yield based on 30.5 bu/A, the 1972 U.S. and Canadian average, and % loss from 100/sq. yd. of the various weeds was based upon competition data (9).

triallate required energy for incorporation, the wheat energy return for wild oat control was 37 times the input compared to 60 for diclofop.

Hoeing returned only 11 times the energy input, which was all nonpetroleum. Thus, hoeing was less efficient than the mechanical or chemical weed control methods when considering total energy but efficient in usage of petroleum energy. The energy for hoeing wild buckwheat would be similar to that for wild oat control; but since wild buckwheat is less competitive, the returns would be only four times the inputs. However, petroleum conservation must be considered in light of productivity, economics and feasibility.

The values in Table 2 assume complete wild oat control with all the treatments without any direct influence upon the wheat. The energy efficiency of various treatments in practice would be influenced by the level of weed control or effect upon the wheat. Delayed wheat seeding is known to cause direct wheat yield reductions and hoeing a solid seed crop like wheat would not control weeds in the rows. The hoeing treatment would probably cause direct crop injury.

Weed control in wheat is energy efficient compared to the return from total energy for crop production. No values were found in the literature for energy return for inputs in wheat, but oats with similar production practices had a return of about three times the input (7). Thus, all weed control practices in wheat because of high yield increases exceeded the energy return for the average of all production practices in oats.

The returns for weed control would decrease with lower weed populations as the energy inputs (except for hand labor) are quite similar regardless of weed population. Herbicide rates and tillage intensity may be slightly reduced with low weed populations, but the reductions would be small and only have a minor effect on the final output/input ratio.

The influence of various wild oat densities on the return for weed control energy inputs based on competition data (9) is presented in Figure 1. All the herbicide treatments give an energy return per input of five or more for the control of wild oat densities as low as 6 plants/yd^2. The control of 25 wild oat plants/yd^2 was necessary for a five times energy return for input with the delayed seeding practice. The assumption relative to the values in Figure 1 again were that all wild oat control practices gave complete control without any direct effect upon the wheat. The per plant competition from wild oats is greater at low than high densities, thus the returns for energy inputs are relatively higher per wild oat plant controlled at low than at high plant density.

The energy return for input with hand hoeing various wild oat densities was not determined but would be similar to that for the delayed seeding control method which had a similar energy input for controlling 100 wild oats/yd^2. Hand hoeing inputs would decrease somewhat with lower wild oat densities but not proportionally as a certain amount of time is required to walk the field which would be required as wild oats are not easily visible in wheat. Hand hoeing at best can only control plants between the rows and thus in practice would not give complete control.

The above discussion was based upon individual weed competition data and complete control with the various treatments. The energy and economic inputs and returns from various weed control treatments based on a field experiment conducted in 1978 are presented in Table 3. The experimental areas contained moderate infestations of wild oats, common lambsquarters (*Chenopodium album* L.) and Kochia (*Kochia soparia* L.) and a light infestation of green foxtail (*Setaria viridis* L.). Triallate increased the wheat

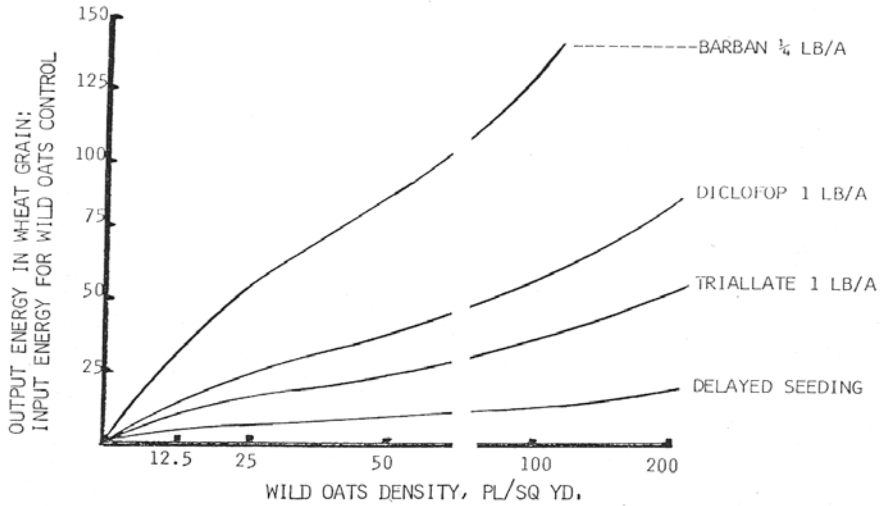

Figure 1. Return in wheat grain energy: energy inputs for wild oats control in wheat with various densities of wild oats. Energy output is based on expected wheat yield increase from competitive data (9) and 113,800 kcal/bu of wheat. Energy inputs include chemical, mechanical, and labor energy (see table 1).

yield 12.1 bu/A providing an energy return of 44 times input which is similar to the calculated return in Table 2 based on competition data and a net economic return for weed control of $40/A. Hoeing increased yield only 3.7 bu/A for a return of 4 times the energy input and economic net loss of $570/A at $3/hr for the 195 hr/A labor. The triallate plus diclofop plus bromoxynil (3,5-dibromo-4-hydroxybenzonitrile) treatment increased wheat yield 7.6 bu/A beyond the triallate alone treatment for an energy return of 41 times input and a $54/A net return for weed control. The addition of hoeing to the three herbicides increased yield 5.2 bu/A probably from the observed better kochia control. However, the hoeing required 89 hr/A and caused a net loss to the treatment for weed control of $177/A.

The use of hand labor which does not use petroleum energy for weed control would not maintain present agronomic production and would dramatically increase the cost of food. The petroleum energy efficient hand hoeing weed control would require 7.8 million hoers working 40 hr/week for a 6 week period during which weed control is required for the 9.6 million acres of wheat in only North Dakota. The hoe help required for only wheat is 13 times the present population of North Dakota. The cost of hoeing at $3/hr would be more than 5 times the present value of the wheat ($4/bu) production. Hand pulling of weeds within the row would be impossible and these weeds would cause yield reductions. Mechanical weed control is less petroleum energy efficient than herbicides. Thus, herbicides are essential toproductive energy efficient agriculture. Future improvements in the

Table 3. Returns from various weed control practices in wheat based on a field experiment at Fargo, ND, 1978.

	Weed Control					
Treatment[a]	Energy[b] input (Mcal/A)	Costs[c] ($/A)	Return[c] ($/A)	Wheat yield (Bu/A)	Energy from weed control (Mcal/A)	Energy (O:I)
None	0	0	-	4.4	0	-
Hoeing (195 hr)	106.1	585	-570	8.1	421	4
Triallate 1 lb/A	31.5	8	40	16.5	1,377	44
Tria + Brom + Dicl	54.5	25	54	24.1	2,242	41
Tria + Brom + Dicl + Hoeing (84 hr)	100.2	277	-177	29.3	2,834	28

[a]Tria = Triallate at 1 lb/A preemergence incorporated, Brom + Dicl = bromoxynil at 3/8 lb/A + diclofop at 3/4 lb/A postemergence and values in parenthesis are hours of hoeing required/A.

[b]Labor was 21,770 kcal/40 hr week, herbicides at 15,000 kcal/lb and mechanical inputs 1.5 times gasoline at 31,248 kcal/gal.

[c]Wheat valued at $4/bu, labor at $3/hr, and herbicides at 1979 cost plus $1/A for application and $2/A for triallate incorporation.

agricultural energy usage can be made within the herbicides used and the substitution of herbicides for mechanical tillage which is mainly for weed control.

The energy and economic inputs and returns for various weed control practices in six field experiments with corn in Minnesota (1) are presented in Table 4. All weed control methods in corn gave 34 or more times return in energy than the input because of high yield increases from weed control. Pimental et al. (11) reported that the average return for energy inputs in corn production was 2.8. Thus, weed control is an efficient part of corn production. Cultivation alone was similar to cultivation plus herbicides or only herbicides in energy return of approximately 55 times input, but corn yielded 10 bu/A less and return for weed control was approximately $20/A less with cultivation only than with the herbicide treatments (Table 4). The return for input and corn yield was similar for herbicide treatments and hand weeding, but economic returns for weed control by hand was a loss of $332/A. Cultivation plus hand weeding gave only 34 times the energy return of the input compared to approximately 50 times return for the other treatments. The in the row hoeing and weeding plus cultivation in between the rows was a $244 loss which indicated that the corn production increases obtained with hand labor are not feasible at today's labor costs and corn prices. The hoeing and weed pulling time reported here are more than two times that reported previously (10). The values presented are from timed hoeing experiments with dense wild oats infestations in corn conducted in 1978 and 1979. Nalewaja (10) previously reported that with a hoeing time of 60 hr/A, 17.7 million hoers working 40 hr weeks over a 6 week period would be needed for the 71 million corn acres in the United States. The 60 hr/A time was based upon estimates. Forty-two million hoers would be required using the 143 hr/A hoeing and hand pulling time obtained from the wild oat control experiments which would be similar to time for hoeing other annual grass weeds.

Weed control practices are all energy efficient because of the large yield increase from weed control. Herbicides generally have an energy and/or economic advantage over mechanical or labor methods of weed control. Continuous evaluation of herbicides and other possible methods or weed control is essential to further efficiency in the use of energy even for weed control.

Table 4. Energy requirements and returns for various weed control practices in corn based upon field experiments[a]

	Weed control inputs/A[b]						Corn[c]			
Weed control practice	Chem. (Kcal)	Mech. (Kcal)	Labor (Kcal)	Total (Mcal)	Labor (H)	cost ($)	Yield (Bu/A)	Weed control return (Mcal)	Energy output: input	Return for weed control($)
Cultivator 2.5 times	0	48,044	310	48.4	0.57	5.0	81	2720	56	62.5
Cultivator + hand atrazine 3 lb/A	21,000	49,450	320	70.8	0.59	8.3	91	3730	53	84.2
Broadcast atrazine 3 lb/A	63,000	4,218	30	67.2	0.05	9.9	90	3630	54	80.1
Cultivator + hand labor	0	48,044	62,355	110.4	114.57	347.0	91	3730	34	-244.5
Hand labor, 2 times	0	0	77,829	77.8	143.0	429.0	92	3830	49	-332.0
None	0	0	0	0	0	-	54	0	-	-

[a] Based upon results from six experiments in Minnesota 1961 and 1962 (1).

[b] Chemical energy from Green and McCulloch (5), mechanical was 1.5 times gasoline energy for 2.5 cultivations (10) as data was from experiments with 2 to 3 cultivations; labor is the time for a 4-row cultivator at 3 mph and hoeing time from experiments with dense wild oats infestations in 1978 and 1979; and treatment costs are 1979 herbicide prices, wage of $3/h, cultivation at $2/A and herbicide application at 0.90/A.

[c] Corn was valued at $2.50/Bu and with 1800 kcal/lb.

The petroleum and nonpetroleum energy inputs for weed control practices increased with herbicide rate, tillage for herbicide incorporation, additives, and soil tillage for mechanical control, Table 5. Trifluralin (α,α,α-trifluoro-2,6-dinitro-*N*,*N*-dipropyl-*p*-toluidine) because of two field cultivations for incorporation had a higher petroleum energy input that the other treatments listed except the roto-tiller. However, the effectiveness of the treatments needs also to be considered. Trifluralin has given consistent season long weed control, while other practices may require several retreatments. Thus, the values in Table 5 are mainly to indicate energy differences in the basic treatment and potential for future even greater efficiency in weed control practices.

Petroleum oils are often added to herbicides to improve postemergence effectiveness. The petroleum energy inputs for weed control with postemergence atraztine [2-chloro-4-(ethylamino)-6-(isopropylamino)-*s*-triazine] are reduced from 51,792 kcal/A when applied with 1 gal/A petroleum oil to 18,183 kcal when applied with 1 qt/A of crop origin oil (Table 3). The use with atrazine of 1 qt/A petroleum oil with surfactants requires approximately 25,332 kcal/A. The crop origin oil linseed oil, has been shown equally as effective as the petroleum oil additive (8). The crop origin oil energy value presented in Table 5 assumed that in the production of the crop origin oil, petroleum energy was involved and consisted of 20% of the oil. However, no value was added to the petroleum oil for energy in obtaining and purifying the oil. Thus the saving with crop origin oil would be even greater if all inputs were calculated. The important advantage to crop origin oil is that less petroleum energy is consumed without the loss in production at low or no added cost.

Table 5. Energy by source for an acre of various weed control practices.

Weed control practice	Petroleum and gas			Non-petroleum			Total energy
	Treatment[a]	Application	Total	Treatment[a]	Labor and application[b]	Total	
Trifluralin 1 lb/A	8,550	87,182	95,732	5,450	43,761	49,211	144,943
Atrazine PE 2 lb/A	27,400	2,812	30,212	14,600	1,436	16,036	46,248
Paraquat ½ lb/A	8,050	2,813	10,863	16,950	1,436	18,386	29,249
Atrazine post 1 lb/A	13,700	2,812	16,512	7,300	1,436	8,736	25,248
Atrazine + Pet. oil 1 gpa	" + (35,280)	2,812	51,792	7,300	1,436	8,736	60,528
Atrazine + crop origin oil 1 qt/A	" + (1,671)	2,812	18,183	" + (6,683)	1,436	8,736	29,946
Picloram ¼ oz/A	109	2,812	2,921	109	1,436	1,545	4,466
Wick herbicide	1,500	8,454	9,954	1,500	4,227	5,727	15,681
EDS	-	26,873[c]	26,873	-	13,436	13,436	40,309
Field cultivator	-	56,649	56,649	-	28,474	28,474	85,124
Row cult.	-	12,811	12,811	-	6,405	6,405	19,216
Roto-tiller	-	91,557	99,557	-	45,778	45,778	137,335
Rotary hoe	-	6,875	6,875	-	3,437	3,437	10,312
Hand labor 40 h-wk	-				21,770	21,770	21,770

[a] Energy for herbicides was from Green and McCulloch (5) and for herbicide with unknown energy content the value used was 15000 kcal/lb of which 50% was assumed petro and 50% nonpetro in origin. The herbicide use rate for the roller was estimated at 0.2 lb/A. Value in parenthesis are for additive alone. Crop origin oil (sunflower at 33415 kcal/gal) was assumed 20% petroleum from crop production inputs and emulsifiers.

[b] The indirect machine energy was calculated as one-half of the average gasoline consumption and assumed not petroleum in origin.

[c] Energy usage for the Electric Discharge System (EDS) was from Kafuman et al. (6).

Electrical discharge (EDS) and wick herbicide application have been used to direct control at escaped weeds without broadcast treatments. The EDS weed control practice required more petroleum energy than broadcast or wick application of herbicides, Table 5. However, again weed control and crop tolerance may need to be the main criteria in selecting a weed control method.

Tillage generally has a high requirement for petroleum energy. Weed control is the primary reason for the various tillages performed in crop production. The substitution of herbicides for tillage in fallow or crop production generally has not affected crop yields (unpublished data, Agronomy Department, North Dakota State University). The use of herbicides in place of tillage for crop production increased the wheat energy output from 4.3 to 6.7 times the input in an alternate wheat-fallow rotation, Table 6. The conventional practice required 802 mcal/A compared to 509 for the zero-tillage production method or a savings of 293 mcal/A or 9.3 gallons of gasoline energy eqjivalents per acre over the two years. The practices presented in Table 6 are presently available. Development of herbicides effective at lower rates or with longer residual and selective tolerance to the following crop will cause even further increases in crop production energy efficiency. For example, DPX4189 (2-chloro-*N*-[(4-methoxy-6-methyl-1,3,5-triazine-2-yl)aminocarbonyl]benzenesulfonamide) at 2 oz/A has given season long weed control in fallow and because of the low rate the energy inputs for a wheat-fallow production system would be reduced to

459 mcal/A. Further, should this or another high activity herbicide also have residual selective weed control in the wheat following the fallow, the enerby inputs for zero-till alternate wheat-fallow production would only be 421 compared to 802 for the conventional tillage system, a reduction of 47% in the energy inputs. Zero tillage crop production may cause shifts in weed populations which may intrease or decrease future inputs. Research is needed on weed production dynamics with reduced tillage in order to determine potential weed problems and develop energy efficient solutions. Presently reduced tillage practices need to be encouraged for use by farmers on a limited basis.

Table 6. Energy requirements for conventional and no-till alternate fallow wheat production.

	Energy for crop production system[b]	
Crop production practice[a]	Conventional (Mcal/A)	Zero tillage (Mcal/A)
Fallow year		
Field cultivation 5x	316	-
Cyanazine + atrazine 2 + 1/2 lb/A[c]	-	57
Crop year		
Field cultivation + harrowing	69	-
Nitrogen fertilizer 40 lb N[d]	337	337
Paraquat 1/2 lb/A	-	29
Seeding[e]	7	11
MCPA 1/3 lb/A	9	9
Harvest	66	66
Total	802	509
Wheat 30 bu	3,415	3,415
Output:input	4.3	6.7

[a]Standard practices only are listed.

[b]Values based on average energy in herbicides (5) and gasoline energy for various operations (4) times 1.5 for indirect machine energy

[c]A registered treatment for fallow in North Dakota. Late season treatment with2,4-D at 1/4 lb/A plus paraquat (1,1'-dimethyl-4,4'-bipyridinium ion) at 1/4 lb/A (20 mcal/A) may be required also in some years.

[d]Urea energy from McColloch and Green (5).

Table 7 contains energy inputs for conventional and zero-tillage corn production. The zero tillage system required 231 mcal/A less energy input which was equal to the energy in 7.4 gallons of gasoline. The cost of the zero-tillage system is approximately $8/A greater than for the conventional system. The zero-till corn production system considers the energy for a typical system presently available and more energy efficient systems are possible with proper selection of herbicides.

In the future greater emphasis will be on energy involved in various weed control practices. Gasoline and diesel fuel prices will increase which will make the substitution of herbicides for tillage economically advantageous. Herbicides requiring low rates for weed control will be developed and formulated as high concentrates in water to reduce costly energy inputs. Postemergence herbicides will need to be developed to permit application to areas within a field according to the weed species present. Weed control is essential to high crop yields which are needed to feed an ever increasing world population.

Table 7. Comparative energy inputs for 100 bu/A corn with conventional and zero-tillage production systems.

Production[a]	Conventional (Mcal/A)	Zero tillage (Mcal/A)
Moldboard plow	147	-
Field cultivation (2x)	127	-
Fertilizer spreader	7	7
Harrow	12	-
Planter	27	40[b]
Cultivation (3x)	57	-
Sprayer	4	8[b]
Harvesting	94	94
Nitrogen 70 lb/A	590	590
Atrazine 1/5 lb/A	-	38
Paraquat 0.5 lb/A	-	29
Alachlor 2.5 lb/A	13	38
Dicamba 0.25 lb/A	-	3
Total	1,078	847

[a]Includes only selected inputs for comparison. Drying and phosphorus and potassium fertilizer were not included, but value would be similar for the two systems.

[b]Assumed one and one-half times more energy for planting and two spraying for the zero-tillage system.

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PUBLIC CONCERNS ABOUT 2,4,5-T

Wendell R. Mullison[1]

There appears to be considerable apprehension among certain sectors of the public about the use of the herbicide 2,4,5-T (2,4,5-trichlorophenoxyacetic acid). These concerns are usually based upon inaccurate and often outright misstatements of facts that are often cited in the news media. This paper discusses certain public concerns about 2,4,5-T which is used in many herbicidal formulations. The 2,4,5-T discussed in this paper contains the trace contaminant TCDD (2,3,7,8-tetrachlorodibenzo-*p*-dioxin). The legal limit for TDCC in 2,4,5-T acid in Denmark, Australia, New Zealand, and many other countries is 0.1 ppm.1 Recent production runs of Dow products contain significantly less TCDD (0.02-0.04 ppm).

There has been a great deal of unfavorable publicity in the news media about the toxicity of 2,4,5-T. According to many accounts this herbicide is a harbinger of doom. The allegations are that 2,4,5-T causes tremendous human health hazards. However, the overwhelming scientific data clearly show that 2,4,5-T with its trace contaminant TCDD does not cause human health problems.

These alleged health problems have been grouped in the following classifications:

1. Miscarriages and birth defects
2. Cancer
3. Diseases or illnesses possible from a multiplicity of causes
4. Rare diseases with an unknown or obscure etiology

Miscarriages and Birth Defects: Background

The worldwide rate of spontaneous abortions or miscarriages has been estimated to be 15 to 20 percent according to the World Health Organization (2). This estimate is probably low. Other authorities quote higher

[1]A former Dow employee, now retired after 32 years experience in research, development and registration, now an agricultural pesticide consultant.

figures. A recent Great Britain report said that 25% of all pregnancies result in miscarriage. One scientist (3) says "a pregnancy wastage of between 30 and 50% seems to afflict laboratory and wild animals, domestic breeds and man."

It is generally recognized that the majority of the miscarriages result from chromosomal or developmental abnormalities in the fertilized egg or the developing fetus. Thus, a miscarriage is Nature's way of handling a mistake.

Birth defects also are far more common than are usually realized. In the United States (4) it has been estimated that 7% of all live babies born each year have a serious birth defect.

The U. S. Department of Health, Education and Welfare in a recent article (5) surveyed the incidence of 16 selected birth defects in the United States in 1970 and 1971 as well as in 1976-1977. They said, "There is no evidence for an overall increase or decrease in malformation rates (birth defects) since 1970." This same study indicated the rate of encephaly declined 5.4% while spina bifida declined by 6.7%.

The etiology of birth defects is not easily characterized although viral infections such as German measles are known to be a common cause. Based on surveys and case reports in medical literature, the following causes of birth defects and their frequency are: genetics 20%, chromosomal aberration 3-5%, radiation less than 1%, disease 2-3%, maternal metabolic imbalance 1-2%, drugs and environmental chemicals 4-5% and unkown causes 65-70% (6). It is noteworthy, as Wilson points out, that 65% to 70% of birth defects still have an unknown cause today. Thus, even with our modern medical knowledge this is still a very poorly understood field. The importance of the figures previously cited is that they show the chances of a woman having a miscarriage or a child with a birth defect are far greater than ordinarily realized. In fact, such problems really are not uncommon.

These problems of birth defects and miscarriages have been with mankind since prehistoric times, long before 2,4,5-T was manufactured. It therefore seems quite unreasonable to assume that 2,4,5-T is necessarily implicated as a cause of these problems, particularly when the charges are based on anecdotal reports. This is especially true when there is a large body of scientific evidence that indicates the use of 2,4,5-T does not cause human birth defects or miscarriages.

Miscarriages and Birth Defects: 2,4,5-T Scientific Facts

2,4,5-T has been carefully studied in scientific experiments on seven species of mammals to determine whether it would cause birth defects. In six species of animals tested (monkeys, rats, rabbits, hamsters, sheep, and reindeer) (7-14), 2,4,5-T has been found to cause no birth defects and no spontaneous abortions or miscarriages (or the animal equivalent thereof). However, 2,4,5-T has been found to cause the birth defect of cleft palate in mice. Mice, however, are so highly susceptible to cleft palate that this defect can be caused by an experimental stimulus as mild as an airplane ride during pregnancy. Since this defect is so easily caused, its occurrence in mice is not a reliable indicator of hazard to humans.

Governmental committees in Australia and New Zealand, after studying the question of whether human birth defects are caused by 2,4,5-T, have found these allegations to be unfounded and have given a clean bill of health to 2,4,5-T. Dr. Donald P. Morgan, a physician in the Environmental Toxicology Division at the University of Iowa, reviewed the Australian report for EPA. He stated: "The calculations confirm what one would expect on the grounds of common sense alone, i.e., that absorption of sufficient amounts of these agents to cause reproductive morbidity is extremely unlikely, if not impossible." Dr. Morgan made some additional observations that are of interest: "Similar reviews of the same literature must have been completed by at least a hundred government agencies in the last five years. A study by the government of New Zealand in June, 1977, arrived at the same conclusions, using essentially the same investigative methods.... Interest in this aspect of human health (reproductive mobidity and congenital defects) will probably increase in the years ahead, and the public will be inclined to fasten on one or another agent as causative of birth defects, according to the fashion of the times."

Any discussion of alleged human miscarriages being caused by 2,4,5-T has to include the Alsea II Oregon Study carried out for EPA. This came about as a result of a well written letter to EPA and subsequent media publicity concerning eight women in the Alsea, Oregon area who had suffered 10 miscarriages (16). The Alsea II Study is important because the EPA in a press conference of March 1, 1979 when announcing the emergency suspension action to halt the use of 2,4,5-T and silvex said, "We are taking emergency action today to halt the spring spraying of the herbicide 2,4,5-T on the basis of new information indicating its potential link to human miscarriages.... We have just received the results of a study which shows a high probability that the herbicide is linked to actual human miscarriages in an area where 2,4,5-T is used regularly. New studies in the Alsea basin area of Oregon show a high miscarriage rate shortly after the spraying of 2,4,5-T in the forests." According to the EPA's printed press conference statement this Alsea II report was instumental in prompting their emergency suspension action against 2,4,5-T and silvex.

Unfortunately, this Alsea II report is seriously flawed scientifically. The following common-sense points indicate why this report is considered to be invalid:

1. There is no exposure data in the report that show the affected women ever came in contact with the herbicide. For instance, only 3% of the basin was sprayed and in addition this was a forest area with the majority of people living elsewhere.

2. There was no dose response effect; that is, when 2,4,5-T was applied to the forest at twice the dosage there was not a corresponding substantial increase of miscarriages.

The Environmental Health Sciences Center of Oregon State University has published a 93-page report with a 21-page supplement entitled "A Scientific Critique of the EPA Alsea II Study and Report with November 16, 1979 Supplement." This Oregon State University report points out in detail the many inaccuracies and erroneous assumptions of EPA's Alsea II Report. The critique states that due to the many flaws in the study methodology the conclusions of EPA's Alsea II Report are wrong. The Oregon State University study is merely the latest criticism. The Alsea II data and report have been critically analyzed by highly respected statisticians, physicians, and other scientists from foreign countries including Canada, Great Britain, Australia, and New Zealand. Their scientists could find no justification for the claims stated in the Alsea II Report.

The Alsea II report was also carefully studied by the Scientific Dispute Resolution Conference on 2,4,5-T (17): "The miscarriages reported in this study were not demonstrated to result from the spraying of the forests with 2,4,5-T.... The group found no evidence for an abortifacient (causing abortion) effect of TCDD in the human."

"The Lancet" (18), the leading medical journal of Great Britain, and one of the most influential in the world, characterized the Alsea II Report in this manner: "Independent statisticians have been unable to find any evidence in the data of a link between abortion and 2,4,5-T; and, the EPA, it seems, is now having second thoughts." They concluded their comments on 2,4,5-T by saying, "To reduce the risks of chemical accidents, we need an inspectorate which is skilled, properly trained, and adequately paid. Getting the technology right is important, too. But it is a waste of effort, resources, and credibility to cry 'wolf' about 2,4,5-T when there is no wolf."

Cancer Assessment

Human cancer generally develops slowly over a latency period of many years and usually is a disease of old age. Thus in studying possible causative agents, especially at low levels of exposure, it is necessary to go back approximately 20 years or more before there is proper human data to study. Since 2,4,5-T has been a commercial product for more than 30 years, there has been sufficient time for a possible carcinogenic effect to have been identified in humans.

During the Vietnam war and subsequently, a physician from North Vietnam, Dr. Ton That Tung, has alleged that there has been an increase in liver cancer from spraying of Herbicide Orange[1] for defoliation in Vietnam. Research by Dr. Tung (19) on this matter was presented at a scientific meeting in France.

In the discussion that followed, Dr. R. Favre made the following comments: "I have no opinion whatsoever concerning the role of defoliants promoting the appearance of primary cancer of the liver since my stay in Indochina goes back to 1949-1952 (prior to the Vietnam war), On the other hand, I was able to verify at this time, with astonishment, the extraordinary frequency of cancer of the liver with respect to its frequency in Europe. One should discuss the difference in diagnosis with amoebic hepatitis, especially since more frequently primary cancer of the liver in Vietnam is a febrile form accompanied by a localized and painful hepatomegalia."

Thus Dr. Tung's allegation as to the cause of the high frequency of liver cancer in Vietnam is invalid since historically there has been a high incidence of this disease there. Tung also did not take into account other possible confusing causative factors such as aflatoxin. Aflatoxin is a common very poisoness mold that causes liver cancer (20). Aflatoxin in spoiled grain could certainly have increased in Vietnam under wartime conditions. Another criticism of Tung's paper is that enough time had not elapsed to draw such conclusions about the increased incidence of liver cancer.

It is not surprising, therefore, that reviews by both the World Health Organization and the Cancer Assessment Group of EPA concluded that Tung's data was inadequate and did not prove Herbicide Orange caused an increase of liver cancer in Vietnam.

There have been nine long-term cancinogenic studies with rats and mice. The two most recent studies, reported last year, were done with rats; these were lifetime studies that used the latest and best technology available (21,22). One of these studies was done in Germany, the other in the United States. The authors in both cases concluded that 2,4,5-T was not a

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[1]Herbicide Orange was the code-name of a 50:50 mixture of the *n*-butyl esters of 2,4-D and 2,4,5-T. It contained 4.21 lb of 2,4-D and 4.41 lb 2,4,5-T acid equivalent per gallon.

carcinogen.

These rat data are confirmed by seven long-term cancinogenic experiments with mice (23). Review of these studies of 2,4,5-T with varying quantities of TCDD confirm each other and clearly show that 2,4,5-T does not cause cancer.

Medical surveillance of the workers engaged in the manufacture of Dow's 2,4,5-T has been carried out and is continuing. A recently published report (24) of some of these studies shows that among these workers there was no excess mortality from cancer caused by exposure to 2,4,5-T. The number of individuals studied is relatively small, due to the small work force involved. However, the results strongly indicate that 2,4,5-T is not carcinogenic. Since this chemical has been in production and use for over 30 years, there was been ample time for cancer to appear if it were a problem. Thus the limited human data are in agreement with the extensive animal data as to the non-carcinogenic effects of 2,4,5-T.

Diseases and Illnesses

Human illnesses mistakenly associated with 2,4,5-T are those with symptoms such as nervousness, chronic tiredness, and mental illness. Such symptoms are very common ones and are associated with many every day ailments having a multiplicity of causes such as normal menstrual difficulties, respiratory problems, flu, overwork, stress, and psychological factors. There are also obscure and rare medical problems that may arise with an unknown or poorly understood etiology. However, there is no scientific evidence that indicates 2,4,5-T causes such disorders.

The question of the toxicity of 2,4,5-T and whether it causes human health problems has been complicated by the trace contaminant TCDD which is an extremely toxic material.

TCDD Toxicity: Animals

Most of the toxicological investigations have been done with 2,4,5-T that contained various amounts of TCDD. However, in carefully controlled animal experiments with rats using only TCDD in both lifetime feeding studies (40) and three-generation reproduction studies (32), no-effect levels for TCDD have been found. These results were confirmed upon review by the Scientific Adisory Panel (39).

A no-effect level has been demonstrated in chronic feeding studies (21) in rats using 2,4,5-T containing 0.05 ppm of TCDD. Such results support the finding from the experiments using TCDD alone. These studies clearly show that TCDD is not a practical hazard at the very low levels at which it is present as a trace contaminant in the herbicide 2,4,5-T.

The Council for Agricultural Science and Technology (CAST) reported that 200 to 2,000 toxic doses of 2,4,5-T would have to be administered, depending on the species, before a single toxic dose of TCDD would be received based on the trace amounts of TCDD present in 2,4,5-T (25). This same report concludes, "Thus the current level of TCDD in 2,4,5-T does not contribute significantly to the toxicity of herbicidal preparations of 2,4,5-T."

To further illustrate the negligible practical hazard from this trace contaminant in 2,4,5-T, CAST also said that if you assume a grazing animal about the size of a sheep or deer (175 lb or 80 kg and also the average weight of many a human) with the sensitivity of the most sensitive species known, the guinea pig, this animal would have to consume all the treated vegetation on more than nine acres of land to get a lethal dose. This assumes all the material is on the vegetation and that none of it decomposes. As a practical matter, TCDD on leaf surfaces is rapidly decomposed by sunlight. TCDD contacting the soil is immobilized immediately and gradually decomposes.

TCDD Toxicity: Humans

There is some toxicological data on the effects of TCDD on humans that has been documented from industrial accidents. This information strongly suggests that the trace contaminant TCDD in 2,4,5-T does not constitute a problem to human health.

Trichlorophenol is used in the manufacture of 2,4,5-T and it is during this process that the impurity TCDD is formed. Subsequently this impurity becomes the trace contaminant in 2,4,5-T. Data from industrial accidents indicate that chloracne is the first visible symptom of human over-exposure to TCDD. At Nitro, West Virginia there was an accident on March 8, 1949 at a plant manufacturing trichlorophenol. Workers in this plant were exposed to TCDD. All of the 121 workers who developed chloracne were studied. Recently a medical evaluation of this 30 year history on the Nitro episode (26) has been published: "it is important that no apparent excess in total mortality or in deaths from malignant neoplasms or diseases of the circulatory system was observed in a group of workers with a high peak exposure to tetrachlorodibenzodioxin who were followed over a period of nearly 30 years." They also note the small number of deaths observed. Unfortunately these results, as the authors acknowledge, are not conclusive because of the small number of subjects available to be studied.

To further put this trace contaminant TCDD in perspective, the incident at Seveso, Italy is summarized. As a result of an industrial accident on July 10, 1976 at Seveso, approximately 37,000 people living in an area of about 6 square miles were exposed to varying amounts of TCDD (27). Estimates of the total quantity of TCDD that was released into the atmosphere vary, from 1.5 to 3.7 pounds. CAST estimated there is only one ounce of TCDD in all the 2,4,5-T used each year in the entire United States. This unfortunate incident at Seveso was unrelated to 2,4,5-T or its manufacture but this accident continues to provide useful information on the toxicity of TCDD to humans.

It is important to consider that the people of Seveso were exposed to thousands of times more TCDD than they would ever get from an accidental exposure to an application of 2,4,5-T for an agricultural use. Seveso and the entire region has been under medical surveillance since the accident. Technical specialists in many fields including statisticians, sociologists, epidemiologists, biochemists, pathologists, pediatricians, dermatologists, obstetricians, and neurologists, have been involved in studing possible health effects on this population.

From such industrial accidents it appears that TCDD is less toxic to humans than would be expected from the animal toxicological data. Although the people at Seveso were exposed to extremely high concentrations of TCDD, no serious medical problems have been identified except the skin disorder, chloracne. A report (28), approximately 3 years after the accident, states that nearly all the chloracne has healed. No spontaneous abortions, fetal malformations, neurological or psychological changes, unfavorable immunoresponses, or other various problems have been attributed to TCDD. This information is strong evident that TCDD when present as a trace contaminant in 2,4,5-T presents no unreasonable hazard to human health.

Dispute Resolution Conference

Another group of scientists carefully studied the scientific data known about 2,4,5-T and its trace contaminant TCDD at the Dispute Resolution Conference (29) in Arlington, Virginia near Washington, D.C. in 1979. These experts came to several conclusions which address the potential effect of 2,4,5-T on human health. Some of their conclusions are: "2,4,5-T is not a carcinogen nor mutagen in animal test systems studied to date." "Phenoxy herbicides containing TCDD have not been shown to be carcinogenic in humans in retrospective epidemiologic studies to date."

"In studies conducted in rats and monkeys, the apparent no-effect level in rats (for TCDD) was 0.001 μg/kg/day; a level of 10X below the demonstrated no-effect level in Rhesus monkeys." This means rats are ten times more sensitive to TCDD than monkeys.

"Analysis of the available data[1] leads this group to the conclusion that no adverse effects on human reproduction have yet been demonstrated after exposure to 2,4,5-T or TCDD."

Genetic Concerns

Data from *in vivo* mammalian tests for possible germ cell mutations are best for predicting genetic risk to humans. Such tests to date show there have been no mutagenic effects of 2,4,5-T in mammals. Chromosomal studies (30) have been made in humans at Seveso, Italy who had been exposed to high concentrations of TCDD. This exposure was thousands of times higher than the actual exposure from herbicidal applications as used in the United States. The Seveso population have shown no evidence of chromosome abnormalities due to TCDD.

Three-generation reproduction studies with 2,4,5-T (31) as well as with TCDD alone have shown that these elements are not mutagenic in mammals (32). In addition, a chromosomal study (33) done on workers at one 2,4,5-T manufacturing plant in the United States showed no chromosomal abnormalities in the exposed work force. This is strong evidence as to its nontoxicity from a genetic viewpoint.

A unique one square mile (640 acres) test site at the Elgin Air Force Base, Florida, was sprayed over an eight-year period with thousands of pounds of 2,4,5-T with its trace contaminant TCDD (34). One test site in this area received 947 pounds per acre of 2,4,5-T between 1962 and 1964 with a formulation that contained approximately 33 ppm TCDD. This test gives results obtained under unusually extreme conditions that would never be reached in actual practice. The highest use rate currently for Dow's 2,4,5-T product, ESTERON 245 Herbicide containing less than 0.1 ppm TCDD, is 16 pounds in 3 to 100 gallons of diluent applied to the basal stems and stumps of brush. This is a spot treatment and not an overall per acre treatment. Furthermore, it is not an annual application. The usual overall treatment is one-half to two pounds per acre and, except for rice, such treatment would not be applied annually. Range applications are made only once every three to five years. Forests are treated once or twice during their life span.

This area at Elgin has been the subject of an intensive ecological study of plant and animal life. The beach mouse, *Peromyscus polionotus*, one of the major inhabitants of the area, was thoroughly studied. There was no gross or histological evidence of any cardinogenic or teratogenic effect in adults or fetuses. The area originally defoliated after the application of this tremendous quantity of 2,4,5-T is now covered with vegetation going through the normal succession stages for the area.

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[1]Data from the United States, Sweden, New Zealand, Australia, Vietnam and Italy were studied.

Species diversity and food chain studies showed no significant differences from the untreated area.

This ecological study (35) on 2,4,5-T has clearly shown that there were no permanent harmful effects to wildlife forms and flora of the region even when tremendously excessive amounts of 2,4,5-T containing very large amounts of TCDD (33 ppm) were applied.

The National Academy of Sciences (NAS) offers another noteworthy study of the uses of 2,4,5-T in Vietnam (36). Also remember that the application rate of Herbicide Orange in Vietnam was approximately 26 pounds per acre of a mixture of 2,4-D and 2,4,5-T. This application was a much higher rate than would be encountered during normal agricultural uses. Their conclusions varied greatly from many sensational news articles that have appeared and still occasionally appear on this subject. NAS concluded that crops could be planted within one year or less from the last spraying (1971). They also point out there has been significant reforestation. It was specifically noted that much of the necessary reforestation was due to causes other than war. NAS concluded the sprayed forests would eventually be restored to productive levels if proper reforestation practices were followed.

Thus there is substantial evidence that no ecological problems have developed or will develop from the commercial use of 2,4,5-T with its trace contaminant TCDD.

2,4,5-T Use History

How safe has 2,4,5-T really been when used for a long time? Manufacturers know a variant of Murphy's law should be: If a product can be made to cause a problem, the public will find the way to make it happen. Therefore, the record of public usage can be important in judging the safety of a product. Two states which have used 2,4,5-T extensively have studied the herbicide's safety record.

The California Department of Food and Agriculture completed a detailed study April 6, 1978 on the aerial application of phenoxy herbicides in California (37). Public hearings were also held on this subject. 2,4,5-T and 2,4,-D have been in use in this state for 25 years. In their summary it was stated:

"At the public hearings, allegations were made concerning gross, readily apparent effects of the herbicides, and these alleged gross effects were the target of a subsequent investigation by the Phenoxy Herbicide Investigation Team. None of these effects, such as human illness, animal deaths or deformities, plant damage, or environmental damage, could be attributed to or associated with spraying of phenoxy herbicides. Similarly, no substantiation could be provided for any correlation between geographical locations of residents in relationship to the spray site and the etiology of disease. Examination of pesticide illness reports from California physicians by this Department have not revealed any signficant health hazards that can be attributed to the phenoxy herbicides as used today in California."

Texas is the state where the most 2,4,5-T has been used. Therefore, it is an excellent area to consider when studying the safety question of 2,4,5-T. Further, 82% of all the rangeland and pasture acreage treated with 2,4,5-T is in Texas and it is the largest producer of beef cattle in the United States. Comments of Texas Agricultural Authorities (38) on the safety of 2,4,5-T to humans and animals are extremely pertinent. Their comments on this subject are quoted in their entirety:

"The chemical has been used in Texas since 1949-1978 (29 years). In this span of years, approximately 50,000,000 acres have been treated, with many areas of land receiving 3 to 5 applications. To date there has not been a single lawsuit because of attributed health damage to man or animal. There have been lawsuits on damage to vegetation outside of target area. Percentage of calf, lamb and kid crop is up in Texas. There are less deformities in newborn animals than in the history of the livestock industry. The cause of practically all deformities has been traced to plants that historically cause deformities to fetuses."

The Texas and California summations of their experiences is convincing evidence that in the real world 2,4,5-T with its trace contaminant TCDD is safe for humans and the environment.

Independent Risk Assessment of 2,4,5-T

Another independent group of scientists have recently reviewed the scientific data pertaining to the safety of 2,4,5-T. The Scientific Advisory Panel (SAP) consisting of seven members was authorized by Congress in FIFRA to advise EPA on scientific questions related to suspension or cancellation actions or any new proposed regulations of EPA. The SAP is particularly concerned with the effect of EPA's proposed actions on human health and the environment.

The SAP on September 26, 1979 issued their review of EPA's proposed notice of intent to hold a hearing on the presently non-suspended uses of 2,4,5-T and silvex. The Panel's initial recommendation stated:

"The Scientific Advisory Panel recommends that the Agency not hold such a meeting at this time. After extensive review of the data we find no evidence of an immediate or substantial hazard to human health or to the environment associated with the use of 2,4,5-T or silvex on rice, rangeland, orchards, sugarcane, and non-crop uses specified in the decision documents." (39)

This reference pertains to the present non-suspended uses of 2,4,5-T and silvex. But recognize that the Scientific Advisory Panel's safety evaluation of 2,4,5-T with its trace contaminant TCDD would also apply to the presently suspended uses of 2,4,5-T.

Conclusions

In summary, there is a tremendous volume of scientific information available on 2,4,5-T. This herbicide has been the subject of many carefully controlled toxicological experiments, perhaps more than any other pesticide on the market today. The known scientific data about this chemical, combined with a 30 year history of safe use, fully support these following conclusions: 2,4,5-T is a safe, efficient, and selective herbicide to control weeds and brush and its use has not caused cancer, birth defects, or miscarriages. 2,4,5-T with its trace contaminant TCDD can be and has been used safely and effectively without harm to people, animals, or the environment.

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COMPUTERIZED COLLECTION AND PROCESSING OF FIELD PLOT DATA

Lee Torgerson[1]

Abstract: The Datamyte 900 and Datamyte 1000 portable, battery powered data collectors are described for use in gathering field plot or greenhouse data. The Datamyte is used to replace the field book and pencil method of collecting data. The advantage of using the Datamyte is that the data are stored in computer format ready for immediate transmission to your computer system. This eliminates manual transcription and keypunching of the data. Results can be obtained immediately and errors can be minimized by using the Datamyte. Details of the system were presented along with examples of data collection techniques.

[1]Datamyte Sales, Electro/General Corporation, 14960 Industrial Rd, Minnetonka, MN 55343.

HOW TO GET BETTER UNDERSTANDING AND HELP FROM THE NEWS MEDIA

Ken Byerly[1]

The opening paragraphs of a letter I received from L.E. Warren, your President-Elect and Program Chairman for this meeting, read as follows:

"We appreciate," he wrote, "your willingness to give us in the Western Society of Weed Science some advice on how to get some truths and perspectives, especially on herbicides and agriculture, through the media.

"It has become become painfully evident that a number of reporters and some editors present very one-sided, adverse reports on these subjects. Of course TV 'news' and documentary reports are also very uncomplimentary.

"We need to know what procedures we can use to change impressions of laymen, legislators and regulators, and consumers, especially in population centers. The media has a large amount of influence in these groups," your President-Elect concluded.

This a large order. I must say right off the bat that there is no sure-fire, ironclad way to accomplish these things as there are a few--very few, but some--media people whose minds are made up and don't want to be "confused by facts."

There are a few--again, very few--who lean toward sensationalism.

There are media people too who have been misled on the facts by some very convincing people and organizations. This has happened to all of us with the media at times. So it is very important that you give news people the facts when this occurs.

But--and please hear me clearly on this--the vast majority of media people with newspapers, radio and television are decent men and women who work hard at being fair and honest reporters.

You can and should work with such people. You can usually obtain better understanding and help from them as a result, and from the media they represent.

But first, you may get the impression now that I am wandering a bit. Not so. I shall use incidents to illustrate how most news people think and operate.

After all, if you hope to get a better understanding and break from news people, it is important that you understand these people... their problems and how they think.

[1]Publisher, Lewistown (Montana) News-Argus; Professor Emeritus, School of Journalism, University of North Carolina.

I'm a nespaperman so shall talk mostly about newspapers and newspaper people. But people are much the same and the basic principles I discuss usually apply also to those in radio and television. They also apply to a surprising degree when you are working with legislators. I'm a former legislator and can say from experience that this is so.

The news media do have great power as your program chairman mentioned in his letter to me.

This was impressed on me forcefully way back in 1948 when the late Senator Alben Barkley of Kentucky was a candidate for Vice President of the United States as Harry Truman's running mate.

He arrived in Lewistown just before a luncheon rally. I learned that he would talk from notes rather than a written speech.

"We publish this afternoon," I told him. "I can pick up your speech as you go along, but you'll finish just before your deadline. So I won't be able to give it the play it deserves. Could you give me the main points now so that I may go back and write my story?"

He did in detail, but many people were kept waiting for him. I was embarrassed and said so.

"Don't apologize to me," said Senator Barkley. "I'm here to get publicity for Harry Truman as a candidate for President of the United States, myself as his running mate and for Montana Democrats who are running for Congress and state offices.

"You and your newspaper can give this publicity to us. So I'm not doing you a favor when I take time to give you this information. You are doing me and my party the favor. I'm the one who should be grateful."

Senator Barley was right, but how many politicians would have said this?

Our ability as newsmen to decide how and what and how much or how little we will or will not report in our newspapers give us tremendous power. But this is no reason for us to beat our chests and shout of our might as did Tarzan of the Apes.

It is reason instead why we with the news media should be humble, using power that is ours with decency, judgement and kindliness... using it instead to inform and help our readers.

I believe this deeply, and so do most other mewmen and women. This is important to you because it gives you a better chance to get your story before the public if--and this is a vital if--if you approach these media people properly. And approach them you should when your story has been told incorrectly, or inadequately.

Not enough of this is done.

I was teaching journalism at the University of North Carolina when high schools in the three largest cities of the state were integrated many years ago. They were the first in North Carolina.

The reporter from a leading New York daily who covered this was a friend of mine.

He wrote many stories before the big day came. Trouble was expected. He reported this. His paper gave it a big play. Their northern readers ate it up.

But when the day came the high schools were integrated without a single incident. It was done peacefully.

My friend thought this was a big story. It was too, and he wrote it. But his newspaper never carried a line on this.

The paper was willing to smear the South, but it said nothing in its favor when the integration went so well.

My friend was furious and rightly so. "I'm thinking of resigning," he told me.

He didn't though and I was glad as he was an excellent reporter.

This was apparently a case of intentional neglect and bias by that metropolitan newspaper.

The whole story was not told. It was unfair. It left a wrong impression. This hurt North Carolina and the South badly, just as you here today are hurt when your story is misrepresented, or not told at all when it should have been. People don't learn the facts. They are short changed.

But nothing was done to correct the unfairness of that New York newspaper in that case except for some angry letters and accusations.

If some responsible person from North Carolina--a representative of the Governor or the schools for example--had gone to the editor and other top news officials of that New York daily and laid the facts on the table this would probably have led to better breaks on other related stories in the future.

This should not have been done in anger, however.

After all most newspapers large and small, and radio and television, want to do the right thing. And they generally will if approached properly.

My wife Scottie and I spent several days recently in Communist Bulgaria. Dimitri, our young Bulgarian guide, had been indoctrinated thoroughly by the party's red teaching.

"I hear," he said to me, "that you had some trouble with the Indians at Wounded Knee." He was sneering...wanted to embarrass me.

I thought he was referring to the uprising of 1890. "That was 100 years ago," I said.

"No," Dimitri replied, "just recently."

I then realized that he was talking about the action of a few Indians in South Dakota several years ago.

"That really didn't amount to much," I told Dimitri, "but I suspect that your Communist press played it up big in an attempt to make the United States look bad."

Dimitri pondered that. All he then said was a meek, "Oh."

I don't kid myself that that little chat with Dimitri, the young and highly indoctrinated Communist, changed his attitude toward the United States, or what he says about it.

But, in most cases here in America you'll get a better break with the media if you approach them properly, and with facts.

There is ignorance at times in reporting because the men or women who write the stories haven't taken the time and trouble to check the facts, are biased, or just don't know.

For example, a reporter from back East who worked for one of our major Montana dailies insisted in his stories that coyotes don't kill sheep.

A sheepman in our area who lost 20 sheep the next night to coyotes was furious with the reporter. He didn't argue with him--just sent the reporter one of the sheep that had been savagely mutilated.

It was a good stunt, and helped.

But it would have been much more effective if he, or several sheepmen, had brought that mutiliated carcass to the editor and other key news officials of that paper and said, in effect, "Look, this is what we are up against."

They should be armed too with facts on other examples of attacks by coyotes, and what they cost the sheepmen in losses.

Chances are good that that newspaper would have a more understanding approach when reporting other incidents involving coyotes.

Let's now talk editorials for a moment.

A newspaper should have a strong editorial policy. However, judgment is very important in this. It is my belief that some of our best editorials are ones that we don't publish or even write.

I'll illustrate by telling about a community where resentment smouldered several years ago among some against an excellent Catholic hospital.

"Emergency patients who need a doctor are usually assigned Catholic ones," some Protestant physicians claimed. "We are entitled to an even break."

Some Protestant preachers asserted that it is "hard for us to see patients except during certain hours, but a priest sees them at any time."

Those doctors and preachers pressed the town's editor, a Protestant, to urge editorially that a second hospital be build. He knew that would stir up religious prejudices. He felt too that there was no need for a second costly hospital.

So he went quietly to the local priest and said, "Father, I may not belong here, but we have a problem." He told of the complaints he was getting, but named no names.

The priest thought it over. "Your reason for coming here is good," he said. "Maybe I can do something."

Apparently he did as complaints to the editor soon ended.

Many readers would have lauded the editor as "courageous" if he had written strong editorials. But the wounds opened would have festered for years and nothing really worthwhile would have been accomplished.

I believe that we newspaper people should act in ways that will do the most good for the greatest number of people in most cases rather than just trying to show how smart and brave we are.

Don't misunderstand me. Courage is a must for newspaper people and I have great admiration for those who demonstrate it. But courage without judgment can be a dangerous and even an evil thing.

And there are editorials that we should write even though they may anger or hurt some people.

Again, what I am trying to stress in telling this story, is the great importance of your going to the news media when you are in trouble, or think that trouble may be ahead. Throw your problems into their laps. Give them the facts. Just sending a release isn't enough.

Now, what else can you in the Western Society of Weed Science do to get better understanding and coverage from the news media that you so often need badly?

I'm talking now about television, radio and newspapers...newspapers from large cities and down to your local weeklies.

As already said, there is no magic formula. But there is much you can do that will help--not with all media, but with most.

First, your work is important. You, for example, are helping agriculture. So you are helping feed Americans, and others in many parts of the world. You help protect and develop our forests, among other things, and play a key role in making them flourish.

This is very important. You're needed. This is a key start.

When at the University of North Carolina I went to the School of Public Health every year to talk to doctors, dentists, nurses and others who were taking advanced or refresher courses.

My job was to discuss ways that the health professions could get along better with the news media--how they could get better news coverage when they deserved it.

It was a revealing experience...pleasant too as it was there that I met my wife Scottie. She was a professor in the School of Public Health.

My approach the first year started like this:

"Half of you in this room probably hate the guts of newspapermen," I said. "Some of you tolerate them as a necessarily evil and a few of you may actually like and understand newspaper people."

A doctor jumped to his feet.

"You're wrong," he said, "if you think half of us hate the guts of newspaper people, We all do!"

He was about right in those days. Fortunately that feeling has been breaking down slowly through the years. The news media and those in health fields often work together now on many things as it is to their mutual benefit.

There are ways that you here in this room can also do this in your important work.

I'll illistrate by recalling a meeting of the American Medical Association's Public Relations Institute in Chicago a few years ago.

There were about 500 doctors there from the 50 states. They wanted to know, as do you, how they could get along better with the news media. They were fiesty with a "show me" attitude.

What I suggested to them then applies also to your problems in weed science.

"Here are tips on gaining the added help from the media that can mean much to you," I told the doctors. They can help you too who are here today, so I'll now quote in part from my talk to the doctors.

"Remember that men and women with newspapers, radio and television are like people everywhere," I said. "They have the same pride, suspicions, ego, hopes and desire to serve. So follow the Golden Rule when dealing with them, 'Do unto others as you would have others do unto you.'

"Our big trouble--yours and mine, medicine and the media--is that we often really don't know each other. Will Rogers once said, 'I've never known a man I didn't like.' So let's know each other.

"We can learn from French women on this. I'm told they make the best wives--not because they are prettier, better cooks, sexier or better with children, but because they understand their husbands and their problems.

"I don't mean you should grovel to newsmen or scratch their backs. But if you understand them, and give them a chance to understand you, they can and in most cases will do a better and more sympathetic job for you.

"Remember though that newspapers are besieged," I told the doctors. "They could fill their papers with the copy that comes in via mail. Scores more telephone or come personally with items that they think are important, and often are.

"So you have stiff competition. It's like the shepherd who cried 'wolf.' Newsmen hear it so often they may overlook the real thing when it comes along, and yours often is the real thing.

"So talk to your publisher, editor or reporter, and to newsmen in radio and TV.

Ask their advice on what you should do to better tell your story. Be sincere in this as they can help, and usually will when asked.

"Don't take it for granted that they know what you are doing. They often don't. This is reason why it sometimes pays to go the news people before you start a new program so that you can give them the 'why,' and what it will do for people, instead of waiting until later when you may be in trouble.

"DON'T assume that they understand and appreciate what you are doing. How can they if they don't know what it is all about?

"DON'T insist on the use of technical language in your news as most readers and listeners won't understand it, so what good is it to you.

'Write it in cowboy language,' I used to tell my students.

"And above all, DON'T have a chip on your shoulder.

"You must impress news people. EXPAIN. Be patient.

"But don't take 60 minutes to tell them what you should in six.

"Don't give them a lot of guff and hot air.

"And please don't just growl about news people and say they are against you. Most of them aren't. But they must know about your programs and problems if they are to report them accurately, or at all.

"You," I also told the doctors, "may have reason to lack confidence in some reporters...fear that they may embarrass you through careless reporting. This is another reason to talk to media people.

"I learned early that doors open wider on touchy and technical stories when I say first to a physician or others, 'May I check my story with you before running it to make sure there are no mistakes?'

"If a reporter says this to you, don't try to rewrite his story as he will quite rightly resent it. Check it for technical accuracy only.

"If you are worried and a reporter makes no such offer, there is no harm in suggesting tactfully that the subject is 'complicated and technical, so call me if you wish after you have written it, and I may be able to help us both.' I've been helped many times by this.

"Be particularly careful and tactful if suggesting this to young reporters as they are often less understanding.

"Lawyers have a saying," I told the doctors, "that a man who acts as his own counsel in court has a fool for a lawyer.

"This might be paraphrased: 'A physician who handles his own news releases has a quack for a public relations man.'

"I don't mean this in most cases, but do stress emphatically the importance of getting help and advice...of talking things over with your publisher, editor or reporter, and with people from other media. They can and almost always will help if approached properly.

"And don't forget the French wives who understand their husbands. Try to understand the problems of the media. Try to help.

"The results can surprise you," I concluded to the doctors. "You'll usually get help and understanding in return that can be vital to you in your work."

Much that I suggested to the doctors can also help you in weed science.

Go to your news people at all levels. Tell them your problems...your programs and what they are designed to do for people.

I now close with a final story--a true one that may also help you in your understanding and working with the media.

It is about an old cowpuncher known affectionately as "Post Hole" Jones who died more than 40 years ago at Thermopolis, Wyoming.

I had just bought the weekly paper there. His would be my first obituary. Writing it properly worried me so I was pleased when a local writer for western pulp magazines said, "I've known Post Hole for many years. May I write the obit?"

He did. It told how Post Hole got his nickname 50 years before when no fences broke Wyoming's endless plains. Young Jones was already known for working hard and well.

His rancher-employer was going to Cheyenne for what he thought would be three or four days.

"I want to build a fence along a line that goes just south of that distant butte," he told young Jones. "Dig post holes every 10 yeards and keep going until I get back."

There was more to do in Cheyenne than the rancher had anticipated. He stayed five weeks instead of three or four days.

"Where," he asked after he finally returned, "is young Jones?"

"I don't know," said a hand. "He rides in for supplies every week and then rides off again."

The rancher saddled up and galloped off along the endless post holes that reached to the horizon. He rode and rode. Seventy miles later, the obituary said, he found Jones--digging another post hole.

I tell this story because newspapers and reporters are pictured as rough and tough with a callous indifference to the feelings of others, and a drive for sensationalism rather than accuracy.

The image is false in most cases.

I used to ask my students if they would run this obituary if they owned my Thermolis newspaper.

Some said digging post holes for 70 miles made Jones look like a moron. But most thought differently. "It makes me like him," they would say. "Here was a hard-working man who asked no questions--just went ahead and did his job."

That was my reaction. I ran the obituary. Readers loved it. "That's good old Post Hole," they said.

My point?

Most newspapers try to avoid embarrassing anyone needlessly. I say needlessly because some stories that embarrass people must be run anyway because of their nature.

Most editors have no use for the reporter who rubs his hands and says, "I've got this guy at last. Watch me pour it on!"

He will be unfair and get himself and his newspaper in trouble.

Some may hide it under a rough veneer, but most reporters have affection and concern for people. I have never known a really good reporter who doesn't have the mild of human kindness in his heart.

So don't despair.

Most news people are pretty darn good guys and gals.

Work with them. Understand their problems, and the great majority of them will be fair and helpful to you.

Remember too that what you are doing in weed science is important to people everywhere--darn important.

So "keep chunkin'" as we used to say down South!

Dr. Newton of Oregon State expressed it tersely and beautifully in seven words this morning when he said, "Speak up! Speak kindly, and speak knowledgeably." I'll add six more words--"And speak to the right people."

EDUCATING THE PUBLIC AND THE PUBLIC EDUCATORS

Octavia Deiner[1]

I very much appreciate the opportunity to talk with you today. It is truly an honor to represent California women for agriculture at your conference and to talk with you about our successes and our industry's public relations needs.

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[1]Chairman, Speakers Bureau, California Women for Agriculture, Fresno, CA.

It is especially thrilling to talk to a group of dedicated, individualistic producers, scientists, researchers and technologists who have done so much to improve the quality of life for people everywhere--here and abroad--through your scientific advancements. Actually, it is a double honor as I earlier had the privilege of speaking to your colleagues in Sacramento in January.

Being here reminds me of a quote by Jonathon Swift in "Gullivers Travels" where he said, "Whoever could make two ears of corn or two blades of grass to grow upon a spot of ground where only one grew before would deserve better of mankind and do more essential service to his country than the whole race of politicians put together."

What this says to me is that we owe a great debt to you, the scientists, who make our lives easier and more healthful.

Therefore, I earnestly salute you for your tremendous contritutions to humankind and I hope government will get off your backs so you can continue to develop new and more effective production inputs so American agriculture can continue to lead the world in production efficiency and commodity diversity.

My purpose here today is to talk with you about the successes we in California Women for Agriculture have had in mobilizing farm women to become active in promoting our industry and improving agricultur's input.

Although we have only been in existance since 1976, we have made a tremendous impact in our state and I want to tell you about it so you, too, can tap the underutilized potentail of your farm women.

By way of background, you may recall the cannery strike we had in California in 1976. As several of us watched thousands of acres of produce rotting in the field, we became incensed and determined that it was time to mobilize our farm women to combat the public's lack of understanding on agricultural issues--such as reclamation law, farm labor, pesticides, mechanization and soon, research.

From a small group of women in several rural areas of California, we quickly grew to 30 chapters and a statewide organization of 8000 members, dedicated to improving agriculture's image.

From a group of well meaning, but woefully untrained women, we soon learned to deal with the media, mount effective grassroots lobbying and letter writing campaigns, and to develop action oriented programs to educate Californians living in urban areas.

The successes of our actions have clearly proved us to be highly successful in developing our objectives and carrying out our plan of attack --so successful that groups that thought we would fail because of our early lack of unity now seek our support and assistance.

Today we continue to be a dominant force in California's agricultural industry. Like E. F. Hutton, people listen when we speak. And, like Merrill Lynch, we deliver what we promise because we are bullish on agriculture.

Some of our most successful programs include:

1. Wormwatchers--Our own legislator monitoring program. Our CWA legislative task force compiles the voting record of our California legislators on major agricultural issues. We then send out press releases throughout California in an effort to inform the public. So successful are our efforts that several legislators have denounced us for revealing their voting records on agricultural issues. I am pleased to tell you, however, that we are still doing it--and will great success. This is an effective way of influencing legislators as Mr. Main will probably tell you.

2. Letter writing campaigns. Because of our strong organizational structure, on very short notice we can launch a letter writing campaing to flood Sacramento with our positions on agricultural issues. Our abilities here have lead some to call us the most successful grassroots lobbying force in California.

3. Educational progams. Knowing the importance of reaching those who hold such sway over our children we have an extensive educational program. It includes monitering textbooks for anti-agricultural sentiment; placing speakers in schools to talk about agriculture; providing filmstrips and teachers' guides on issues; putting together "Calle," a highly successful puppet show which extolls the good points of California agriculture. ("Calle" has visited many county fairs and classrooms throughout California); We sponsor Ag Day activities; and supply background material for teachers of grades 1 through 3.

Being a former teacher, I can assure you that this program pays great dividends and reaches far, far beyond the students and teachers.

4. Media program. Having learned that we have to get our message to the greatest numbers possible we have assiduously cultivated media coverage. We do this through local and state speakers bureau and public relations efforts.

In our short existence, we have learned that today's consumers are pretty sophisticated persons. Everyday they are bombarded with hundreds of messages--from radio, television, billboards, Beta-Max, Newsweek, to Agri-Chemical Age and the Lewistown News-Argus.

We have found that because we haven't done the best job possible communicating with these sophisticated urbanites we have to develop professional media programs that will successfully compete with all the others they hear.

Undoubtedly, you know this from hearing Mr. Beeler's and Mr. Byerly's comments earlier.

5. Other programs. In addition to these highly successful programs, we also seek to educate our urban neighbors by speaking on college campuses, testifying at legislative hearings, and sponsoring pro-agriculture displays at large gatherings, such as county fairs.

We also seek to further the cummulative effect of these programs through little things like having our checks point out that these are farm dollars, having 100% cotton stationary, and other such things.

The point is that it doesn't have to be a major grandiose scheme to be effective. The little things do count.

As you are undoubtedly well aware, California leads the nation in many areas--including a number of "weirdos" who do things like chain themselves to rocks to prevent the filling of a dam or fasting for weeks to protest allegedly "inhuman conditions in the fields" and then misusing federal grants given to alleviate the alleged conditions, and rock singer first ladies.

This is significant because the things that happen in California very often start a trend and soon thereafter, affect other states.

Therefore, it is certainly not too soon to start your own educational programs in your own states to head off resulting problems. For instance, you are probably aware of recent regulations adopted in California concerning pesticide regulations. Can your own state be far behind?

While the problems faced by many of the states that are represented here today may vary considerably, there is a common thread--and I would like to challenge you with a uniform solution.

I urge you to start now to develop your own educational program and you can begin by drawing upon the vast, hidden, unutilized talents of your farm women, just as we did.

As you get the ball rolling, I am sure you will realize there are four elements you will need to be succussful--the 4 C's.

1. Communication. Tell your story to your city cousins, but tell it in terms of *their* own self interests, rather than how it will affect you.

Also learn to cultivate the media. Agriculture is a newsworthy subject because it directly affects the quality of life on a daily basis in many ways.

2. Cooperation. Learn to use the strengths of your various agricultural associations. By unifying and rallying around your commonalities, your voice and impact will be much greater, than if you merely to it alone.

3. Contribution. Modifying public attitudes is a big job and will require your resources. To do the job right, you will have to contribute your time, talents, energy and yes!!! your money, too!

The investment will pay big dividents--now and in the future.

4. Confidence. While it seems to be an insurmountable task, have hope. Just remember: If a group of farm women, untrained in politics and public relations, such as California Women for Agriculture, can become such a success in a short period of time, just think what you can do; If we can do it, I know you can.

You don't have to be told that our farmers spare little expense in producing food and fiber. They know it takes the proper combination of inputs--soil, water, fertilizers, pesticides, labor and management to optimize their yields. They know it takes resources to do this.

It is time we applied the same logic to the fertile field of public opinion and education about agriculture.

Therefore, I challenge you to get on the move and mobilize your own resources, in your own communities, to speak out for agriculture.

If we in California Women for Agriculture can help, just let us know. After all, its united we stand and divided we fall.

Thank you very much for the opportunity to speak with you. It has been an enjoyably time. I wish you great success as you develop your own programs to educate the public and the public educators.

THE "SOFT" ENERGY TECHNOLOGIES

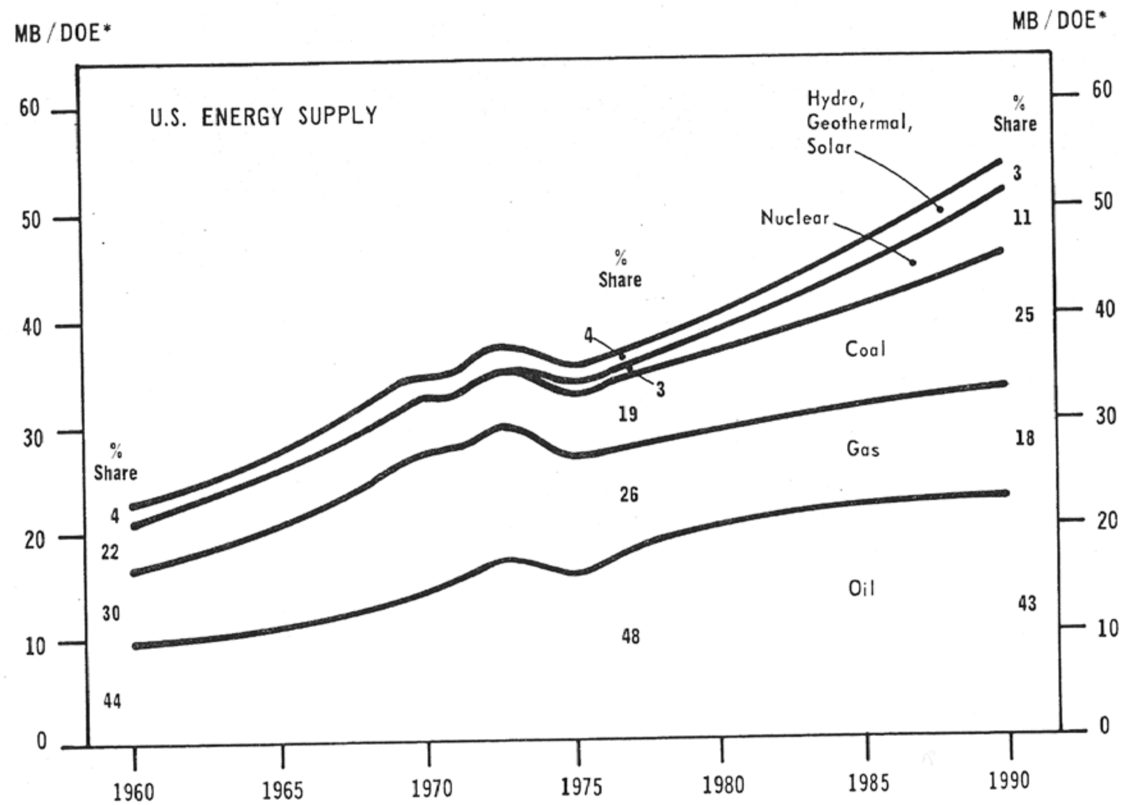
John D. Kemper[1]

First, I would like to set the scene briefly to give an over-all picture of the energy situation. Then we should get as quickly as we can to the more interesting kinds of things to talk about, such as the so-called "soft" energy technologies which are being offered as alternatives to nuclear energy these days.

First of all, in Figure 1, we can see our energy pricipally comes from oil, gas, and coal--mostly form oil. The proportion shown for nuclear energy is not very large and it probably is not going to expand very much. The proportion to come from all the "soft" technologies such as solar and biomass, plus geothermal and hydropower, is shown by the narrow band at the top.

In Figure 2, we can see where our energy goes. Whenever there is an energy crisis, the first thing the government seems to think about is

[1]Dean, College of Engineering, University of California, Davis.



*Million Barrels Day Oil Equivalent

Source: Exxon Co., U.S.A.

Figure 1

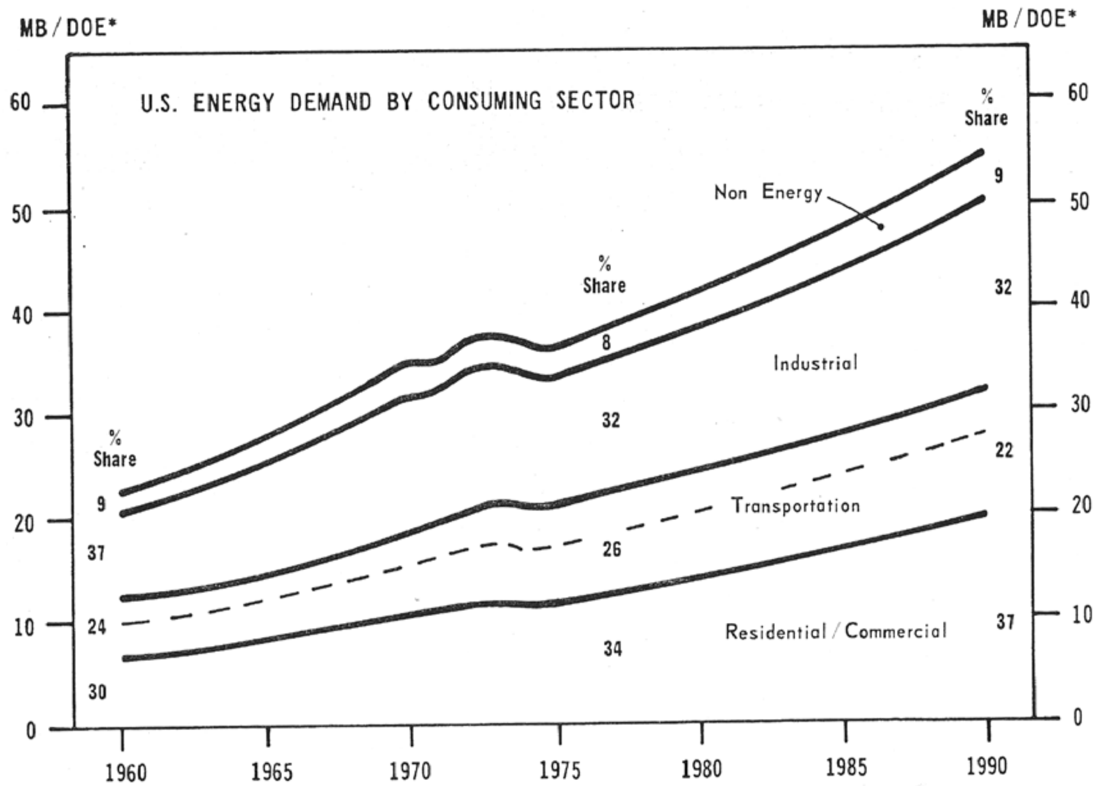
gasoline rationing, as if automobiles are the principal things which are consuming our energy. The fact is that automobiles only account for a portion of the band labelled "Transportation," up to the dotted line, or about 15% of our total energy use. The rest of the transportation energy goes to railroads, to steamships, airlines, and so on. One of the most important things to gain from this particular figure is the large proportion of energy which goes into the industrial sector. Later on, when I talk about conservation, I am going to recall to your mind the fact that industrial use of energy is a very large part of our total usuage. The narrow portion at the top of Figure 2 is the part which goes into non-energy uses, the making of plastics and things of that sort.

It is no news to people these days that U.S. oil production is declining, as is shown in Figure 3. In this particular case the reference used is 1976, but in 1980 things haven't changed very much, except that the band which shows the known, proved reserves in the U.S. is a smaller proportion than it was in 1976, because it is true that we are discovering less oil than we are producing each year. The black portion is the amount that we have already used. In the first half of this century, oil usage expanded rapidly, but the situation has not gotten to the point where additional supplies are becoming harder and harder to find. In the figure, the white portions shows that there is an expectation of a considerable amount of oil still to be discovered, yet the rate of production continues to decline, because it gets harder and harder to find and produce new oil.

The situation in the world is similar, of course, as is shown in Figure 4, except that we are somewhat earlier on the curve than we are in U.S. oil production. The black part again shows the amount produced already, and the shaded part shows the amount of world proved reserves. According to this particular chart, if we continued to produce as fast as the oil resources were capable of, why around the year 2000 we would get to the point where resistance would begin to develop, resistance in the sense that it would be more difficult to find new supplies. In the case of world oil supply, however, we find something else is coming in other than the simple capacity of the resource to produce, and that is political resistance. Some countries are deciding that they simply don't want to produce as fast as the rate at which their fields might be capable of. Their view is, why should they hurry up and get rid of the resource which is the only present source of their wealth? As a consequence, world oil supplies are coming into stress earlier than might be supposed, simply from looking at this chart alone.

The situation in coal is quite different, as is shown in Figure 5. For one thing, the time base along the bottom is quite different than it was in the earlier charts. The earlier charts went out to about the year 2040, but this chart goes out to the year 2400. The amount of coal in the world is simply enormous and the amount that we have used of that coal is realatively small. It is clear that coal is one of the principal resources we are going to have to depend upon in the future.

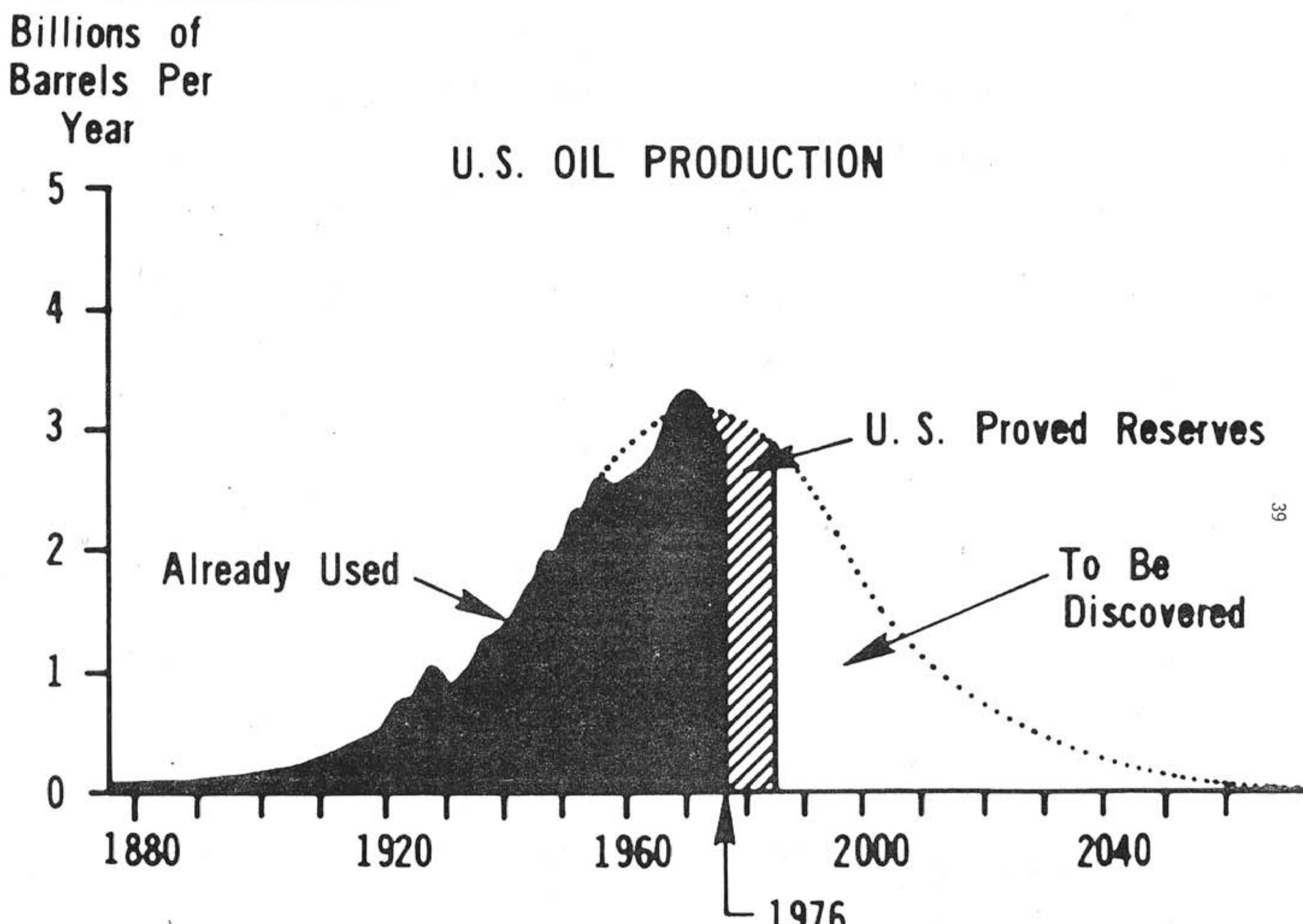
Who has the coal in the world? Looking at Figure 6, it appears that Russia, principally Siberia, has most of the coal reserves. The United States' reserves are very, very large and this can be put into perspective by observing the part of the chart on the right which shows Western Europe. Western Europe began before anyone else to use coal in significant quantities and it depended upon coal for a long time. Western Europe still has lot of coal left, yet it looks like the smallest of the resources in the world. When viewed in that light, the amount of coal in the United States in truly enormous.



*Million Barrels Day Oil Equivalent

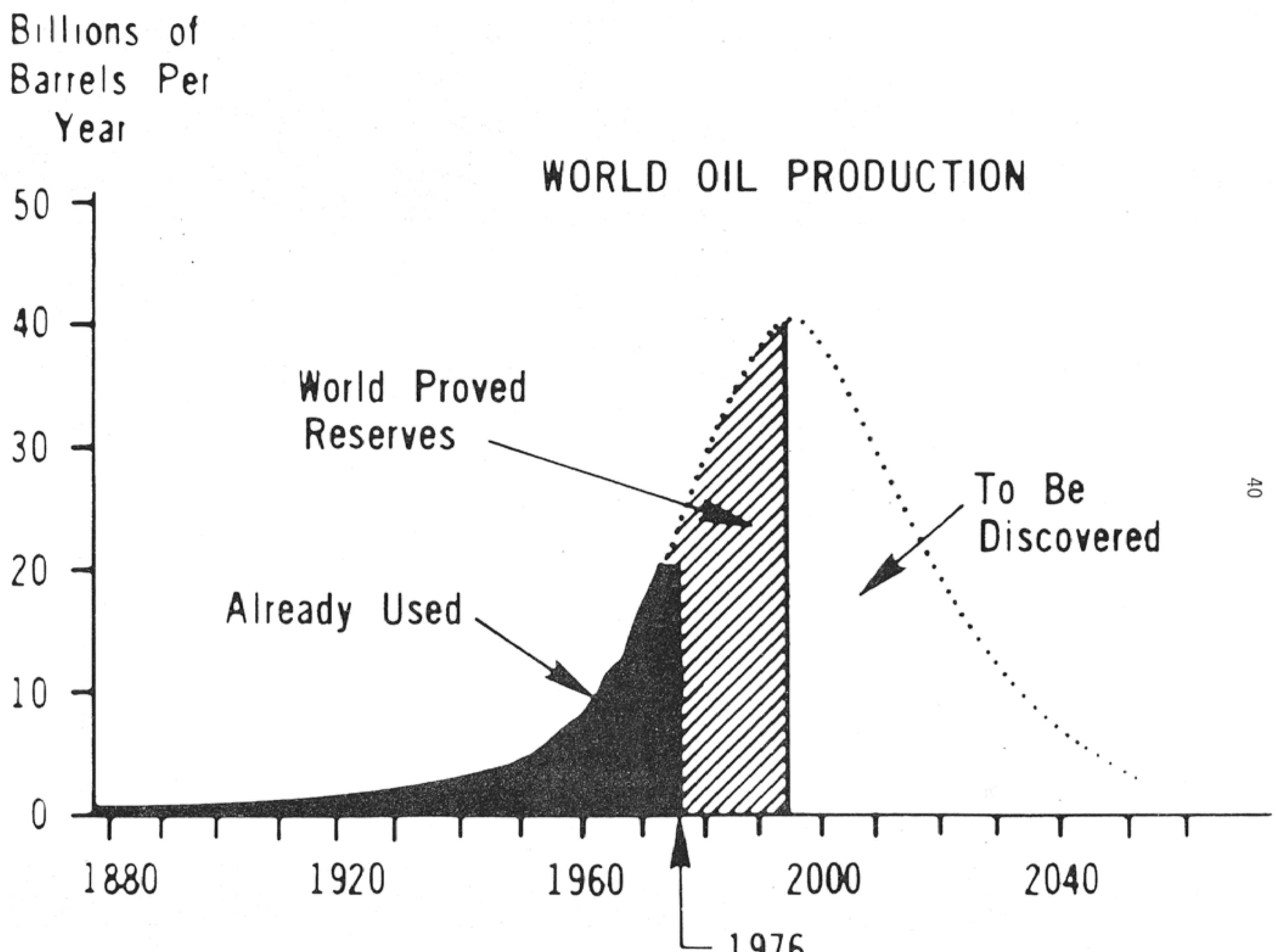
Source: Exxon Co., U.S.A.

Figure 2



Source M K. Hubbert

Figure 3



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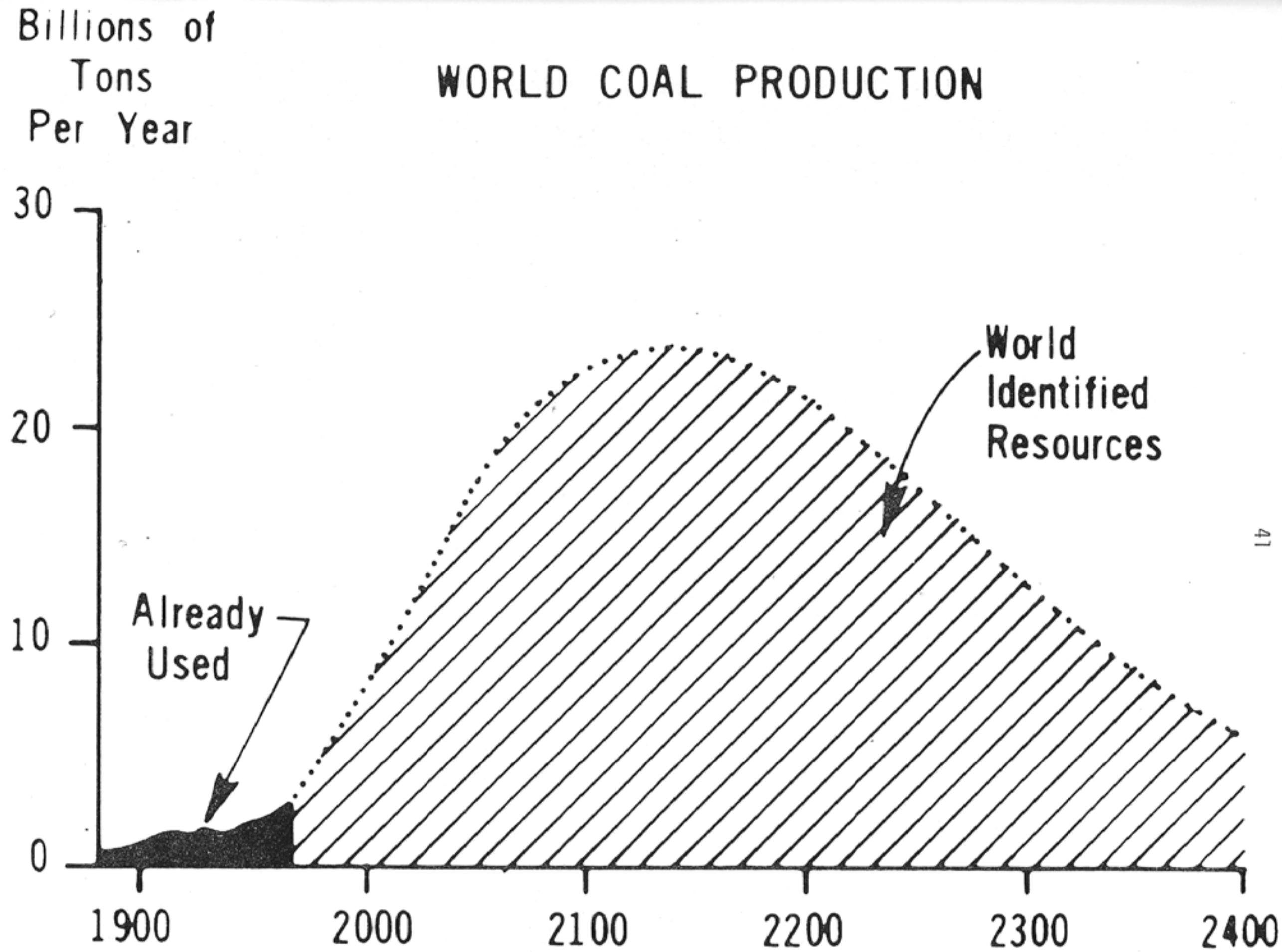

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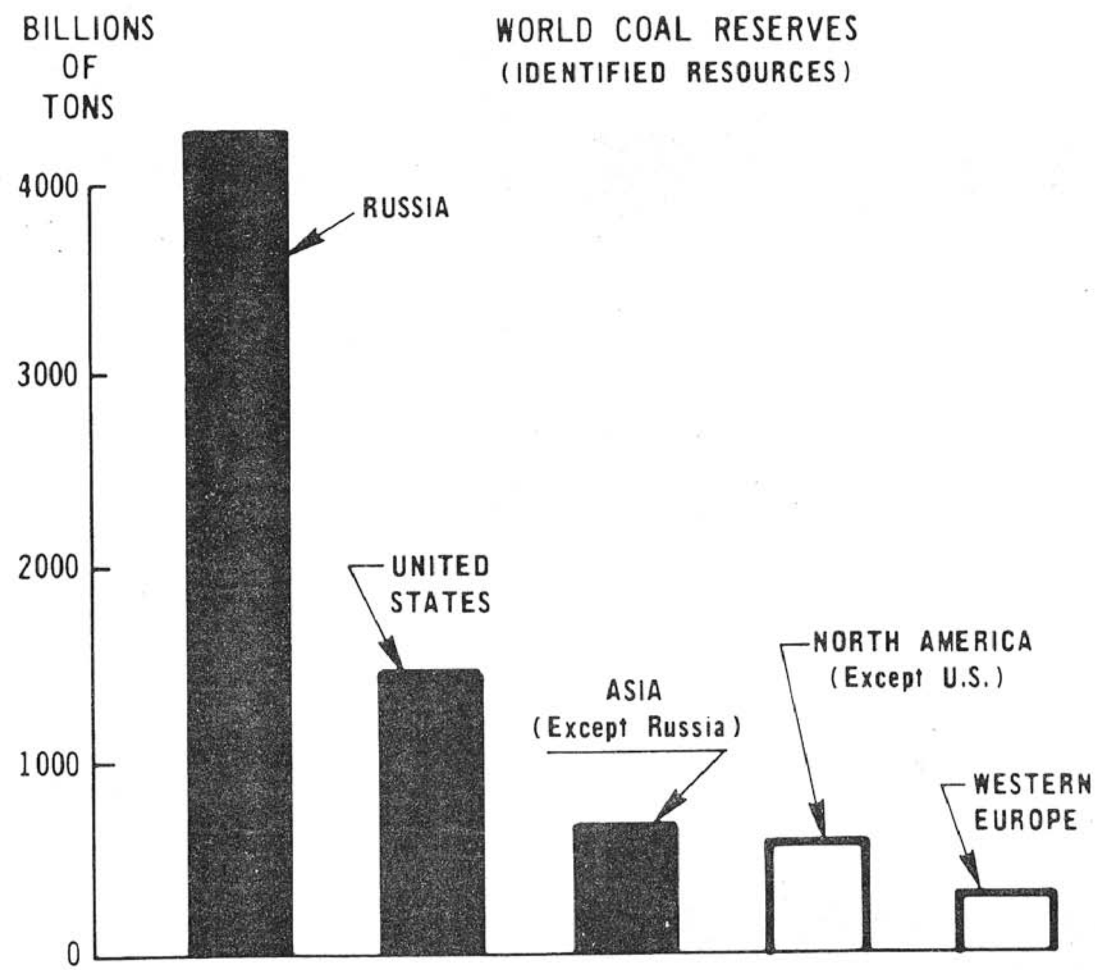
Figure 5


WORLD COAL RESERVES
(IDENTIFIED RESOURCES)
BILLIONS OF TONS
4000
3000
2000
1000
0
RUSSIA
UNITED STATES
ASIA (Except Russia)
NORTH AMERICA (Except U.S.)
WESTERN EUROPE

That gives a bit of the general energy background. Let's go now to the question of the "soft" technologies, skipping nuclear energy and the environmental consequences of coal usage, which are major topics in themselves.

What *are* the "soft" technologies? The principal one, of course, is the sun--solar energy. The other soft technologies are wind, biomass, energy from wastes, geothermal, hydropower, and probably the most important one of all, conservation. Too many people are making broad statements to the effect that our salvation lies in employment of the soft technologies. Let's see what some of the facts are.

Science magazine published an article recently which contained a careful economic analysis of the pay-back period for solar energy, including federal tax credits, for four locations in the United States (1). In Washington, D.C., for example, it was shown that by comparison to the cost of natural gas, if you were going to supply your hot water needs from solar energy it would take 22 years to get your investment back. If you compared against the cost of electricity, it would still take 13 years for pay-back. In Los Angeles, it would take 9-11 years for pay-back when compared to the cost of electricity, and 23-24 years when compared to the cost of natural gas, which is the most commonly used fuel in Los Angeles. The big issue is, will your solar energy system last for 20, 13, or even 9 years without additional cost? I'm afraid there is a great deal of extravagant economic information being purveyed in the newspapers about solar energy as it currently stands.

Another point which is not generally recognized is that the full savings from solar energy, calculated on the usual basis, may not be available. To illustrate this, suppose that everyone in the United States was on solar. Nevertheless, they would all have to be connected to the usual utility systems, such as the electricity grid, because there are always protracted stormy periods, covering large regions, when the solar systems do not function. This means the entire electric grid has to be in place, as large as ever, ready to be brought into action at peak capacity on short notice. The users would have to pay for the capital amortization of the power plants, and the standby costs of the utility personnel, even though they would use only a fraction of the power they once did. This means that the unit cost would have to rise significantly, and the full supposed savings would not be available, because duplicate energy facilities would have to be kept available at all times. Now, in practice, the situation would not be as dramatic as this. Only a portion of our energy appears in electric form, and, besides, much standby energy would be storable in the form of fuel oil. Furthermore, solar would not completely displace all other forms of energy, so there would be a considerable base load for the utilities. Nevertheless, it is the innate nature of solar power to be unavailable when it needed most, i.e., during protracted cold, stormy periods, so the perennial "peaking power" problem of the utilities would be exacerbated by the widespread adoption of solar energy. Such a condition will force up the price of alternate power, wishful thinking notwithstanding. This means that solar power systems must be very inexpensive in order to be practical; otherwise, the capital investment is doubled--once for the solar system, and once for the standby peaking power system.

Nevertheless, in my own opinion, there is a very great potential for solar energy for the future, specifically in the area of direct energy conversion from sunlight to electricity, through photovoltaics. There is considerable research going on presently in this area. If is widely believed that this is going to lead to major cost breakthroughs in the next few years, which will really make solar energy practical in the economic sense.

The basic question for solar energy is: Can solar systems replace themselves? Whenever you build any kind of a system, it takes a lot of energy to make that system, to mine the ore, to refine it, to form the materials, to assemble the systems, to transport them and so on. A lot of energy goes into the system. Once it is installed, we start getting energy back from it. How long does it take before you get as much energy back from that system as went into it in the first place? I know of only one study which has gone into this in detail, which analyzed a solar heating system at Colorado State University (2). For that system, it would take six or seven years before you got the energy back which went into the making of the system. If your solar energy system lasts longer than six or seven years, fine, you've got a net energy pay-back, but it if lasts less than six or seven years then you have a net loss.

When the topic of wind energy comes up, most people react positively. They probably tend to think in terms of farm windmills which almost everybody likes or perhaps in terms of Dutch windmills, which are universally loved. However, we have to ask ourselves the questions, why don't the Dutch use windwills for generating power today? The answer is simple. It is because they are not economic. In fact, there would be no windmills in Holland today if they hadn't been turned into historical landmarks. Well, people like windmills like the kind I mentioned, but suppose they were 300 feet tall, with propellors 360 feet in diameter? I recently saw a rough analysis of what it would take in the State of California to generate one-fifth of its power from windmills. The estimate was that it would take 25,000 to 50,000 windmills, spaced about a half mile apart, of the size I mentioned, which would cover about 10,000 to 20,000 square miles. Or, you could go to the smaller ones, 60-foot propellors on towers 50 feet high, spaced 600 feet apart. That would require 6,000,000 windmills. I think there would be strong environmental resistance to building that many windmills in places which had sufficient wind, as, for example, along the Northern California coast.

What about biomass production? This turns out to mean mostly wood. Of course, wood is a fine source of energy. It wasn't too many years ago that it was the *only* source of energy for human beings. In some countries today it is still the only source and it is becoming very scarce. One fact should stand out in our minds about wood: In Briatin in the 17th century they had to convert to coal because they were running out of wood. Nevertheless, we probably will get some significant energy production from biomass, and, in particular, from wood. Wood-burning stoves have become so popular they are in short supply. A sobering aspect is the fact that the price of wood in urban areas of the East has gone up to the point where it is essentially equal in cost to an equivalent amount of fuel oil. An excellent example of biomass utilization occurs in walnut harvesting and processing. When you have finished taking out the walnut meats you have an enormous number of walnut hulls left over. These can be converted to energy. In the case of the brewing industry there is spent grain left over which can be used for energy (although it can also be used for animal feed). In the case of lumbering, some companies have the intention to become completely energy sufficient by utilizing all of their own forest residues.

Within the category of biomass the subject of gasohol generally comes up. Gasohol seems to be very popular these days, with politicians and newspapers. Usually they are talking about converting corn to alcohol, and then mixing it with gasoline. The trouble with that is that corn is also a food. If you try to produce very large amounts of corn for fuel production, pretty soon you will run into competition for the growth of corn for food. There are also some current economic disadvantages to gasohol. To make the alcohol, first you have to ferment the grain, then you have to distill to get rid of the water. The distillation process requires heat. If you use any high grade fuel for the heat source, such as oil, it turns out that you do not get back as much energy form the alcohol as you put into distilling it. That's a net energy loss. Some have proposed that a low grade fuel, like agricultural waste, should be used. Then you are using a low grade fuel to create high grade fuel. That may make some economic sense, but only if there is no other more effective use to which that low grade fuel can be put. Others have said that research and process improvement will change the picture so that gasohol is a net energy producer. That will be fine, when that happens. Then we will only have to worry about the competition between using land for food or fuel production.

What about geothermal energy? The western part of the United States is blessed with geothermal sources, as shown in Figure 7. The round black spots are the concentrated hot water or steam sources, the dark gray areas are other hot water sources, and the light gray areas are areas of hot rock where it may be possible to recycle water down through the hot rock and get hot water back up. California is extremely fortunate because it has one of the best steam sources in the world. At the present time there is about 600 megawatts, or about half of a nuclear reactor, installed at The Geysers in Sonoma County. By 1995 it is expected that there will be about 2600 megawatts at The Geysers, or close to about three nuclear reactors in size. It has been estimated that there may be enough potential in the entire West for 20,000 to 30,000 megawatts --in other words, the equivalent of about 20 or 30 large nuclear reactors. Thus, geothermal energy is important.

Another important source of energy in the Northwest, but not for most of the country, is hydropower. In northern California about 20 percent of the capacity of Pacific Gas & Electric, for example, is hydropower. Sometimes, in years when the Northwest can export power, about 40 percent of P.G. & E.'s power may come form hydropower. But in the overall energy usage it is small, only about 1/10th quad per year in California, out of the total state usage of 5 quads (1 quad = 1 quadrillion B.t.u.'s). Also there is strong environmental resistance to hydropower. It is probably the cleanest source of power, but you do have to build big dams to get it, and environmentalists generally oppose big dams. In addition, whenever we think of the relative dangers of various energy forms, we should regard hydropower as potentially dangerous, because dams do fail from time to time.

Now we come to conservation, which is an extremely important "source" of energy. For example, in Figure 8, across the base of the chart we have energy consumption per capita. The United States is the biggest energy consumer per capita, followed by Canada. In the middle of the chart are West Germany, Sweden, and Switzerland. They use less than half as much energy per capita as the United States. The vertical part of this chart is a rough measure of standard of living: gross national product per capita. The GNP per capita of Switzerland and Sweden is at least as high as that of Canada and the United States. They have been able to achieve a standard of living equal to that of the United States, and yet use only half as much energy per capita. The question is how have

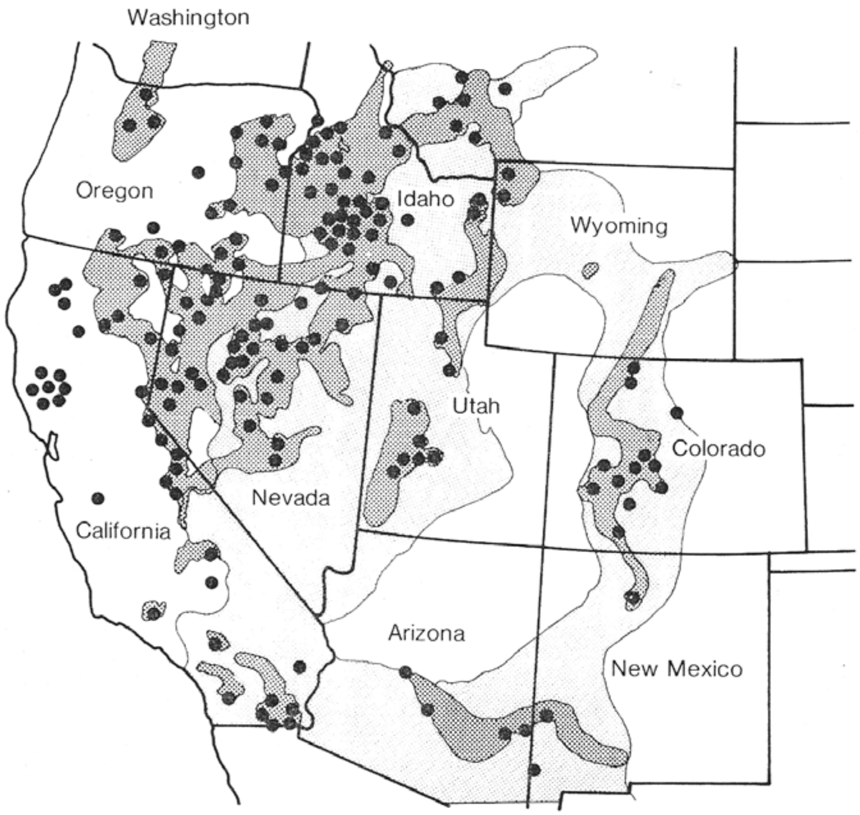
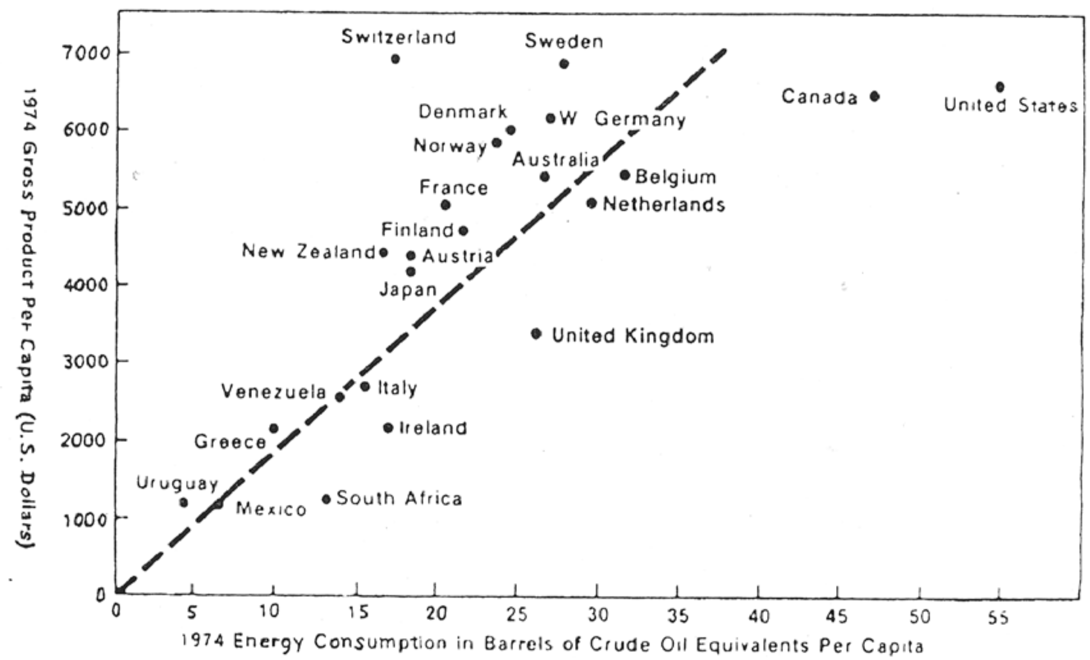


Figure 7. Geothermal energy sources in the Western United States. Round dark spots = concentrated hot water or steam sources, dark gray areas = other hot water sources, light gray areas = areas of hot rock.

Figure 8. **Energy Consumption Per Unit of GNP**



Source of Data: U N Statistical YearbooK, 1975 they done it? The first and most important answer is that the economic incentive has been there to do it. That incentive is lacking in the United States today, because there is great resistance to letting energy find its natural price. There is a desire to keep the price down by government controls, and then limit utilization by rationing, rather than to let price be the rationing mechanism. But price rationing has been very effective in European countries where energy has been expensive for a long time. Europeans have simply had no choice but to be effective in their use of energy. They have more efficient industry than we do, drive cars smaller than ours, and probably get on the average of twice the mileage per gallon that we do. They use better insulation, too. We're moving in that direction now. They also have smaller living quarters. Some people might decide that smaller living quarters means a degradation in standard of living but the Europeans do not seem to think so. Finally they utilize more efficient industrial techniques, such as co-generation of steam, which means that once you have used steam for a high-grade purpose, such as producing electric power, you use it again for lesser purposes such as space heating.

A great deal can be done by energy conservation and in fact is being done. One of the places where conservation has been most effective is in the industrial sector. That is where a major penetration can be made rapidly, because the economic incentive is there to do so. Industries are willing to make analyses which show that if you make a capital investment now, you can get a return over several years which more than pays back your capital investment. The average consumer doesn't think in those terms, but usually thinks primarily in terms of initial capital outlay. It turns out that a great deal of progress has been made in this country by industry in the area of conservation. I will give you a couple of examples. First of all, take one close to home--the Davis campus. Between the years 1973 and 1978, the campus increased in square footage by 13 percent, but the actual energy usage declined by 25%. That means that per square foot there was a decrease of 33% in energy utilization. The Proctor & Gamble Company, which I visited recently in Sacramento, has decreased by 38% per unit product the energy usage in one of their product lines. They had done this by such simple things as closing off steam leaks, but also by the re-use of waste heat (co-generation), and by replacing furnace linings with material which took only a fraction of the time to heat up as the old linings.

The bottom line of all of this comes out as follows: We have to do everything within our reach if we expect to be able to solve our energy problems. We are not going to be offered the luxury of denying ourselves the use of nuclear energy, or denying ourselves the use of coal, or denying ourselves the use of solar energy. We are going to have to use every one of them which offers any economic potential of payoff, including coal and nuclear fuel. We are going to make them as safe as we possibly can, and we are going to have to work very hard to find more and more ways to conserve.

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TEN-YEAR CONTROL OF WESTERN FALSE HELLEBORE

M. C. Williams and E. H. Cronin[1]

Abstract: Western false hellebore (*Veratrum californicum* Durand), a member of the family Liliaceae, contains highly teratogenic alkaloids. Gross malformations were observed in lambs after the plant was eaten by ewes during early stages of pregnancy.

A western false hellebore infestation in southern Idaho was treated in 1968 and 1969 at 2.2 kg/ha with amine salts of 2,4-D [(2,4-dichlorophenoxy)acetic acid]. Complete control of the western false hellebore was achieved with the 1969 treatment. The plots were re-examined in 1979. Although dense stands of western false hellebore bordered the treated plots, we observed neither lateral reinvasion from established plants nor establishment of new plants from seed. Following removal of the western false hellebore, grass, sedge, and rush production increased 100%, or by approximately 1,500 kg/ha (dry weight). Forb production was significantly reduced on treated plots. Overall vegetative production was reduced by herbicide treatment, but the reduction resulted from removal of the western false hellebore which accounted for 46% of the dry weight of all vegetation on control plots.

Many economic benefits are derived from control of western false hellebore on western range. Cost of treatment is low and a two-year treatment provides at least 10 years of control, with actual control probably lasting for decades. Increased production of desireable forage should persist over the same period as the control of the hellebore. Treated areas can be incorporated into a rest-rotation system to further increase the production of desirable species. The removal of the western false hellebore, a heavy water user, conserves water for desireable plants. Lamb losses from hellebore poisoning are eliminated.

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COMPETITION FROM SPOTTED KNAPWEED (*CENTAUREA MACULOSA* LAM.) ON MONTANA RANGELAND

Laurence O. Baker[1]

Abstract: Spotted knapweed is the most serious perennial weed problem on much of Montana rangeland infesting an estimated 1.5 million acres. Timely applications of 2,4-D [(2,4-dichlorophenoxy)acetic acid] will kill established plants. The inclusion of picloram (4-amino-3,5,6-trichloropicolinic acid) at low rates extends the spray season by providing sufficient residual activity to control seedlings that often establish after spraying at a very early bud stage growth. A suggested control program includes spraying every other year.

To determine the competitive effects of spotted knapweed seven widely diverse areas were treated and sampled in 1979. Yield of knapweed and grass was separately harvested from unsprayed and early sprayed plots. In spite of an extremely dry growing season increased grass production

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ranged from 30 to 75 percent. Knapweed production was eliminated at two locations by spraying and was reduced to 10 percent or less at the other sites.

Results of this study also showed that diffuse knapweed (*Centaurea diffusa* Lam.) is much more widely distributed in Montana than previously thought. While control measures for the two species are not different, diffuse knapweed is avoided by grazing livestock more than spotted knapweed and appears to be better adapted to drier sites.

EFFECTS OF HERBICIDES ON CONTROL OF LEAFY SPURGE (*EUPHORBIA ESULA*) AND RESULTING FORAGE RESPONSE

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

Abstract: Herbicides were applied to leafy spurge infestations on rangeland to determine spurge control and response of forage grasses. Chemicals used were 2,4-D [(2,4-dichlorophenoxy)acetic acid] amine, dicamba (3,6-dichloro-*o*-anisic acid), dichlorprop [2-(2,4-dichlorophenoxy)propionic acid], glyphosate [*N*-(phosphonomethyl)glycine] and the potassium salt and granules of picloram (4-amino-3,5,6-trichloropicolinic acid). All chemicals were applied when leafy spurge was in the early bud stage. Glyphosate alone and in combination with 2,4-D (amine) and dicamba was also applied at maturity and after frost. Treatments containing picloram resulted in the greatest control of the target species. Grass response was variable but stand was improved by some treatments. After-frost applications were generally equal to early bud applications in controlling leafy spurge but applications at maturity were less effective.

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VARIABILITY AMONG 12 LEAFY SPURGE (*EUPHORBIA ESULA* L.) ECOTYPES

C. L. Barreto, L. O. Baker and P. K. Fay[1]

Abstract: Leafy spurge is among the most troublesome weeds in Montana and infests more than 500,000 acres of rangeland. Experiments were established to measure the amount of genetic diversity among twelve leafy spurge strains.

Root cuttings were collected from locations in Montana, Colorado, Idaho, North and South Dakota, Wyoming, and Canada. The root cuttings were established in the greenhouse and later transplanted to the field. Field experiments were conducted 15 months after transplanting.

Measurements of leaf shape, bracts, plant height, and date of flowering indicate that a number of ecotypes exist in the collected material. The strains differed in plant vigor and root dry matter production. Differential tolerance to several herbicides was observed (Table 1). The variability among leafy spurge ecotypes may have important implications

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for biological control research being conducted at the present time.

Table 1. Order of herbicide tolerance among 12 leafy spurge strains

Strain	Herbicide		
	2,4-D	Picloram	Aminotriazole
Canada 1	7[1]	4	9
Canada 2	10	10	5
Colorado	1	5	2
Wyoming	9	3	7
Idaho	2	2	4
South Dakota	8	11	3
North Dakota 1	11	12	12
North Dakota 2	4	9	8
Montana 1	5	6	11
Montana 2	12	7	6
Montana 3	6	8	10
Montana 4	3	1	1

[1]Order of increasing tolerance to herbicide treatment

ROLLER APPLICATION OF HERBICIDES FOR LEAFY SPURGE CONTROL IN PASTURES[1]

Calvin G. Messersmith and Rodney G. Lym[2]

Abstract: Two experiments were conducted in 1978 and 1979 to evaluate the roller application technique for leafy spurge control in pastures. For the first experiment, the treatments were applied on June 21, 1978 and control was evaluated on August 3, 1978. Picloram (4-amino-3,5,6-trichloropicolinic acid) at 2 lb/A applied at either broadcast or with the roller while travelling forward at 3 and 6 mph provided approximately 95% leafy spurge control. Treatments applied with the roller while driving forward were more effective than comparable treatments applied while backing. The rotation of the roller seemed to push plants away from the roller while backing and lifted the plants against the roller when driving forward.

The treatments for the second experiment were applied on September 22, 1978 and control was evaluated on May 31 and August 29, 1979. Generally, leafy spurge control was over 90% with picloram at 2 lb/A and was similar when applied either broadcast or with the roller. The control decreased approximately 5 to 10% between the May 31 and August 29, 1979 evaluations.

[1]Published with the approval of the Agric. Exp. Stn., North Dakota State Univ., Fargo, ND.

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HERBICIDAL CONTROL OF RUSH SKELETONWEED (*CHONDRILLA JUNCEA* L.)

T. M. Cheney, W. S. Belles and G. A. Lee[1]

Introduction

Rush skeletonweed is a taprooted herbaceous perennial. It is a member of the family Compositae. It's seasonal cycle begins in the fall with germination of seeds and regeneration from established root stocks. The plant overwinters as compact rosettes resembling miniature dandelions. With increasing daylength in the spring and summer, the plant will bolt and develop flower stalks (1). Rush skeletonweed reproduces sexually by seeds and asexually with satellite plant growth emanating from the meristematic crown portion of the plant. Rush skeletonweed is capable of producing several thousand seeds per year. Rush skeletonweed is a Eurasian native that was introduced into the United States as early as 1935. Skeletonweed was a problem in cultivated crops in Australia, particularly small grains. In Australia it is reported to reduce yields of small grains by 50% (2). Rush skeletonweed currently infests 3.5 million acres of rangeland in Idaho alone, with subsequent infestations occurring in Washington, Oregon and California. Rush skeletonweed is encroaching upon our cereal grain areas of northern Idaho. Chemical control of rush skeletonweed on rangeland is often uneconomical because of low productivity of the acreage infested and high costs of effective herbicides (3). Time of application and the effect of dicamba (3,6-dichloro-*o*-anisic acid), 2,4-D [(2,4-dichlorophenoxy)acetic acid], glyphosate [*N*-(phosphonomethyl)glycine], dichlorprop [2-(2,4-dichlorophenoxy)propionic acid] and picloram (4-amino-3,5,6-trichloropicolinic acid) on control is evaluated.

Materials and Methods

Field studies were established in the spring of 1977 and 1978 and the fall of 1977 at three locations in Boise County on rangeland infested with rush skeletonweed. Plots were established on May 25 of 1977 in Boise County near Banks, additional applications at the same location on October 5, 1977. Subsequent visual evaluations were taken at six month intervals on both spring and fall applied plots. The soil at this location was sandy and well drained. Climatic conditions after spring application were extremely dry and hot throughout summer and early fall. Plots established at Coyote Creek on June 11, 1978, were evaluated 3, 10 and 18 months after application. Plots were established on May 28, 1978, at Drybuck Ranch. Evaluations were taken three months later on August 11, 1978. Subsequent evaluations were impossible due to heavy grazing of livestock in the plot area.

Results and Discussion

Boise County: Evaluations taken six months after application showed little control with 2,4-D formulations. Dicamba and dichlorprop showed some burn down, however, this decreased by the time of the 12 month evaluations. Fall applied herbicides gave better but not adequate control with 2,4-D amine, 2,4-D LVE, dicamba and dichlorprop. Plots applied with dicamba at 1.0 and 2.0 lb ai/A showed adequate burn down when applied in the fall and evaluated in the spring. Plots applied with formulations of picloram, gave the best overall control at all evaluation dates, with fall

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application giving the best control regardless of application date. Picloram in combination with 2,4-D at .5 and 2.0 lb ai/A gave the best prolonged control at all evaluation dates (Table 1).

Coyote Creek: Plots receiving applications of dicamba alone and in combination with 2,4-D gave good preliminary burn down, however, later evaluations showed decreased or no control with an actual increase in weed density from induced satellite growth. Applications of dichlorprop and 2,4-D amine at the higher rates of 2.0 lb ai/A respectively gave good foliage burn down after three months from time of application, but decreasing to virtually no control at six and eighteen month evaluations. Dowco 290 at 1.0 lb ai/A and in combination with 2,4-D at .5 and 2.0 lb ai/A, respectively, gave good burn down up to six months after application. All formulations of picloram gave adequate extended control when applied in the spring. However, a slight reduction in control was noted after applying the higher rate of picloram and 2,4-D at .25 and .50 lb ai/A, respectively, in the spring. Forage samples taken one year after application from plots treated with picloram at 2.0 lb ai/A at Coyote Creek showed a 200% increase in forage yield over the untreated check plots. Desirable species present included intermediated wheatgrass and several species of bunchgrass (Table 2).

Drybuck Ranch: Picloram formulations of 221 and 212 were applied at .5 lb ai/A and 1 qt/A, respectively. Picloram 212 resulted in slightly better foliage burn down while vigor reduction obtained with the two herbicides was identical. Dicamba alone at 4.0 lb ai/A resulted in marginal burn down while in combination with 2,4-D at 4 qt/A gave good burn down at three month evaluations. Dicamba in combination with glyphosate at .5 and 2.7 lb ai/A, respectively, resulted in virtually no foliage burn down (Table 3).

Summary

Picloram formulations gave the best prolonged control of rush skeletonweed while in combination with 2.4-D good control resulted. Dowco 290 alone will give good control up to a year after application. All other herbicides used may result in preliminary burn down, while prolonged control is not achieved. The best time to apply herbicides for control of rush skeletonweed is in the fall when a high population of rosettes and seedlings are present.

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Table 1

RUSH SKELETONWEED CONTROL - BOISE COUNTY

TREATMENT	RATE LB ai/A	% CONTROL SPRING APPLIED 10/5/77	% CONTROL SPRING APPLIED 6/6/78	% CONTROL FALL APPLIED 6/6/78
UNTREATED	0	0	0	0
PICLORAM, 2% BEADS	.25	87	57	97
PICLORAM, 2% BEADS	.50	74	60	100
PICLORAM, 5% BEADS	.25	48	30	88
PICLORAM, 5% BEADS	.50	51	50	96
GLYPHOSATE	3.0	18	12	16
GLYPHOSATE	4.0	35	22	43
PICLORAM + 2,4-D	.125 + .25	89	23	95
PICLORAM + 2,4-D	.25 + .5	92	62	98
PICLORAM + 2,4-D	.25 + 1.0	85	33	99
PICLORAM + 2,4-D	.5 + 2.0	92	83	100
PICLORAM NA SALT	.25	91	38	98
PICLORAM NA SALT	.50	72	78	99
2,4-D AMINE	1.0	34	8	40
2,4-D AMINE	2.0	15	5	56
2,4-D LVE	1.0	25	10	28
2,4-D LVE	2.0	10	3	31
DICAMBA	1.0	58	3	78
DICAMBA	2.0	76	23	81
DICAMBA + 2,4-D	.5 + 1.5	30	5	63
DICAMBA + 2,4-D	1.0 + 3.0	41	20	55
DICHLORPROP	1.0	31	15	2
DICHLORPROP	2.0	74	33	30

Table 2

RUSH SKELETONWEED CONTROL - COYOTE CREEK

TREATMENT	RATE LB ai/A	% CONTROL SPRING APPLIED 8/11/78	4/26/79	10/15/79
UNTREATED	0	0	0	0
PICLORAM 2% PELLETS	.5	88	94	85
PICLORAM 2% PELLETS	1.0	88	93	92
PICLORAM 2% BEADS	.5	98	96	88
PICLROAM 2% BEADS	1.0	97	99	94
PICLORAM 5% PELLETS	.5	83	82	82
PICLORAM 5% PELLETS	1.0	89	99	99
PICLORAM K SALT	.5	98	98	93
PICLORAM K SALT	1.0	95	99	92
PICLORAM + 2,4-D	.125 + .25	60	80	57
PICLORAM + 2,4-D	.25 + .50	85	96	78
DICHLORPROP	1.0	63	0	2
DICHLORPROP	2.0	82	2	0
2,4-D AMINE	1.0	47	0	3
2,4-D AMINE	2.0	70	7	0
DOWCO 290	.5	75	86	63
DOWCO 290	1.0	85	99	78
DOWCO 290 + 2,4-D	.25 + 1.0	86	50	40
DOWCO 290 + 2,4-D	.5 + 2.0	100	85	73
DICAMBA	1.0	77	2	0
DICAMBA	2.0	78	13	0
DICAMBA + 2,4-D	.5 + 1.5	60	0	0
DICAMBA + 2,4-D	1.0 + 3.0	82	0	0

Table 3. Rush skeletonweed control - Drybuck Ranch

Treatment	lb ai/A	% Control Spring applied SR	8/11/78	VR
Picloram 225	.5	92.3		88.3
Picloram 212	1 qt	95.3		88.3
Dicamba	4.0	65.0		81.7
Dicamba + 2,4-D	4 qt	92.7		56.7
Dicamba + glyphosate	.5 + 2.7	46.7		85.0
Untreated	0	0		0

CONTROL OF TANSY (*TANACETUM VULGARE*) IN PASTURE AND HAYLAND BY CHEMICALS

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

Abstract: Tansy is a serious pest of pasture and hayland in the panhandle region of northern Idaho. Herbicide trials were initiated to determine effects on tansy control and forage production. Chemicals used were: 2,4-D [(2,4-dichlorophenoxy)acetic acid] amine and low volatile ester, asulam (methyl sulfanilylcarbamate), bentazon [3-isopropyl-1*H*-2,1,3-benzothiadiazin-4(3*H*)-one 2,2-dioxide], dicamba (3,6-dichloro-*o*-anisic acid), dichlorprop [2-(2,4-dichlorophenoxy)propionic acid], glyphosate [*N*-(phosphonomethyl)glycine) and picloram (4-amino-3,5,6-trichloropicolinic acid) potassium salt and granules. Visual evaluations were taken for control ratings. The treated areas were harvested and separated into tansy and desirable forage for yield determinations. Treatments containing picloram alone and in combination with 2,4-D (amine) resulted in the highest percent control of tansy but not necessarily the greatest yield response. Picloram formulations and combinations with 2,4-D (amine) resulted in the greatest control of tansy 30 months after treatment.

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THE USE OF ALACHLOR AND ALACHLOR PLUS METRIBUZIN FOR CONTROL OF WEEDS IN POTATOES

S. L. Kimball[1]

Abstract: Large plot research trials were established to evaluate alachlor [2-chloro-2',6'-diethyl-*N*-(methoxymethyl)acetanilide] and alachlor plus metribuzin [4-amion-6-*tert*-butyl-3-(methylthio)-*as*-

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triazin-5(4*H*)-one] on potatoes. Treatment rates, method of application and timing of treatments were examined. Applications by aerial and center pivot irrigation systems gave weed control comparable to applications by groud equipment. Applications through center pivot irrigation systems gave the most uniform weed control. Crop tolerance to the tank mixture was comparable to tolerance of individual treatments of the two herbicides. Tank mixture applications of alachlor plus metribuzin (3.0 + 0.38 lb ai/A, respectively) gave better control of barnyardgrass [*Echinochloa crus-galli* (L.) Beauv.], lambsquarters, (*Chenopodium album* L.), redroot pigweed (*Amaranthus retroflexus* L.), black (*Solanum nigrum* L.) and hairy nightshade (*Solanum sarachoides* Sendt.), and Russian thistle [*Salsola kali* (L.) var. *tenuifolia*] than treatments of either herbicide when applied alone.

RESPONSE OF CANADA THISTLE AND POTATOES TO BENTAZON AND METRIBUZIN

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

Abstract: Bentazon [3-isopropyl-1*H*-2,1,3-benzothiadiazin-4(3*H*)-one 2,2-dioxide] was applied to emerged Canada thistle (*Cirsium arvense* L.) and Russet Burbank potatoes (*Solanum tuberosum* L. cv. Russet Burbank) in three commercial fields on silt loam. Canada thistle was generally 6-10 inches high; potatoes were generally 10-14 inches high and in a pre-bloom stage. Metribuzin [4-amino-6-*tert*-butyl-3-(methylthio)-*as*-triazin-5(4*H*)-one] was included at one location. Bentazon (Basagran 4L) was applied at rates of 0, 0.75, 1.0, and 2.0 lb ai/A in 35 pga water to 12 foot by 40 foot plots in four replicates with an air pressure sprayer. Canada thistle stands and potato damage were recorded at two subsequent dates, and tuber samples were harvested for yield at one location.

Results indicate that bentazon rates adequate to control Canada thistle were excessively injurious to Russet Burbank potatoes. Canada thistle control increased with bentazon rate but potato injury likewise increased with bentazon rate. Thistle control was reflected in live stem populations; some stem succumbed and died while others survived and regained vigor. The 0.75 lb/A bentazon dose did not provide noticeable control although some chlorosis and occasional leaf necrosis was evident. The 1.0 lb/A dose killed many stems but control was not commercially satisfactory. Two applications at 1.0 lb/A a week apart provided better thistle control than 2.0 lb/A in one application. Potatoes were nor severly injured by 0.75 lb/A, but at higher doses, appreciable leaf and stem kill occurred.

Metribuzin treatments resulted in acceptable thistle control without adversely affecting the potatoes. A single treatment with 0.5 lb/A metribuzin (Lexone 4L) provided control basically equivalent to that resulting from two such applications spaced several days apart. Sequential application of metribuzin followed with bentazon or bentazon followed with metribuzin resulted in adverse bentazon effects on potatoes.

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THE EFFECT OF LATE SEASON IRRIGATION AND VINE KILL PRACTICES UPON STEM-END DISCOLORATION IN POTATO

R. H. Callihan and T. S. Longley[1]

Abstract: The influence of soil moisture and speed of vine kill upon stem-end phloem necrosis in potato (*Solanum tuberosum* L. cv Russet Burbank) was examined in 1979. The soil moisture variable (high vs low) was imposed by cessation of irrigation on different dates in August. The kill-speed variable (fast vs slow) was imposed by vine desiccant and natural frosts in 1978, and by using contact herbicides in 1979. Effects of soil-moisture levels among or within kill speeds or kill speed among soil-moisture levels were not discerned. A distinct speed by moisture interaction was observed wherein rapid vine kill resulted in more necrosis than slow kill in dry soil conditions but not in moist soil conditions.

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MEFLUIDIDE: PLANT GROWTH REGULATOR

Garry D. Massey[1]

Abstract: Mefluidide (*N*-[2,4-dimethyl-5-([(trifluoromethyl)sulfonyl] amino)phenyl]acetamide) is now registered with EPA as a plant growth regulator for use on turf grasses. The turf species presently labeled include Kentucky bluegrass, tall fescue, common bermudagrass, red fescue, chewing fescue, St. Augustine, centipede, quackgrass, perennial ryegrass, Reed canarygrass, and kikuyugrass.

Growth regulator activity includes grass retardation and seedhead suppression. Woody ornamental and tree growth regulation have also been noted with this chemical. Other areas of research include weed control in soybeans and as an agent to enhance quality in forage crops, including pasture grasses.

It is formulated as a diethanolamine salt solution and contains 2.0 lbs mefluidide per gallon (240 grams per liter). The formulation is stable under normal conditions of storage.

Present toxicological information indicates that the formulated chemical has oral (rat) and dermal (rabbit) LD_{50} of >5000 mg/kg. The formulation is nonirritating to skin, minimum irritating to eyes, and is of a low order of toxicity to fish and wildlife.

[1]3M Company, Fresno, CA

INCREASING THE MARGIN OF SELECTIVITY OF REGISTERED HERBICIDES FOR SPECIFIC WEED CONTROL PROBLEMS IN CROPS

A. H. Lange[1]

Abstract: There are many registered herbicides that we have not learned to use to our best advantage in controlling weeds selectively in row crops. Chloropropham (isopropyl-*m*-chlorocarbanilate) and chloramben (3-amino-2,5-dichlorobenzoic acid) are two of these herbicides in California. They cannot be used selectively in several crops for which they are registered in most California soils unless the crop seed is protected during germination. Plug planting or some similar means of altering the micro environment could be used to protect the crop seed until the level of herbicide in the vicinity of the seedling has decreased or the crop roots have developed below the zone of treated soil. The method of incorporation, the characteristics of the herbicide, the soil type and other factors are involved in the success of these techniques as much as they are for most herbicides used selectively in crops.

Herbicides with a complete lack of any selective advantage may not be successfully used in these procedures. This is true in plug planting. More basic work on the protective mechanism of the plug needs to be worked out. We need to know if the herbicide is deactivated in the water of imbitition; in the soil solution near the newly developing root and/or shoot; or if the increased vigor of the plug planted crop seedling will withstand more herbicide injury or some other factor is involved. In the process of learning more about the mechanisms of protection in the plug, we are sure to learn more about herbicide usage in selective weed control and at the same time we will learn to maximize our presently available weed control tools by allowing more flexibility in their use.

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ANNUAL WEED CONTROL IN YOUNG ORCHARDS WITH GLYPHOSATE, DINOSEB, AND PARAQUAT

L. A. Rupp and J. L. Anderson[1]

Abstract: Weed control studies were conducted in apple and tart cherry orchards during their first two years after planting. Best control of annual weeds was obtained with dinoseb (2-*sec*-butyl-4,6-dinitrophenol) at 9 lb ai/A and glyphosate [*N*-(phosphonomethyl)glycine] at 3/4 lb ai/A. Paraquat (1,1'-dimethyl-4,4'-bipyridinium ion) treatments gave significantly less control but were superior to the untreated controls. A shift in weed species was evident following herbicide treatment. Paraquat was very effective on annual grasses but allowed a build up of broadleaved weeds. Glyphosate was also more effective on grasses. Dinoseb contolled the broadleaved weeds but at lower rates allowed the grasses to increase. Economic analysis showed an advantage in using chemical and mechanical weed control over hand weeding. Glyphosate appeared to be the most economical treatment, allowing more tree growth per cost of weed control treatment.

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Introduction

Several studies have shown that competition between weeds and fruit trees is most critical during the first few years of an orchard's life (2, 3, 6). With the high cost of new orchard establishment, it is imperitive that adequate weed control be practiced in order to allow an early and profitable return from the trees.

There are many methods of weed control that can be used in orchards, however, many of them have serious drawbacks as to their feasibility and effectiveness. Mulches, such as alfalfa, have been used effectively, but they are expensive to obtain and to apply. Mowing a sod cover between the rows of trees is effective, but if the sod is near the base of young trees it competes with them for water and nutrients, while allowing mice and insects to over winter near the tree trunk and cause damage. Cultivation is also an alternative, but it is costly and can be damaging to feeder roots. It is also impractical to attempt to cultivate where there is a solid set drip irrigation system. Furthermore, it is hard to cultivate under limbs that have been lowered by the weight of ripening fruit.

Chemical weed control with herbicides has proven to be an effective alternative to the problems found in other methods of weed control (4, 8). However, it too has run into its share of problems. Residual, soil applied herbicides have shown phytotoxicity when used on young trees growing in the low organic matter soils of many orchard sites (1, 5, 7). Foliar applied herbicides avoid this problem of soil related phytotoxicity. The foliar applied herbicides examined in this study were paraquat, dinoseb, and glyphosate. Of these three, both paraquat and dinoseb have had their registration questioned by the Environmental Protection Agency, and are being reexamined as to their risks and benefits. Because of these questions it was necessary to do an indepth study comparing the three herbicides with each other and with cultivation to see which treatment was most effective and efficient.

Materials and Methods

The study was primarily conducted on orchards planted in 1978 at Willard, Utah, and at the Utah State University Horticultural Field Station in Farmington, Utah.

The study was conducted during 1978 and 1979. The major portion of the study was conducted on a tart cherry orchard and an apple orchard at the Farmington Field Station. The orchards consisted of 100 trees each, planted in four rows with 25 trees per row. The orchard was furrow irrigated as required and weed control between the tree rows was maintained by frequent cultivation with a spring-tooth harrow.

A total of eight treatments was applied to each orchard. These treatments consisted of a hand weeded control plot, an unweeded control, and six herbicide treatments. The treatments were applied to 10 x 30 foot plots within the tree row comprising 3 trees per plot, and were replicated 4 times in each orchard. While the unweeded control was left entirely alone, the handweeded control was hoed by hand each time weed seedlings were noticed, which amounted to several times during the season.

The herbicide treatments were paraquat (1/3 and 1/2 lb ai/A), dinoseb (6 and 9 lb ai/A), and glyphosate (1/2 and 3/4 lb ai/A or .38 and .56 lb ae/A). The high rates are those recommended by the label, while the lower rates were evaluated for seedling control in an attempt to justify expansion of the lower limits of the label-allowed rates are continued use in weed seedling control.

During the first growing season an aluminum foil shield was placed around the lower trunk of each tree to prevent absorption of herbicides, especially glyphosate, through any green bark. All treatments were applied while winds were less than 5 mph, with most treatments being applied at or near daybreak when there was little or no wind in the orchard.

The herbicide treatments were applied with a backpack sprayer (CO_2 powered), at 30 pounds pressure. All treatments were originally applied in 50 gallons of water per acre, with the surfactant X-77 being added at 0.5%. The plots were sprayed twice during 1978, on June 8, and August 1. During 1979 the plots were sprayed four times (May 10, June 11, July 18 and September 28); the last treatment being an attempt to control winter annuals.

On July 18, 1979 it was determined that the paraquat and glyphosate rates should be doubled to try to increase their effectiveness. The glyphosate carrier was also changed from 50 gal. water/A to 10 gal/A.

The second major study site was located at the Elmer Ward orchard in Willard, Utah. The management of this orchard was much the same as Farmington, with it too being furrow irrigated. Mechanical weed control with a rotary tiller was practiced both between the tree rows and across the tree row approximately six times per year. Due to the cross-wise cultivation, herbicides were applied to a 6 x 8 foot area around each tree. The method and rates of application were identical to those at Farmington. A completely randomized design was used, dividing the 128 trees involved into plots of four trees each, replicated four times. Herbicides were applied June 6 and August 5 during 1978. The 1979 applications were sprayed on May 15, June 15, July 8 and October 3.

A visual evaluation of herbicide efficacy was taken two weeks after each treatment during both summers. Efficacy was determined by evaluating each plot on a 0-10 scale for annual weed control, determining the control of individual weed species within the plot using the same scale, recording the percentage of soil surface area covered by weeds, and evaluating the seedling control, again using a 0-10 scale. In addition, the percentage of broadleaf and grassy weeds in the plots was recorded to help observe for population shifts.

Weeds present in the Farmington orchard are listed in Table 1. Of these weeds, the predominate ones found throughout the orchard were wild lettuce, lambsquarters, witchgrass, cheese mallow and redroot pigweed.

Results and Discussion

The evaluation of total weed control at Farmington in both orchards indicated that the best control with herbicides was obtained with dinoseb at 9 lb/A, which registered 8.1 and 7.8 on the scale. This treatment was statistically equal to the control given by glyphosate at 3/4 lb/A (7.13 and 7.25 on the scale or approximately 7% less control). The poorest control was obtained with the paraquat treatments, which gave significantly less control than all the other treatments. Paraquat, however, showed significant control when compared to the unweeded checks (Tables 2 and 3).

Weed seedling control closely paralled that of the overall control. However, the best control was with the dinoseb treatments. The measurements of the percent soil surface covered by weedy vegetation also paralleled the results obtained in the overall control evaluation. Once again the high rates of dinoseb and glyphosate were best, followed by their lower rates and then the paraquat treatments.

Table 1. Weed species present in the Farmington, Utah orchard plots.

Common name	Scientific name
Redroot pigweed	*Amaranthus retroflexus* L.
Cheatgrass	*Bromus tectorum* L.
Shepherdspurse	*Capsella bursa-pastoris* L.
Lambsquarters	*Chenopodium album* L.
Tansymustard	*Descurainia sophia* L.
Barnyardgrass	*Echinochloa crusgalli* L.
Foxtail	*Hordeum* spp. and *Setaria* spp.
Kochia	*Kochia scoparia* L.
Wild lettuce	*Lactuca seriola* L.
Cheese mallow	*Malva neglecta* Wallr.
Black medic	*Medicago lupulina* L.
Yellow sweet clover	*Melilotus officinalis* L.
Witchgrass	*Panicum capillare* L.
Prostrate knotweed	*Polygonum aviculare* L.
Wild buckwheat	*Polygonum convolvulus* L.
Purslane	*Portulaca oleracea* L.
Russian thistle	*Salsola kali* L.
Jim Hill mustard	*Sisymbrium altissimum* L.
Nightshade	*Solanum* spp.
Goatsbeard	*Tragopogon dubius* Scop.

Table 2. **Effect of weed control treatments on total weed populations and individual weed species** at the Farmington cherry orchard.

Treatment	Rate (lb/A)	% Cover	% Grass	Weed control on a 0-10 scale[1]				
				Overall control	Seedling control	Lambs-Quarters	Witch-grass	Prickly lettuce
Unweeded		93.4 d[2]	42.0 c	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
Paraquat	1/3	79.3 c	4.6 a	3.1 b	2.9 b	1.0 b	8.9 e	3.0 b
Paraquat	1/2	69.6 c	3.2 a	4.2 c	3.4 b	1.2 b	9.7 e	5.6 c
Dinoseb	6	51.3 b	79.5 d	6.6 e	6.4 d	9.4 d	1.9 b	8.4 e
Dinoseb	9	28.6 a	72.1 d	7.8 f	8.4 e	8.9 d	4.6 c	8.6 e
Glyphosate	1/2	55.9 b	14.3 b	5.6 d	4.4 c	4.6 c	6.6 d	4.9 cd
Glyphosate	3/4	33.6 a	6.4 ab	7.3 ef	6.1 d	5.0 c	8.9 e	6.8 d

[1]Rating: 0 = no control and 10 = complete control.

[2]Treatment means in the same column followed by the same letter do not differ significantly at the 5% level according to Fisher's LSD procedure.

A dramatic shift in the weed species making up the population was noted in the different plots after the second treatment. Paraquat, even at the lowest rate, was very effective on annual grasses, causing the population to shift from the original 42-54% broadleaved weeds to 96-97% broadleaf weeds. Glyphosate also proved to be more effective on grasses than on broadleaved weeds, however, it did not cause the population shift to the same extent as paraquat. Dinoseb, on the other hand, exhibited a marked ability to control broadleaf weeds, thus significantly shifting the population with the sprayed plots to 75-78% grasses.

Table 3. Effect of weed control treatments on total weed populations and individual weed species at the Farmington apple orchard.

				Weed control on a 0-10 scale[1]				
Treatment	Rate (lb/A)	% Cover	% Grass	Overall control	Seedling control	Lambs-Quarters	Witch-grass	Prickly lettuce
Unweeded		98.8 a[2]	54.1 b	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
Paraquat	1/3	80.2 b	6.2 a	3.1 b	2.9 b	3.5 b	9.6 ef	4.3 b
Paraquat	1/2	76.1 bc	4.1 a	3.6 b	3.9 bc	2.4 ab	9.9 f	6.2 c
Dinoseb	6	61.8 cd	76.5 c	5.8 c	6.1 de	9.0 cd	3.5 b	8.2 de
Dinoseb	9	33.9 e	78.6 c	8.1 d	7.8 f	9.8 d	5.6 c	9.0 e
Glyphosate	1/2	60.7 cd	17.0 a	5.9 c	4.45 cd	6.7 c	7.9 d	6.6 c
Glyphosate	3/4	48.1 de	11.1 a	7.1 cd	6.35 e	6.9 c	8.1 de	7.4 cd

[1]Rating: 0 = control and 10 = complete control.

[2]Treatment means in the same column followed by the same letter do not differ significantly at the 5% level according to Fisher's LSD procedure.

Examination of the herbicide effect on the individual weeds revealed an increase in control of each species with all applied treatments as compared to the weedy check. Lambsquarters and prickly lettuce were controlled most effectively by dinoseb. Glyphosate at the low rates and paraquat gave poor control of these weeds. By doubling the glyphosate rates the control was increased 40 to 50%. Witchgrass was most effectively controlled by paraquat and the high rate of glyphosate. Dinoseb gave fair control at the high rate but very poor control at the lower rate of 6 lb/A. Cheese mallow populations were decreased significantly by all herbicide treatments except paraquat at 1/3 lb/A and glyphosate at 3/4 lb/A. Red-root pigweed was controlled significantly by all herbicide applications.

The weed populations at Willard included all species present at Farmington with the exception of witchgrass, barnyardgrass, goatsbeard, shepherdspurse, black medic, tansy mustard, Jim Hill mustard, and yellow sweetclover. In addition, dandelion (*Taraxacum officinale* L.) and volunteer rye (*Secale cereale* L.), (left over from a small grain interplanting management system) were present in the orchard. The most prominent weeds were prostrate knotweed, kochia, lambsquarters, foxtail, rye and nightshade.

The overall weed control data at Willard shows results similar to those recorded at Farmington (Table 4). The highest degree of control was again found with high rates of dinoseb and glyphosate. The poorest weed control was observed in the plots treated with paraquat at 1/3 lb/A.

Control of weed seedlings was greater with the dinoseb treatments. They provided almost 60% greater control than was obtained with glyphosate. Plots treated with paraquat (1/3 lb/A) were not significantly different from the unweeded plots. Evaluation of the percent soil surface covered with weedy vegetation showed results similar to those observed for the overall weed control data.

Table 4. Effect of weed control treatments on total weed populations at Willard.

Treatment	Rate (lb/A)	% Cover	% Grass	Weed control on a 0-10 scale[1]	
				Overall control	Seedling control
Unweeded		90.0 a[2]	27.1 bc	0.0	0.0 a
Paraquat	1/3	85.0 a	6.6 ab	3.3 b	1.6 ab
Paraquat	1/2	51.9 b	1.6 a	5.7 c	2.8 bc
Dinoseb	6	24.4 c	46.9 c	7.4 d	7.5 d
Dinoseb	9	13.8 c	77.2 d	8.6 d	8.0 d
Glyphosate	1/2	33.4 bc	10.0 ab	7.3 cd	4.3 c
Glyphosate	3/4	18.0 c	10.9 ab	8.1 d	4.3 c

[1]Rating: 0 = no control and 10 = complete control.

[2]Treatment means in the same column followed by the same letter do not differ significantly at the 5% level according to Fisher's LSD procedure.

Measurements of population shifts indicated that paraquat and glyphosate caused a significant reduction in grassy weeds as comaped to the dinoseb treatments. Dinoseb (9 lb/A) resulted in a significant increase in the ratio of monocots to dicots, compared to the weedy check. Paraquat treatments significantly shifted the population to broadleaf weeds.

The data compiled on individual weed species once again showed a different reaction of each species to the herbicides (Table 5). Prostrate knotweed was controlled fairly well by glyphosate and dinoseb, which resulted in approximately 50% more growth reduction than paraquat. Lambsquarters was controlled completely by the dinoseb treatments, and fairly well by the glyphosate applications. Paraquat, as was observed at Farmington, gave very poor control of lambsquarters. It was found that paraquat rates must be increased to 1 1/2 or 2 lb/A to obtain effective kill of mature lambsquarters.

Volunteer rye was reduced most efficiently with paraquat and glyphosate, while poor control was obtained with dinoseb. The remaining common weeds, kochia, foxtails and nightshade all were significantly controlled by the herbicide applications. Only a minor difference was noted between herbicides, with paraquat and glyphosate giving slightly better control of rye and the foxtails. Glyphosate appeared to be slightly less effective as a control of kochia than the other herbicides.

Summarizing the results of the herbicide applications, it appears that the best overall weed control was obtained with dinoseb and glyphosate treatments. Weed control obtained with the paraquat rates used was generally inadequate.

If one examines the data for control of monocot weed species it becomes readily apparent than paraquat, even at the low use rate, provided excellent control. However, this elimination of the grasses allowed a severe invasion of broadleaf weeds, so there was still almost 80% weed cover. The dinoseb treatments were most effective on broadleaf weeds; however, they were also effective enough on grass seedling control to prevent a great influx of annual grasses into the plots. This difference [31% weed cover for dinoseb (9lb/A), 80% for parquat (1/3 lb/A)] in the amount of weedy vegetation present accounts for the great difference in tree growth observed between the two treatments. Glyphosate, while controlling grasses better than broadleaved weeds at lower rates, was more general in its control, thus covering a wider spectrum of weed species.

Table 5. Effect of weed control treatments on individual weed species at Willard.

Treatment	Rate (lb/A)	Weed control on a 0-10 scale[1]				
		Lambsquarters	Kochia	Prostrate knotweed	Annual grasses	Volunteer rye
Unweeded		0.0 a[2]	0.0 a	0.0 a	0.0 a	0.0 a
Paraquat	1/3	1.6 a	8.3 bc	1.7 b	8.8 bcd	8.5 c
Paraquat	1/2	4.8 b	9.6 bc	2.8 b	10.0 d	8.6 c
Dinoseb	6	9.9 d	9.6 bc	6.3 c	7.8 b	5.3 b
Dinoseb	9	10.0 d	9.9 c	7.5 d	8.1 bc	5.8 b
Glyphosate	1/2	7.6 c	7.6 b	7.7 cd	10.0 d	8.5 c
Glyphosate	3/4	8.2 cd	8.1 bc	8.0 cd	9.8 cd	8.0 c

[1]Rating: 0 = no control and 10 = complete control.

[2]Treatment means in the same column followed by the same letter do not differ significantly at the 5% level according to Fisher's LSD procedure.

It is interesting to speculate on the advantages that could be obtained by utilizing the great ability of dinoseb to control broadleaved weeds, and paraquat to control grasses. Obviously they have great potential for control of isolated weed problems where there are concentrations of annual grasses or broadleaved weeds. It also seems feasible that they could be used on a mixed or rotation basis at light rates, thereby allowing one to control monocots while the other controls annual dicots. While this seems economically advantageous, it is unknown as to whether or not these light rates could keep the area free from weeds, or if they just have the ability to shift the population to a group of weeds that is more competitive. In other words, it is not known if the herbicides are just active enough to weaken one species and allow another to push it out by competition, or if they are active enough at these rates to keep the niche empty from all vegetation except trees.

Weed seedling control was very difficult to evaluate. If was difficult to tell if weed seedlings had germinated before or after treatment. Furthermore, it was also difficult to observe small dead weed seedlings with larger weeds around them. Dinoseb was the best herbicide used for seedling control. We believe this was due to its limited soil residual activity, which prevented the growth of germinating weed seedlings.

The data on weed control costs (Table 6) show a definite advantage in using chemical and mechanical weed control methods over hand weeding. It was very difficult to determine accurately how long it took to hand weed an area because of variables such as speed of the worker and the extent of the weed problem. Therefore, a large variable exists in the comparison of herbicide treatment costs to hand weeding costs. Nevertheless, the comparisons between the herbicides themselves, especially within each orchard should be quite accurate indicators of the true cost since all inputs were equal except for the cost of the herbicides.

Table 6. Annual cost of weed control per acre and per tree (Farmington, Utah).

Treatment	Rate (lb/A)	Cultivation	Spraying	Herbicides	Hand Weeding	Total Cost/Acre
Paraquat	1/3	$23.43	$11.67	$14.52	$0.00	$49.62
	1/2	23.43	11.67	19.38	0.00	54.48
	2/3	23.43	11.67	23.97	0.00	59.07
	1	23.43	11.67	33.75	0.00	68.85
Dinoseb	6	23.43	11.67	40.44	0.00	75.54
	9	23.43	11.67	33.75	0.00	93.24
Glyphosate	1/2	23.43	11.67	15.75	0.00	50.85
	3/4	23.43	11.67	21.06	0.00	56.16
	1	23.43	11.67	22.38	0.00	57.48
	1 1/2	23.43	11.67	33.12	0.00	68.22
Hand weeded		23.43	0.00	0.00	174.00	197.43

The results of this study bear out the fact that glyphosate control of weeds allowed tree growth equivalent to that of trees grown in the hand weeded and dinoseb treated plots, even though the actual weed control was slightly lower. Glyphosate also appeared to be the most economical treatment, allowing the most tree growth per cost of treatment than any other herbicide used. In addition, glyphosate has the advantage of having very low mammalian toxicity. It is also effective on perennial weeds, can be applied at low gallonages, and is much more pleasant to work with than dinoseb. Using the Farmington data, the second most economical weed control treatment (after the glyphosate treatments), was dinoseb (6 lb/A).

There is a very real potential for damage to trees due to drift from all three of the herbicides, and especially from glyphosate absorption through green bark. We were able to avoid any phytotoxicity problems by carefully avoiding herbicide drift onto the trees.

Dinoseb and paraquat still provide a very important weapon in the growers' fight against weed competition in young orchards. Both have distinct advantages such as dinoseb's slight soil activity, and paraquat's activity on annual grasses. And, as previously mentioned, using them together appears to have some potential.

Acknowledgment

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WEED CONTROL IN ORCHARDS WITH SOLICAM 80WP HERBICIDE

Louis J. Russo and Eric L. Ummel[1]

Solicam 80WP herbicide is based on a substituted pyridazinone [norflurazon: 4-chloro-5-(methylamino)-2-(α,α,α-trifluoro-*m*-tolyl)-3(2*H*)-pyridazinone] that has shown efficacy on a wide spectrum of weeds in orchards throughout the United States.

Its mode of action is an indirect interference with the formation of chlorophyll by inhibition of carotenoid biosynthesis in plant tissues. The lack of carotene pigments which act as a photoprotective shield for chlorophyll causes the chlorophyll to be broken down by sunlight. This results in the typical symptom of norflurazon which is a partial or total whitening of susceptible plants.

Norflurazon demethylates to the biologically inactive desmethyl norflurazon.

It is a relatively safe compound and has an acute oral LD_{50} of greater than 10,000 mg/kg on rats. The dermal toxicity on rabbits is greater than 20,000 mg/kg.

Norflurazon is sold and registered for use in certain orchard crops including apricots, cherries, filberts, nectarines, peaches, plums, prunes, and walnuts in California and west of the Cascade Mountains in the states of Oregon and Washington. It is used at 2.5 to 5.0 lbs of the 80% wettable powder per acre, depending on soil types. The higher rates are used on medium and fine textured soils with high organic matter content.

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Norflurazon is primarily a soil residual herbicide for use where the orchard floor is relatively free of trash and weeds. It can be used any time from fall to early spring on trees that have been established in the field for at least 12 months.

Norflurazon is dependent on water for activation and incorporation into the soil. The interval between application and first water may not be as critical as with other herbicides that are used or are currently being tested in tree crops. For best results, the soil should be wet to a depth of 2 inches by rainfall or sprinkler irrigation within 2 weeks after application.

Norflurazon has excellent residual activity and a single application will normally give season-long control.

Results from over 300 field trials in the western states have shown that norflurazon gives excellent control of annual grasses including annual blue grass (*Poa annua*), Italian ryegrass (*Lolium multiflorum* Lam), wild barley (*Hordeum*), barnyardgrass [*Echinochloa crus-galli* (L.) Beauv.], crabgrass [*Digitaria sanguinalis* (L.) Scop.] and witchgrass (*Panicum capillare* L.). It is also very effective against many winter annual broadleaf weeds including chickweed [*Stellaria media* (L.) Cyrillo], shepherds purse [*Capsella bursa-pastoris* (L.) Medic.], fiddleneck, (*Amsinckia intermedia* Fisch. & Mey), and redmaids [*Calandrinia caulescens* (R.& P.) DC var. *menziesii* (Hook.) Macbr.]. Other weeds including *Malva* spp., filaree [*Erodium cicutarium* (L.) L'Her.], purslane (*Portulaca oleracea* L.), and puncturevine (*Tribulus terrestris* L.) are also controlled with timely applications of norlurazon.

The residual qualities of norflurazon that allow early fall applications coupled with the control of annual grasses and winter broadleaf weeds offer a distinct advantage over other currently registered materials. In addition to the controlled species, norflurazon suppresses several important weeds including the perennials bermuda grass [*Cynodon dactylon* (L.) Pers.], nutsedge (*Cyperus*), and quackgrass [*Agropyron repens* (L.) Beauv.]. Field trials have also demonstrated that some weeds are tolerant to norflurazon. They include henbit (*Lamium amplexicaule* L.), clovers (*Trifolium* spp.), dandelion (*Taraxacum officinale* Weber), field bindweed (*Convolvulus arvensis* L.), johnsongrass [*Sorghum halepense* (L.) Pers.] (from rhizomes), and knotweed (*Polygonum* spp.).

Norflurazon has demonstrated excellent crop safety when used according to label directions. Of the crops that are registered or being considered for registration, almonds is the most sensitive. For this reason, numerous field trials designed to prove safety have been directed toward almonds. In one trial conducted by Dr. A. Lange and J. Schesselman there was no damage to almond trees at three times normal rates utilizing 3 different application timings. In some cases, foliar symptoms have occurred where label rates have been exceeded. These symptoms are normally confined to the lower portions of the tree, and do not appear to cause reductions in tree growth or vigor.

Much of the recent research with norflurazon has been aimed at label expansion. Currently pending registration requests include:

In California:

Almonds (medium and fine textured soils only), apples, pears, and citrus.

In Oregon and Washington:

Removal of restrictions on currently registered crops so that norflurazon can also be used on them east of the Cascades, and registration on apples and pears.

In Arizona:

Citrus.

Combinations of norflurazon with other herbicides has also been studied in recent years. The addition of low rates of simazine to norflurazon has demonstrated increased effectiveness on certain broadleaf weeds. Combinations with paraquat and DNBP have also shown good results when there are some weeds present at the time of application.

In summary, norflurazon should be applied as a directed spray any time from fall to early spring. It should be applied to an orchard floor that is relatively free of trash and weeds, and activated by water within two weeks following application. When used according to label directions, norflurazon offers several advantages. It is a relatively safe product to handle that offers season-long control and good crop safety from a single application.

POSTEMERGENCE WEED CONTROL IN REDUCED TILLAGE SYSTEMS

Sheldon E. Blank[1]

Abstract: In recent years, reduced tillage systems have become more and more an integral part of American agriculture. These systems have resulted from a growing desire to conserve energy, moisture and soil. A natural consequence of reduced tillage crop production is a reliance upon chemicals rather than cultivation for weed control.

In 1978 and 1979 extensive field investigations were undertaken by technical representatives of Monsanto Agricultural Products Company in the Western United States to evaluate the commercial formulation of the isopropylamine (IPA) salt of glyphosate [*N*-(phosphonomethyl)glycine] for annual weed control in reduced tillage, cereal grain systems. When combined with additional nonionic surfactant at 0.5% (v/v), rates of IPA glyphosate as low as 0.38 lb ae/A provided excellent postemergence control of numerous annual grass and broadleaf weed species including volunteer wheat (*Triticum aestivum* L.), barley (*Hordeum vulgare* L.), or rye (*Secale cereale*) L., downy brome (*Bromus tectorum* L.), wild oat (*Avena fatua* L.), annual ryegrass (*Lolium* spp.), tumble mustard (*Sisymbrium altissimum* L.), wild mustard [*Brassica kaber* (DC.) L.C. Wheeler var. *pinnatifida* (Stokes) L.C. Wheeler], tansymustard [*Descurania pinnata* (Walt.) Britt.], redroot pigweed (*Amaranthus retroflexus* L.), fiddleneck (*Amsinckia intermedia* Fisch. & Mey), lambsquarters (*Chenopodium album* L.) and field pennycress (*Thilaspi arvense* L.). Numerous nonionic surfactants were evaluated for their ability to enhance annual weed control with IPA glyphosate. Reducing carrier gallonage from 30 to 10 gallons/acre also enhanced efficacy of IPA glyphosate on annual weeds.

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WEED CONTROL IN NO-TILL WINTER WHEAT

E. Eldredge and G. A. Lee[1]

Abstract: A forty-acre field near Tensed, Idaho was seeded with Dawes winter wheat in October of 1978 using different drills each on a ten-acre strip of the field. Three drills used to plant directly into winter wheat stubble were: the University of Idaho Agricultural Engineers' minimum tillage drill, a John Deere no-till drill and a Melroe no-till drill. The Melroe no-till drill was also used to seed a conventionally tilled ten-acre strip for comparison. A study was established in May of 1979 to evaluate the effectiveness of eleven herbicides on the four drills. Herbicides were applied in water and in a nitrogen fertilizer solution. Principle weed species present in the minimum-tillage drill strips were: fiddleneck (*Amsinkia* sp.), field pennycress (*Thlaspi arvense* L.) and corn gromwell (*Lithospermum arvense* L.). The principle weed species in the conventionally tilled comparison was field pennycress. Metribuzin [4-amino-6-*tert*-butyl-3-(methylthio)-*as*-triazin-5(4*H*)-one] + bromoxynil (3,5-dibromo-4-hydroxybenzonitrile) at .42 + .56 kg/ha provided the best selective weed control of all species on each strip, but plots treated with 2,4-D [(2,4-dichlorophenoxy)acetic acid] amine at .56 kg/ha had the highest yield. treatments with R-40244 [1-(*m*-trifluoromethylphenyl)-3-chloro-4-chloromethyl-2-pyrrol=idone] at .56 and 1.12 kg/ha and terbutryn [2-(*tert*-butylamino)-4-(4thylamino)-6-(methylthio)-*s*-triazine] + chlorbromuron [3-(4-bromo-3-chlorophenyl)-1-methoxy-1-methylurea] at .9 + .9 kg/ha provided good weed control but resulted in reduced crop stand, vigor and yields.

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SELECTIVITY OF DICLOFOP-METHYL BETWEEN WHEAT AND WILD OATS: GROWTH AND HERBICIDE METABOLISM

William W. Donald and R. H. Shimabukuro[1]

Abstract: Growth of the second leaf of susceptible wild oat (*Avena fatua* L.) was inhibited within 2 days after treatment with the herbicide, diclofop-methyl {2-[4-(2,4-dichlorophenoxy)phenoxy]propanoate} in the 1-1/2 leaf stage of growth. Leaf growth of resistant wheat (*Triticum aestivum* L.) was unaffected by dichlfop-methyl. Chlorosis developed 1 day after leaf growth was inhibited in wild oat. Foliar absorption of dichlofop-methyl was similar between wild oat and wheat with 67 and 61% of the recovered radioactivity form [^{14}C]dichlofop-methyl being absorbed by wild oat and wheat, respectively, after 4 days. Wild oat was equally sensitive to the methyl ester and acid forms of the herbicide when the compounds were injected into the stem. Wheat was unaffected by both forms when treated similarly. Very little diclofop-methyl and dichlfop (combined total of 10 to 12% in wild oat and 5 to 7% in wheat) remained in plant tissues 2 days after leaf treatment in both susceptible and resistant plants. Therefore, the active form of the herbicide must inhibit growth of susceptible plants very rapidly and at relatively low concentrations. Diclofop-methyl was rapidly hydrolyzed by wild oat and wheat. Wild oat predominantly conju-

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gated diclofop to an ester conjugate but wheat hydroxylated the 2,4-dichlorophenyl ring and form a phenolic conjugate. The formation of the different conjugated between wild oat and wheat was the most significant eifference in metabolism between the two species. Nearly 60 and 70% of the methanol-soluble radioactivity was present as water-soluble conjugates in wild oat and wheat, respectively, 4 days after treatment.

EFFECT OF METRIBUZIN ON WINTER WHEAT (*TRITICUM AESTIVUM*) WHEN APPLIED AT VARIOUS STAGES OF GROWTH

P. L. Rardon and P. K. Fay[1]

Abstract: The effects of metribuzin [4-amino-6-*tert*-butyl-3-(methylthio)-*as*-triazin-5-(4*H*)-one] applied at various stages of the development of winter wheat was studied. A high degree of correlation exists between time of application and winter wheat yields. Three rates of metribuzin, 0.38, 0.50 and 0.75 lb ai/A, were applied to winter wheat periodically throughout the spring with the growth stage being described using the parameters of: number of tillers and crown roots, number of leaves per tiller, and the length of the seminal root, crown roots and leaf length. Yield reductions of winter wheat ranged from 60 to 90 percent in early applications when crown roots were undeveloped. Yield reductions of 5 to 25 percent resulted from late season applications which corresponded to increased leaf area.

[1]Agronomist, Central Montana Agr. Exp. Sta., Moccasin, MT and Asst. Professor, Plant & Soil Sci. Dept., Montana State University, Bozeman, MT, respectively.

PERFORMANCE OF METRIBUZIN FOR DOWNY BROME CONTROL IN WINTER WHEAT GROWN IN THE NORTHWEST

H. L. Ramsey[1]

Abstract: Downy brome (*Bromus tectorum* L.) also termed cheatgrass is one of the most serious problems in the dryland winter wheat areas of the Pacific Northwest. Metribuzin [4-amino-6-*tert*-butyl-3-(methylthio)-*as*-triazin-5-(4*H*)-one] has been studied as a herbicide for use in cereal grains by researchers for many years. Extensive field testing has been conducted in the Pacific Northwest with research plots and Experimental Use Permit trials evaluating the efficacy of metribuzin as a herbicide in cereal grain.

A recent registration has been granted to permit the application of metribuzin to wheat as a broadcast postemergence application. Stage of growth for application for maximum efficacy was found to be when the downy brome plants were in the 1 leaf to 3 tiller stage with an application rate of metribuzin of 0.25 to 0.5 lbs ai/A. Other grass and broadleaf weeds present were also controlled with these rates.

Postemergence applications of metribuzin for maximum crop tolerance

[1]MOBAY Chemical Corporation, Yakima, WA

were found to occur when wheat plants were in the fully tillered stage of growth with prominent secondary root development. Uniform application of metribuzin was found to be essential for efficacy and crop safety. When metribuzin was applied with the above criteria, metribuzin offered the wheat producer a new tool for downy brome control in winter wheat.

A NEW HERBICIDE FOR CEREALS IN THE WESTERN UNITED STATES

G. E. Cook and N. D. McKinley[1]

Abstract: A new postemergence herbicide for small gains, coded DPX 4189 {2-chloro-*N*-[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)aminocarbonyl]-benzenesulfonamide}, controls a broad spectrum of broadleaf weeds and suppresses some of the common problem grasses. Weeds can be controlled in both winter and spring-sown cereals. Wheat, oats, and barley are tolerant to properly-timed postemergence applications.

Most of the problem broadleaf weeds in cereals, including perennial weeds, are controlled by 15 to 60 g/ha of DPX 4189. Applications made early post to the weeds are most effective. In some situations, combinations with a grass herbicide are desirable. The half-life of the compound appears to be one to two months under temperate conditions, but because of the activity at very low rates, possible effects on broadleaf crops in rotation will need to be considered.

DPX 4189 also has considerable potential for use in reducing tillage fallow systems. Fall applications are particularly promising.

[1]Development Representatives, E.I. du Pont de Nemours & Co., Inc., Menlo Park, CA

FIELD EVALUATION OF DPX-4189 IN WINTER WHEAT UNDER TWO TILLAGE SYSTEMS

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

In the Palouse areas of northern Idaho and eastern Washington, the severe erosion problem is primarily the result of winter season precipitation. The combination of frozen soil, predominant winter precipitation, terrain with long steep slopes, and reduced crop residues result in increased soil erosion potential during the winter and early spring runoff periods. Because of the need for erosion control and increasing demands for energy conservation, more growers are turning to reduced tillage practices.

The elimination or reduction in tillage operations to prevent soil erosion also eliminates mechanical tillage as an effective cultural weed control practice. Without the influence of intensive cultivation, shifts in weed communities occur, altering the habitat and conditions for weed establishment and persistence. The use of effective herbicides for weed control becomes an essential part of reduced tillage systems.

DPX-4189 {2-chloro-*N*-[(4-methoxy-6-methyl-1,3,5-triazin-2yl)aminocarbonyl]-benzenesulfonamide} is an experimental herbicide manufactured by

[1]Plant & Soil Sci. Dept., University of Idaho, Moscow, ID 83843

E. I. Dupont and Company. Preemergence or postemergence applications of DPX-4189 have herbicidal activity on annual broadleaf weed species. Wheat (*Triticum aestivum* L.), barley (*Hordeum vulgare* L.), and oats (*Avena sativa* L.) are not adversely affected when the herbicide is applied after the cereals initiate tillering.

Herbicide trials with DPX-4189 and tank mixes of DPX-4189 + metribuzin [4-amino-6-*tert*-butyl-3-(methylthio)-*as*-triazin-5(4*H*)-one] were conducted at two locations in northern Idaho. The purpose of the studies were to determine the spectrum of broadleaf weed control and winter wheat tolerance under no-till and conventional tillage systems.

Materials and Methods

'Nugaines' and 'Hyslop' winter wheat varieties were planted in the no-till and conventional tillage systems, respectively. Plot sizes were 3 m by 10 m arranged in a randomized complete block design. Herbicide applications in the no-till area were made April 27, 1979, when the wheat plants were in the 4- to 5-tiller stage-of-growth. Weed population densities averaged 22 mayweed (*Anthemis cotula* L.), 33 prickly lettuce (*Lactuca serriola* L.), and 121 tumble mustard (*Sisymbrium altissimum* L.) per square meter. It was also observed at the time of herbicide application, the presence of heavy crop residue from the pervious year. Herbicide applications in the conventional tillage area were made May 11, 1979, when the 'Hyslop' wheat plants were in the 3- to 5-tiller stage-of-growth. Weed population densities in this trial averaged 33 henbit (*Lamium amplexicaule* L.), 275 field pennycress (*Thlaspi arvense* L.), and 440 mayweed per square meter. All applications were made with a knapsack sprayer equipped with a 3 nozzle boom calibrated to deliver 374.75 l/ha water carrier. Crop stand reduction and percent weed control were determined in the no-till and conventional tillage plots.

Results and Discussion

In the no-till trial, single applications of DPX-4189 at rates of 0.035, 0.07, and 0.14 kg/ha resulted in complete elimination of all weed species present (Table 1). No crop injury was observed from any rate of herbicide applications.

Table 1. Effects of herbicides for selective broadleaf weed control in winter wheat at Viola, Idaho.

Treatment	Rate kg/ha	% crop stand reduction	% Control tumble mustard	may-weed	prickly lettuce	field pennycress	bu/a	% yield by wt. of check
check	0	0c[1]	0b	0b	0b	0b	73d	100
DPX-4189	.034	0c	100a	100a	100a	100a	87abc	119
DPX-4189	.07	0c	100a	100a	100a	100a	90a	123
DPX-4189	.14	0c	100a	100a	100a	100a	90a	123
DPX-4189+metribuzin	.034 + .42	13b	100a	100a	100a	100a	76cd	104
DPX-4189+metribuzin	.07 + .42	13b	100a	100a	100a	100a	77bcd	106
DPX-4189+metribuzin	.14 + .42	13b	100a	100a	100a	100a	84a-d	115
metribuzin	.42	22a	100a	87ab	70a	100a	78bcd	106

[1]Means followed by the same letter(s) in the same column are not significantly different at the .05 level.

DPX-4189 at rates of 0.035, 0.07, and 0.14 kg/ha in combination with metribuzin at 0.42 kg/ha resulted in complete elimination of all annual broadleaf weed species. However, significant 'Nugaines' winter wheat stand reduction was measured in plots where metribuzin was applied alone or in combination with DPX-4189. Less crop injury was observed in plots treated with DPX-4189 + metribuzin than in plots receiving an equal rate of metribuzin alone. Winter wheat yields from plots treated with DPX-4189 at 0.035, 0.07, and 0.14 kg/ha were significantly higher than yields from plots treated with DPX-4189 + metribuzin at 0.07 + 0.42 kg/ha and 0.14 + 0.42 kg/ha and metribuzin at 0.42 kg/ha as well as the nontreated check. DPX-4189 at 0.035 and 0.07 kg/ha treated plots provided the highest yields in the no-till system trial (Figure 1).

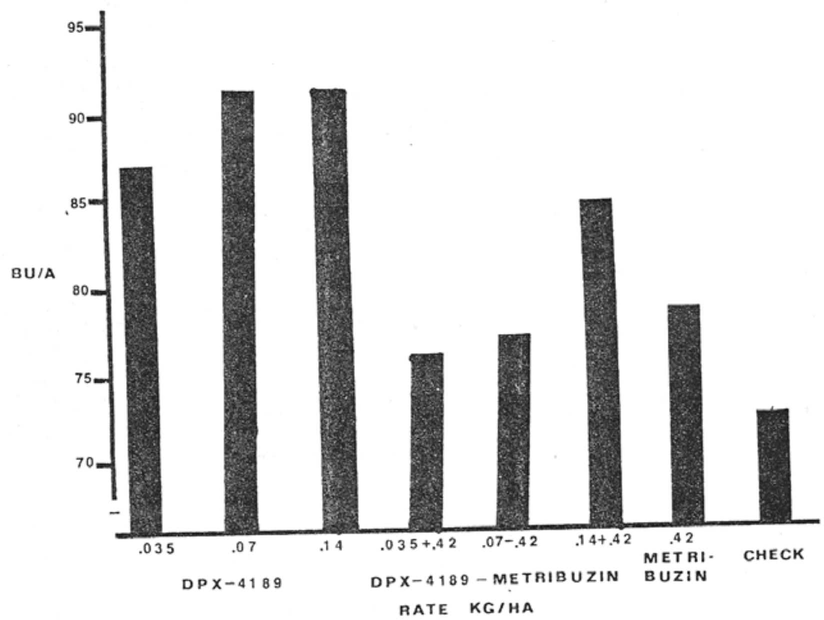

Figure 1. Broadleaf weed control in winter wheat (no till) 1979.

In the conventional tillage system, DPX-4189 at rates of 0.07 and 0.14 kg/ha provided excellent broadspectrum weed control (Table 2). However, due to the variability in population density and growth stages of lambsquarter (*Chenopodium album* L.), control at the higher rate was not significantly better than the lower rate of DPX-4189. No crop injury occurred at either rate of application. Evaluation of DPX-4189 + metribuzin tank mixes in the conventional tillage trial resulted in good to excellent control of all weed species at the 0.07 and 0.28 kg/ha rates of DPX-4189 + metribuzin at 0.42 kg/ha. Weed control was not as good at the higher tank-mix rate of metribuzin; however, the percentages were significantly different. Yields of 'Hyslop' winter wheat from plots treated with both rates of DPX-4189 were doubled compared to the nontreated checks in the conventional tillage trials. The highest yield was measured in plots treated with DPX-4189 + metribuzin at 0.07 + 0.42 kg/ha (Figure 2).

Table 2. Effect of registered and candidate herbicides for broadleaf weed control in winter wheat at Potlatch, Idaho.

Treatment	Rate kg/ha	% Crop stand reduction	% Control				bu/A	% Yield by wt. of check
			Sheperds-purse	May-weed	Pineapple weed	Lambs-quarter		
DPX-4189	.07	0a[1]	100a	92ab	100a	38abc	63ab	200
DPX-4189	.14	0a	100a	100a	100a	93ab	65ab	200
DPX-4189 + metribuzin	.07 + .42	10a	87ab	73abc	98a	93ab	69ab	224
DPX-4189 + metribuzin	.07 + .28	8a	100a	100a	100a	87ab	59abc	185
metribuzin	.28	13a	67ab	68abc	97a	97ab	67ab	211
metribuzin	.42	10a	35bc	43c	95ab	97ab	55abc	166
metribuzin + bromoxynil	.42 + .42	2a	100a	78abc	97a	97ab	70ab	223
check	0	0a	0c	0d	0c	0c	36c	100

[1] Means followed by the same letter(s) are not significantly different at the .05 level.

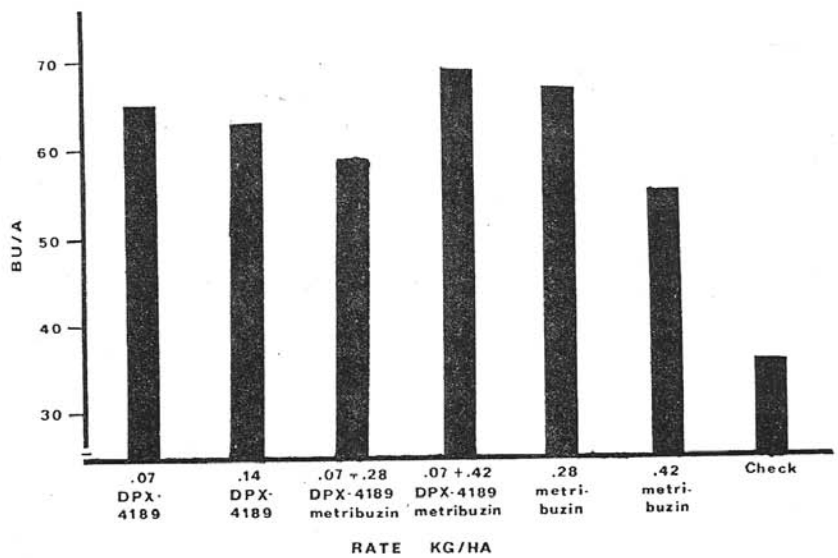

Figure 2. Broadleaf weed control in winter wheat (conventional tillage) 1979.

Summary and Conclusions

All single applications of DPX-4189 provided excellent control of all weed species with the possible exception of lambsquarters. Plots treated with the herbicide exhibited excellent crop tolerance and increased yields at all rates in both tillage systems. Tank mixes of DPX-4189 + metribuzin in the no-till trial resulted in excellent weed control but measurable crop phytotoxicity was observed. Consequently, lack of positive yield response was attributed to crop stress. Tank-mixes in the conventional tillage trial resulted in good to excellent weed control. Yields from plots treated with DPX-4189 alone and in combination with metribuzin were better than the check.

DPX-4189 appears to be an excellant candidate herbicide for annual broadleaf weed control in both conventional and no-till winter wheat systems.

GLYPHOSATE FOR CHEMICAL FALLOW

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

Abstract: The use of glyphosate [*N*-(phosphonomethyl)glycine] for chemical fallow is increasing in Montana because of its broad spectrum of control and non-residual properties. A major problem faced by farmers is the proper time and rate of application of glyphosate. Farmers tend to delay application of glyphosate because of its non-residual properties. The consequences are more glyphosate is needed to control existing vegetation, and soil moisture is lost through transpiration by weeds.

This study was conducted to determine the rate of glyphosate needed to control 15 species of weeds at three stages of growth. Soil samples were taken to a depth of 3 feet to measure soil moisture loss due to weed growth during the season. Glyphosate was applied on approximately June 10, June 24, and July 8, 1979 at 0, 1/8, 1/4, 1/2, and 1 lb ae/A at four locations in Montana.

Prickly lettuce (*Lactuca serriola* L.), dandelion (*Taraxacum officinale* Weber), Russian thistle [*Salsola kali* (L.) var. *tenuifolia* Tausch.], yellow goatsbeard (*Tragopogon major*), Canada thistle [*Cirsium arvense* (L.) Scop.], shepherdspurse [*Capsella bursa-pastoris* (L.) Medic.], and hoary cress [*Cardaria draba* (L.) Desv.] require one pound of glyphosate per acre or more for control (Table 1). Alternatively, field pennycress (*Thilaspi arvense* L.) and downy brome (*Bromus tectorum* L.) are susceptible to low rates of glyphosate. A field survey found that stubble fields in Montana contained from 3 to 12 species of weeds and usually one or more of the species present was tolerand to glyphosate at rates below 1 lb/A.

Small weed seedlings are capable of extracting water from soil profile depths in excess of three feet. Each two-week delay in application of glyphosate resulted in substantial loss of subsoil moisture. Glyphosate is an effective chemical for chemical fallow; however, farmers will need to pay close attention to the stage of plant growth because of soil moisture loss as well as the degree of weed control after application of glyphosate.

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Table 1. The rate of glyphosate required for 80% control of 15 weeds at several stages of plant growth.

No.	Weed	Stage of Growth (pints of glyphosate/acre)			
1.	Prickly Lettuce (*Lactuca scariola*)	6-8" Tall (1/2)	8-10" Tall (1)	10-14" Tall (2)	Flowering (> 2)
2.	Dandelion (*Taraxacum officinale*)	10-14" Rosette Flowering (1)	Post Flowering (>2)		
3.	Yellow Goatsbeard (*Tragopogon major*)	8-10" Tall (1)	10-12" Tall (budstage) (2)	12-18" Tall (flowering) (>2)	
4.	Canada Thistle (*Cirsium arvense*)	6-8" Tall (1)	10-16" Tall (2)	24-38" Tall (flowering) (>2)	
5.	Kochia (*Kochia scoparia*)	2-4" Tall (1/4)	4-12" Tall (2)	8-13" Tall (2)	
6.	Russian Thistle (*Salsola kali*)	1-3" Tall (1)	2-6" Tall (2)	5-8" Tall (2)	6-12" Tall (2)
7.	Tansy Mustard (*Descurainia pinnata*)	10-12" Tall (1/4)	14-18" Tall (1/4)	16-18" Tall (bud stage) (1/2)	18-24" Tall (flowering) (1/2)
8.	Shepards Purse (*Capsella bursa-pastoris*)	6-8" Tall (bud stage) (1)	10-14" Tall (flowering) (2)	14-18" Tall (flowering) (>2)	
9.	Field Pennycress (*Thlaspi arvense*)	8-10" Tall (flowering) (1/4)	10-12" Tall (flowering) (1/4)		
10.	Volunteer Wheat (*Triticum spp.*)	4-5 leaf (1/2)	6-12" Tall (5 lf.-milk) (1)	10-12" Tall (milk) (1)	10-12" Tall (soft dough) (1)
		12-16" Tall (soft dough) (1)	12-18" Tall (hard dough) (2)		
11.	Downy Bromegrass (*Bromus tectorum*)	6-10" Tall (headed) (1/4)	6-12" Tall (near maturity) (1/4)		
12.	Wild Oats (*Avena fatua*)	3-4 lf. stage (1/2)	10-16" Tall (1)	10-20" Tall (heading) (1)	
13.	Wild Buckwheat (*Polygonum convolvulus*)	2" Tall (1/4)	2-3" Tall (1)	3-5" Tall (1)	
14.	Hoary Cress (*Cardaria draba*)	6-10" Tall (1)	8-10" Tall (budstage) (1)	8-12" Tall (flowering) (1)	
15.	Bedstraw (*Galium aparine*)	4-6" Tall (1/2)	5-8" Tall (1/2)		

JOINTED GOATGRASS - A NEW PROBLEM IN COLORADO WHEAT

William W. Donald[1]

Annual broadleaf and grass weeds have caused major yield losses in winter wheat in Colorado (4). In addition to lowering yield by competing for growth requirements and reducing harvesting efficiency, weeds reduce crop quality by contaminating the harvested grain. Weeds also intensify problems of insects, diseases, and other pests by serving as alternate hosts.

There are three major grass weed problems in Colorado wheat: downy brome (*Bromus tectorum* L.), common or cultivated rye (*Secale cereale* L.), and jointed goatgrass (*Aegilops cylindrica* Host.). All three are annuals.

Jointed goatgrass is difficult to distinguish from wheat. In the seelding stage, its coleoptile and first leaf are brownish green, whereas wheat is green. More mature plants have long hairs near the base of the leaf blade, on the ligule and on the leaf sheath. The goatsgrass seedhead is distinctly different than the wheat spike. It is stem-like and divided into a variable number of rachis segments. Under highly competitive conditions only three to five rachis segments form. Under more favorable

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conditions eleven or twelve segments are formed. Usually each segment contains two seeds, but as many as four may be present (6).

Jointed goatgrass is well adapted to stubble-mulch tillage in the winter wheat-fallow rotation (5,12). As sweep tillage has increased in winter wheat for residue management and erosion control (11), so has the grass weed complex of downy brome and jointed goatgrass (12). Sweep tillage, rodweeding or discing leaves about 70 to 75% of the soil seed reserve in the top 1 1/2 inch of the soil. The bulk of the remaining seed lies between 1 1/2 and 3 inches deep. The fibrous roots of these grasses readily reestablish after subtillage in moist soil. Lack of profitable rotation crops has also promoted the increase of these weeds, in part because their life cycles are similar to winter wheat. Germination and seedling characteristics of jointed goatgrass and similarity of crop and weed phenology make this weed difficult to control. It germinates at the same time as wheat and its development matches that of wheat throughout the season (2,7,18). Such similarities in development should not be too surprising since the weed is genetically related to wheat. Because of common progenitors, both species share the D chromosome (9).

Not only does jointed goatgrass compete with winter wheat to reduce yields (2,5) but it lowers the quality of the harvest. Goatgrass seed is harvested with wheat during combining. Goatgrass seed matures at about the same time as wheat and its seedheads are as tall as those of wheat. Attempts to reduce seed contamination by combining high were futile.

Because of similarities in seed diameter, the goatgrass seed is not easily removed from wheat seed by conventional means. Indent-disc or indent cylinder seed cleaners may be needed to separate the seed on the basis of length (1). Such devices are slow, costly to acquire and operate, and are not now used commercially in the state. They would represent a significant economic investment to the seed cleaning operations of grain storage businesses. The cost of seed cleaning is passed on to the farmer. Thus, farmers with a severe jointed goatgrass problem are put at an economic disadvantage. From a farmer's viewpoint seed cleaning is a superficial answer to this problem.

In 1979 a survey was sent to county agents and grain dealers in Colorado's wheat growing counties to determine the distribution of jointed goatgrass. The grain elevator managers were asked whether goatgrass seed was found in the last two wheat harvests, what proportion of farmers in their area had it, and where it existed in their marketing regions. The survey showe that jointed goatgrass was a harvest problem in a broad swath stretching from Phillips and Sedgwich Counties, through Washington County into Lincoln and Elbert Counties (Figure 1). In this region, 70% of the responding grain dealers reported that it was a problem among less than a quarter of their farmers. Thirty percent reported that between 25 and 75% of the farmers in their area had it. Dockages of up to 20 to 25% for goatgrass contamination in wheat were reported by two elevators in Limon and Genoa. Such high dockages are somewhat unusual.

Jointed goatgrass is not limited to Colorado. It was also reported in Washington, New York, Pennsylvania, Indiana west to Wyoming, and Utah south to Texas (6). Recently weed scientists is Montana and Idaho reported that it was present in their winter wheat growing areas. This wide distribution mirrors the range of adaptation of winter wheat in the United States. Consequently, edaphic factors are unlikely to be limiting the distribution of this weed.

Goatgrass seed was probably moved from state to state and county to county by the custom combines. Once established on a farm it can be moved by water and may become heavy in low lying areas or draws. Because of the large size of the seed dispersal units, it is unlikely to be moved far by the wind. Goatgrass seed can be spread on farms and between farms if infested seed rather than certified seed is planted. Although there are reports of jointed goatgrass in certified winter wheat seed (8), this does not appear to be a major means of weed spread.

In 1978, goatgrass was declared a noxious weed seed in Colorado by state law (8). Hopefully, this law will help to limit spread of the weed in certified wheat seed and consequently on framland.

From the grain elevator survey, it is obvious that goatgrass is present in a large part of Colorado's wheat growing region. However, it is not present on every farm. It represents a serious potential threat to winter wheat production in Colorado. The chief objective of my experiment station project is to develop systems of management to control it and prevent its spread.

Selective winter wheat herbicides for goatgrass control. Any strategy for selective control of jointed goatgrass in winter wheat must also be suitable for downy brome, the other major grass weed in winter wheat. In turn, control strategies for these grass weeds must be compatible with broadleaf weed control in winter wheat-fallow rotation. The majority of experimental and registered herbicides for broadleaf and grass control are most effective in Colorado when applied postemergence in the spring (4). There is generally insufficient soil moisture to activate preemergence or pre-plant incorporated treatments in the fall in Colorado. Consequently, postemergence treatments are the method of choice.

There are no published reports of effective postemergence herbicides for selective goatgrass control in wheat. Much more is known about downy brome control. Several postemergence herbicides have been registered to control grasses in winter wheat: barban (4-chloro-2-butynyl-*m*-chlorocarbanilate), triallate [*S*-(2,3,3-trichloroallyl)diisopropylthiocarbamate], diallate [*S*-(2,3-dichloroallyl)diisopropylthiocarbamate], difenzoquat (1,2-dimethyl-3,5-diphenyl-1*H*-pyrazolium) and MSMA (monosodium methanearsonate). These were screened on goatgrass in the greenhouse and some of them were field-tested.

A new control strategy involving herbicide antidotes was recently tested on jointed goatgrass and winter wheat (16). Pre-plant incorporated treatments of vernolate (*S*-propyl dipropylthiocarbamate) and EPTC (*S*-ethyl dipropylthiocarbamate) at 4 lb/A and 3 lb/A, respectively, normally control both winter wheat and jointed goatgrass. By treating winter wheat seed with a protectant dressing of 0.75% R-32822, it was hoped that either EPTC or vernolate could be used selectively in winter wheat. While several barley varieties were adequately protected, winter wheat varieties, 'Luke', 'Daws', 'Fieldes' and 'Urquire', were not. This approach will be tried with other wheat varieties, as well as other protectants (e.g. naphthalic anhydride, R-25755, etc.).

Mechanical and chemical control in fallow. Since goatgrass is an annual, long-term control measures should be directed at reducing the weed seed reserve in the soil and preventing further seed-set. This reserve is responsible for the yearly recurrence of this weed. Two approaches will be tried:

1. Nonselective control with herbicides in chemical fallow.
2. Mechanical control during fallow.

Within the last decade, the development of suitable herbicides has made chemical fallow a practical reality in some rotations. There is a great deal of interest in chemical fallow among Colorado farmers.

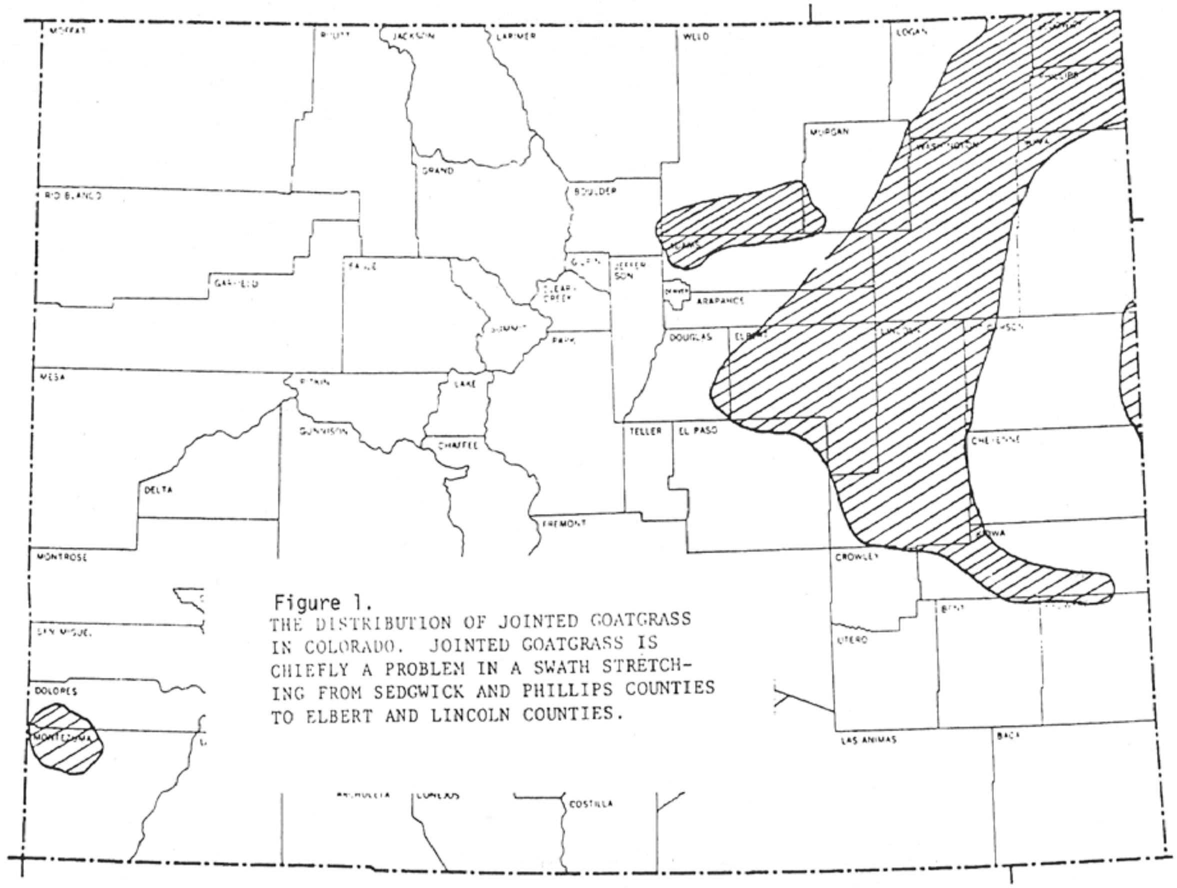

Figure 1.
THE DISTRIBUTION OF JOINTED GOATGRASS IN COLORADO. JOINTED GOATGRASS IS CHIEFLY A PROBLEM IN A SWATH STRETCHING FROM SEDGWICK AND PHILLIPS COUNTIES TO ELBERT AND LINCOLN COUNTIES.

Consequently, it is of practical importance to determine whether the currently tested chemicals can effectively control jointed goatgrass. At present, there is little published data on the effectiveness of fallow herbicides on goatgrass (2).

The most successful fallow treatments have employed sequential applications of different herbicides. Generally contact herbicides, such as paraquat (1,1'-dimethyl-4,4'-bipyridinium ion) or glyphosate [*N*-(phosphonomethyl)glycine], were followed by more presistent herbicides, such as triazines [e.g. atrazine [2-chloro-4-(ethylamino)-6-(isopropylamino)-*s*-triazine] or cyanazine {2-[[4-chloro-6-(ethylamino)-*s*-triazin-2-yl]amino]-2-methylpropionitrile}]. Work in the mid-60's demonstrated that where fall or spring treatments were applied, late germinating, warm season grasses, such stinkgrass [*Eragrostis cilianensis* (All.) Lutati] or witchgrass (*Panicum capillare* L.) developed as problems (3). Sequential chemical fallow treatments of atrazine at 1 lb/A in the fall and paraquat in the spring were effective in reducing the reproductive capacity of downy brome (21,22). Combinations of amitrol (3-amino-*s*-triazole) and atrazine (0.5 and 0.25 lb/A) were also effective on downy brome (15,17).

Weed scientists have developed chemical fallow systems in Kansas and Nebraska. However, these states have more rainfall than Colorado. Less rainfall and different rainfall patterns during the year contributed to making chemical fallow less consistent and less successful in Colorado than elsewhere (4). Soil crusting on chemical fallow plots permitted less infiltration than on stubble mulch plots. During dry years there was excessive carryover and consequent wheat injury from chemical fallow treatments applied in the spring.

The effectiveness of available chemical fallow herbicides on goatgrass will be tested in the greenhouse prior to field testing.

Existing fallow data suggest that a combination of mechanical and chemical control is best for suppressing weed growth and promoting water conservation during fallow. Studies will be conducted on the timing of fallow subtillage (i.e. noble sweeps) in combination with various dates of wheat planting. In other studies, the effectiveness of plowing in moving goatgrass seed to soil depths which prevent emergence will be examined. This approach might be used once every five to six years alternating with stubble-mulch tillage or chemical fallow.

The following control measures were originally developed for downy brome and hold promise for managing jointed goatgrass. Cultivation during fallow plays a pivotal role in downy brome control. However, the effectiveness of either fall discing or spring disc-harrowing depended on the timing and quantity of summer and fall rainfall. The chief objective of such methods was to prevent seed production, deplete soil weed reserves and prevent soil moisture depletion by killing existing weeds and volunteer wheat. The date of the final tillage may determine which species will infest the crop and to what extent (19). Efficient downy brome control in Oregon was achieved by an initial tillage early in the spring of the fallow year with the final rod-weeding just prior to late wheat planting (10). Early tillage killed downy brome before seed set and before large decreases in soil moisture in the top 15 cm. Later spring-tilled plots failed to benefit from rod weeding, because the soil had dried. Other studies corroborate this report in that late tillage failed to control downy brome or jointed goatgrass (14). Greater downy brome control was achieved as the frequency of cultivation increased. In order to deplete soil weed seed reserves of either species to economic levels, it may be necessary to fallow for two or three consecutive years.

Some data on planting date effects on downy brome control in Oregon hold promise for goatgrass control in Colorado. Late fall planting coincided with a reduction in natural downy brome emergence late in the growing season (10). Consequently, the weed was less of a problem in later-planted winter wheat, especially when planting was immediately preceded by rod-weeding. This, however, was not the case in Oklahoma (13). When compared to planting between September 10 and December 22, planting in mid-October was deemed the best. Delayed planting may have failed to completely eliminate downy brome in Oklahoma because of difference in rainfall pattern and seedling emergence in these two states.

Similar kinds of management studies involving planting date will be conducted for control of jointed goatgrass in combination with studies of time of initial subtillage and frequency of rod-weeding during fallow.

Moldboard plowing (bare fallow) in late summer after wheat harvest or in the spring of the fallow year prior to spring rains may move most of the goatgrass seed deep enough to prevent successful emergence. This approach effectively controlled downy brome because it emerged most effectively from depths of only 0.6 to 1.1 inches (20). The plow was more effective than the one-way disc or sweep plow in a continuous winter wheat cropping system (13,20).

Plowing is not viewed as a practice which should be used every year. Cerlainly, if it were used every year, it would be incompatible with water or soil conservation (11). Wheat stubble is more effective in water conservation than bare soil. A 38-year study of Akron has shown that on the average an inch more water is conserved in wheat stubble than bare fallow. Plowing might be useful as an initial treatment followed by mechanical or chemical fallowing. Consequently, the effectiveness of spring and fall plowing goatgrass seed to various depths will be examined alone and in combination with the better mechanical or chemical fallow treatments of the previous experiments. Wheat yields will be determined.

Whether plowing is a long term solution to the problem will depend on how persistent goatgrass seed are in the soil and on whether goatgrass can emerge from the plow depth.

A long term field experiment was set out to examine seed persistence. The viability of goatgrass seed in the field will be studied as a function of time and planting depth. Goatgrass seed in lots of 100 were sealed in nylon mesh packets and planted at depths of 0, 5, 15 and 30 cm in the field. Enough seeds will be planted so that 400 seeds for each depth can be tested for viability each year over six years. At the same time each year seeds will be exhumed from the soil and percent seed germination will be determined in the lab under optimal conditions. Ungerminated seeds will be tested for viability using the tetrazolium chloride assay.

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METRIBUZIN AS A BARLEY HERBICIDE

Richard L. Pocock[1]

Abstract: Metribuzin [4-amino-6-(1,1-dimethylethyl)-3-(methylthio)-1,2,4-triazin-5(4*H*)-one] was evaluated as a barley herbicide in Idaho, Montana, and Utah for the control of many broadleaf weeds and certain grasses. In 1978 and 1979, 12 tests were conducted on irrigated barley and three tests on dryland barley. Sprinkler irrigation was used in eight of the 12 irrigated trials and furrow irrigation in the other four trials. Weed control was consistently superior with sprinkler irrigation than with surface irrigation.

Broadleaf weed control was very good to excellent in all trials. Wild oat (*Avena fatua* L.) control ranged from 20% to 97% on dryland barley and from 75% to 97% on irrigated barley. Metribuzin rates of 0.25 to 0.5 lb a.i./A were applied when barley plants were fully tillered and possessed secondary root development.

Uniform application, timing of application, and proper rate of metribuzin were found to be critical elements for weed control in irrigated or dryland barley.

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TOLERANCE OF SUNFLOWER AND SAFFLOWER TO INFURROW APPLICATIONS OF THIOCARBAMATE HERBICIDES

J. V. Handly and G. A. Lee[1]

Abstract: Greenhouse and field studies were established in 1979 to test the feasibility of placing thiocarbamate herbicides directly in the seed furrow and for evaluation of crop tolerance of sunflower and safflower. Crop tolerance to herbicide applications was observed to be low with in-furrow treatments. Both sunflower (*Helianthus annuus*, var. 894) and safflower (*Carthamus tinctoris*) suffered stand and vigor reductions with most treatments studied. Plots treated with EPTC (*S*-ethyl dipropylthiocarbamate) at 6.72 kg/ha had the greatest reductions in stand and vigor for both crops. Sunflower stand reduction and vigor reduction were 72 and 92%, respectively. Safflower stands were reduced 100%. While other treatments produced less damage almost all gave unacceptable vigor reductions, stand reductions, or both. Treatments that showed promise are butylate (*S*-ethyl diisobutylthiocarbamate) plus R-25788 (*N*,*N*-diallyl-2,2-dichloroacetamide) in both sunflower and safflower, and cycloate (*S*-ethyl *N*-ethylthiocyclohexanecarbamate) in sunflower. Both of these compounds gave stand reductions of 10% or less and fairly low vigor reductions at the lower rates of 2.24 and 4.48 kg/ha for cycloate and 3.36 and 6.72 kg/ha for butylate plus R-25788.

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COMPETITION OF SUNFLOWER AND VELVETLEAF IN SUGARBEETS

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

Abstract: Sunflower (*Helianthus annuus* L.) and velvetleaf (*Abutilon theophrasti* Medic.) weeds generally are not abundant in sugarbeet fields; however, even low densities of these two annual weeds can be very competitive. This experiment was initiated in 1978 to determine the competitive effects of low densities of sunflower and velvetleaf plants on sugarbeet yield components and recoverable sucrose, and to derive a predictive equation relating sugarbeet yield components with weed densities. Sunflower and velvetleaf were planted in separate experiments by sowing seeds at specified intervals to establish weed densitites of 0, 6, 12, 18, and 24 plants per 30 m of sugarbeet row. To aid our understanding of the biology of sunflower and velvetleaf, the height of individual weeds was measured at 4-week intervals, terminating in mid-August. Height of sunflower and velvetleaf plants measured in mid-August did not differ significantly at any density. During September sunflower and velvetleaf were harvested from the plots and weighed. Weights of these two weed species on a per plant basis decreased with increasing densities. Weed densities of 6, 12, 18, and 24 sunflower plants per 30 m of row reduced the average root yields over a two-year period by 40, 52, 67, and 73%, and recoverable sucrose 42, 54, 70, and 74%, respectively. Equal densities of velvetleaf plants reduced the root yield 14, 17, 25, and 29% and recoverable sucrose 14, 17, 25, and 31%, respectively. These data suggest that sunflower is considerably more competitive than velvetleaf in sugarbeets.

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CONTROL OF FIVE BROADLEAF WEEDS IN SUGARBEETS WITH GLYPHOSATE

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

Abstract: Annual broadleaf weeds that excape cultivation and herbicidal treatments applied in sugarbeets compete with the crop. Since even low populations of annual weeds can reduce root and sucrose yields, we conducted field studies for 3 yr to determine the effectiveness of glyphosate [*N*-(phosphonomethyl)glycine] to control or minimize the competitiveness of low densities of eaual populations of common lambsquarters (*Chenopodium album* L.), kochia [*Kochia scoparia* (L.) Schrad.], and redroot pigweed (*Amaranthus retroflexus* L.) (Experiment 1) or equal populations of sunflower (*Helianthus annuus* L.) and velvetleaf (*Abutilon theophrasti* Medic.) (Experiment 2). These weeds were spaced alternately within the row to achieve broadcast densities of 0, 6, 12, 18, and 24 plants per 30 m of row. Glyphosate was sprayed 10 cm above the sugarbeet canopy with a recirculating sprayer at 1.7 kg/ha and at a volume of 280 L/ha in 1977 and 187 L/ha in 1978. In 1979, a 20% solution of glyphosate was applied with a vertical roller. Glyphosate was applied twice each year. In both experiments,

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weed control varied from year to year depending on weed species and herbicide coverage. The stand of sugarbeets was reduced the most in 1977 and was associated with weed density. Since weed competition was reduced significantly by glyphosate, root yields in treated plots were higher than those in untreated plots at comparable densities. In Experiment 1, the average reduction in root yields over a 3-yr period was 15, 28, 39, and 45% where the original densities were 6, 12, 18, and 24 weeds per 30 m of row. In a comparable study in which these three broadleaf weeds were treated with glyphosate, root yields were reduced only 8, 15, 15, and 22%, respectively. In Experiment 2, the average reduction in root yields over a 2-yr period was 21, 40, 50, and 57% where the original densities were 6, 12, 18, and 24 weeds per 30 m of row. When these two broadleaf weeds were treated with glyphosate, root yields were reduced only 13, 13, 25, and 35%, respectively.

VEGETATION MANAGEMENT IN FORESTS--BASIC PROBLEMS: WHAT NEXT?

Michael Newton[1]

Vegetation management in forests has become highly publicized and the focus of a charged emotional debate. The use of herbicides is currently in the center of action but furor exists regarding smoke management, clearcutting and various other forestry methods. A diverse and effective set of technologies has been developed to aid foresters in dealing with a large backlog of problems. Public acceptance has been slow in coming, and looms today as a major management problem in a program of considerable social benefit.

The debate over these practices centers on health effects for those who oppose herbicides and other technologies, and on their versatility, safety and economy for those who wish to use them. The argument has become focused on "industry against mothers", or "how much profit is a deformed baby worth?" The arguments are intense and are spreading nationwide. Under threat (for different reasons) are professionalism in both resource management and journalism.

The conflict started in Arizona, whence it spread to Oregon, California, Idaho, Washington, Wisconsin, Minnesota, Arkansas, Maine and Vermont. The controversy has erupted in many locations recently settled by groups who support a non-technological approach to resource management. In the past few years, 2,4-D [(2,4-dichlorophenoxy)acetic acid] and 2,4,5-T [(2,4,5-trichlorophenoxy)acetic acid] have become household words, not because of their immense value for crop production but for their role as "environmental poisons". A major contributing factor to the spread of the controversy has been the news media. An example of a non-uncommon reporting slant is exemplified in a letter from one of America's largest dailies to one of our local citizens, in which one of the senior editors explained, "we tried very hard to avoid taking sides (on the herbicide issue) in our series, the *Poisoning of America*".

So let's pause and see what uses are made of these chemicals to make them so "terribly destructive" to human health and yet so very profitable that such "destruction" is worthwhile.

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Several herbicides are used for controlling grasses lethal to young plantations. In the same way that selective herbicides are used for growing all manner of other crops, they are used with great selectivity for conserving moisture and nutrients for the benefit of forest crops. They are also used to manage rodent habitat so that it is unnecessary to use poisonous baits. The "fearsome" herbicides used for this purpose are atrazine [2-chloro-4-(ethylamino)-6-(isopropylamino)-*s*-triazine], 2,4-D, pronamide [3,5-dichloro(*N*-1,1-dimethyl-2-propynyl)benzamide], dalapon (2,2-dichloropropionic acid), and hexazinone [3-cyclohexyl-6-(dimethylamino)-1-methyl-1,3,5-triazine-2,4(1*H*,3*H*-dione]. One commonly finds accounts in the popular press of the ability of these chemicals to produce mutations in bacteria, and cancer and birth defects in mice. Reference to the immense dosages to produce these problems are omitted. Reference to decades of use in agriculture without adverse consequences is omitted. Reference to the very low levels of human exposure from such uses in omitted. The benefits are seldom noted.

So, our grass control chemicals have been reported as dangerous and to the public they are frightening. Yet these safe chemicals have given reforestation specialists in dry zones an impressive boost in successfully reestablishing forests.

We also use chemicals to prepare sites for planting when they have been occupied by excessive woody cover. For this purpose, the chemicals are 2,4-D, 2,4,5-T, silvex [2-(2,4,5-trichlorophenoxy)propionic acid], picloram (4-amino-3,5,6-trichloropicolinic acid), triclopyr [[(3,5,6-trichloro-2-pyridinyl)oxy]acetic acid], dicamba (3,6-dichloro-*o*-anisic acid) and others. Again, the familiar phenoxy herbicides are described in the press according to their ability to produce harmful effects in mice or monkeys; information about elevated doses is withheld. The other herbicides, with their very low toxicity levels, are criticized because too little is known about their harmful effects.

There are many millions of acres in which investments have already been committed to reforestation, and where brush threatens to destroy the plantation. Several chemicals can be used with nearly complete selectivity in so-called "release" operations, in which diverse woody plant communities may be controlled without injuring planted conifers. Among the chemicals that are useful in this program are our old friends the phenoxies, glyphosate [*N*-(phosphonomethyl)glycine], fosamine ammonium [ethyl hydrogen (aminocarbonyl)phosphonate] and others. The job these chemicals can do in providing a measure of control in massive and diverse weed communities is an incredible technical achievement. The perspective of such uses held by the public is one in which chemical companies withhold critical data on risk, foresters are continually damaging crop species or in which the chemicals are regarded as extremely harmful because the labels indicate that they should be kept out of water. None of these perspectives reflects either the track records of manufacturers or current estimates of potential harm.

The public is not being informed about the remarkable field record of safety of these compounds, or that animals have been fed high dosages without any effects, often for a lifetime. Our readers and viewers have been thoroughly impressed that these chemicals are the likely source of cancer and reproductive disorders throughout forested regions, and that the solution to their problems is to stop using herbicides. Information is not reaching news audiences that cutting brush by hand or pushing it out with a bulldozer is immensely more dangerous (even due to chemical insult) than controlling it chemically.

How many voters know that taxpayers have a substantial additional burden if public agencies are unable to use these products in the management of forests? Can we expect a "public" informed in this way to support the most constructive programs for reclaiming brushed-up timberlands? I think not under present conditions.

Democratization of public involvement in resource management is increasing resource problems. The general public remains largely unsympathetic with programs developed by professionals based on the best available evidence. Use of the "public input" process by federal agencies at the technical level has foreclosed the use of best management techniques, hence has eliminated integrated pest management refinements in weed control. As the result, the foresters' ability to manage ecosystems by selective control of primary producers has been subordinated to a focus on non-management. "Scenic" brushlands and absolute purity of water are pre-empting commodity management even at the expense of community stability and long-term availability of renewable resources. The public simply hasn't been informed well on the technical issues, yet the input of laymen at the technical level is an important part of the federal decision process today.

Where have we failed to deal with public psychology, education and politics? Some features of modern forestry apparently contribute to this problem. First, we have only recently arrived at a position where our future availability of timber will depend on our ability to grow it deliberately. We have only recently discovered that we cannot grow a forest of high quality on a large scale without weeding any more than other crops. So foresters are beginning to use weed control on an appreciable scale. A new phenomenon, large patches of very visible dead brush, is appearing in cutover forest land. This is not a surprise to anybody who specializes in growing things, but it is a surprise to our urban oriented majority. It upsets them. The new experience awakens a fear of the unknown and uncontrollable.

Foresters and other resource managers normally have weed control as a minor responsibility. Not much time is spent explaining to the public what is happening in the woods. Professionals therefore find themselves on the defensive end of technical discussions with irate environmental interest groups who have informed themselves thoroughly on limited technical questions. Foresters often find themselves inadequately prepared to carry on a detailed technical discussion in an area of marginal relevance with articulate protagonists who have taken the time to read and to marshall arguments. When such confrontations are picked up the media, they have the disastrous effect of undermining public confidence in resource professionals who are very well trained in relevant technology.

Professional resource managers are a minority group. Their limited numbers have restricted their ability to keep a stream of information going to news media, to legislators and to congressmen about the important features of their new programs. Yet numerous environmental groups have engaged themselves vigorously in public education through all forms of media. By default, resource managers have essentially turned over public education to organizations that are not particularly sympathetic with professional resource management.

A major problem in federal programs has arisen from a failure of professionals to demand accountability of political appointees and of those who appoint them. It is common for policy level appointive offices in resource management areas to be filled by persons with little or no relevant professional training in resource management. Such persons have had substantial difficulty with communicating with resource professionals, and have demonstrated inability to communicate professional resource management judgment to their elected superiors.

Resource management professionals have not impressed editors with the need to put informed reporters on technical issues. Forestry, in particular, seems to draw "environmental' editors for coverage of professional forestry topics. Such reporting tends to be sympathetic to preservationist rather than professional resource management perspectives. Even when professionals try to meet reporters for constructive communication, the message is often unrecognizable.

So matters may well get worse.

Let me share some specific prognostications:

1. The cancellation hearings on 2,4,5-T will be a regulatory scientific donnybrook. An enormous amount of data supports the continued use of 2,4,5-T and the EPA has taken a firm stand in the direction of cancelling the product. The EPA is in serious danger of compromising its scientific objectivity. In its present information status, the public is likely to judge harshly restrictive action as entirely appropriate.
2. Elected officials will not pressure regulatory agencies to rely on the preponderance of scientific data. Resource-oriented decisions arising from scientific analysis are unpopular with an urban majority informed by an environmentally oriented media. So, forests and farms will be confronted by more and more restrictions of increasing arbitrary nature.
3. High quality wood will become scarcer and prices will raise.
4. Publicly-owned forest land will become less available for production of commodity products, such as timber, as increasing acreages are diverted to recreational and other non-commodity pursuits.
5. In 20-40 years, public officials will discover that it is a good idea to have privately-owned renewable resources in productive condition and will discover belatedly that it will take 40 to 100 years to get results.

We seem to be confronted with the inescapable conclusion that the value of forest resources is likely to decline at a time when renewable resources are vital to our national security, to our comfort, and to our independence of imported fuel and building materials. The policy-level solutions to this problem are educational rather than technical. It is our responsibility to convey this message. We must work with existing media and work with reporters we can trust for accuracy.

In conclusion, vegetation management has become highly successful in solving many problems of forest biology. Our production of forest commodities can double easily with appropriate use of tools. Few sacrifices need be made. Forests occupy a special place in people's philosophies and emotions, and management philosophy requires some adjustment of public attitude. Public acceptance of the appropriate use of these tools will improve only with public trust in professionalism in resource management. A massive educational program is needed.

"Neutral court" resolution of technical matters by professionals will have to replace the over-responsive and adversarial public-input process at the technical level. The place for public input is clearly at the level of management goals, not the level of science and technology. There has been a clear lesson to all those involved in resource management that science may not be compromised if technical questions are to be resolved in the best public interest. This will require professionalism among policy-level public officials.

I believe the current public attitude is temporary. Future production deficits will be determined by its life expectancy, however, and a turn-around will take an enormous effort by the professional minority. I am hopeful that the agricultural and chemical communities can learn from forestry problems. I hope the resource management community, in general, can all join together in aggressive public educational programs to head off similar confrontations elsewhere in the spectrum of resource management. In order to achieve this, I believe all professionals will have to be involved in the educational process. So, speak up! Speak knowledgeably! And speak with kindness and understanding.

TO KILL, CULL, OR CUT A FOREST WEED

Michael Newton[1]

Management of vegetation is the forester's job. With it, he manages the wildlife, the water, and the aesthetic values while he grows forest products.

Today's forester has to correct the problems of centuries of exploitive management. These problems have arisen from a continuous removal of desirable trees while leaving weed trees to flourish. In a pasture where cows eat the grass and leave the thistles, it is not long before there are mostly thistles. This is also true in a forest. Close to half of America's standing wood is of low quality. If weed-beset forest land were blocked together it would cover Texas, Washington, and California. Unnaturally promoted weeds are the primary culprit, making them by far the worst pest of timber production in the country.

Biological problems of such scope are inevitably complex. But one principal is clear: one does not solve forest weed problems by letting weeds grow, any more than one gardens by encouraging weeds.

The general problem of forest weeds takes many forms. The use of a single tool for solving the problems of weeds would be like using a single medicine for curing all human ailments. So the forester needs a variety of methods and management systems to manage a diverse forest community for many uses.

But today's forester is beset by attacks on his tools and his management philosophy. There is more public pressure to desist from management than there is to press of with successful reforestation. At the same time, non-management is not an option since our nation has placed high priority on the improvement of its forests.

The forester has only a few choices for weeding the forest and restoring desirable timber stands. Because the principal effect of any successful method will be the growth of a forest, his most crucial decision is to pursue that goal. Next he must choose a method to fit the task.

Every action the forester takes to control weeds must have some impact or no space will be created where a young tree can grow. He makes his choices after judging the array of impacts and costs and chances of success.

Among the choices that work well, the forester must be concerned with safety for his workers, wildlife, water quality, and protection of the soil resource. Every method must be judged by the same criteria, with the best available data brought to bear.

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Let's look at the effects of six possible weeding methods for which data are being gathered at Oregon State University. The first and obvious thought is, let's try doing nothing! The list of consequences below is unumpressive--one does nothing, the weeds grow, and one accomplished nothing toward his reforestation goal.

No Vegetation Management

1. Innate site productivity--no effect.
2. Success in controlling weeds--none.
3. Wildlife--very slow change from status quo, favorable or unfavorable.
4. Water--no effect.
5. Human environment--none immediate. Eventual shortage of renewable resource amenities.
6. Costs/Benefits--taxes and investment continue with diminishing benefits if harvests continue without compensatory removal of weeds.
7. Over-all utility--low, inconsistent with silvicultural principles related to continuous production of wood.

That seems generally unsatisfactory where weeds are prevalent, so let's look at cutting brush by hand.

Hand Cutting

1. Innate productivity--no effect, focussed on species dominant after cutting.
2. Success in controlling weeds--poor unless herbicides used in conjunction. Better at some seasons than others.
3. Wildlife--major negative effect on large mammals, positive effects on rodents. Long-term dependent on forest cover.
4. Water--no effect.
5. Human environment--high operator hazard.
6. Costs/Benefits--high human resource need, high fire hazard, high energy cost, high medical insurace, high risk of injury to desirable species. Effective for release under limited circumstances.
7. Over-all utility--useful when combined with herbicides with or without fire. Not effective enough when used alone.

We discover that swinging cutting tools on steep terrain amid falling weed trees is a very hazardous task. Indeed, it is one of the most hazardous industrial jobs in Oregon. Furthermore, where every shrub of hardwood is cut, a hundred sprouts grow like a trimmed hedge. Perhaps a bulldozer would be safer and more effective.

Bulldozer

1. Innate site productivity--no effect or slight loss, but mostly available for planted species.
2. Success in controlling weeds--short term.
3. Wildlife--attracts some, eliminates some locally.
4. Water--maximum impact, siltation.
5. Human environment--moderate hazard.
6. Costs/Benefits--moderate human resource need and operator hazard; maximum energy need. Success high.
7. Over-all utility--a useful tool on gentle slopes.

Unfortunately, the bulldozer can only work on gentle slopes. Even there, it is limited to dry weather and to places where siltation won't result. And it is still quite hazardous and highly energy and captial intensive. Perhaps herbicides will work.

Herbicides

1. Innate site productivity--no impact, focussed on resistant species.
2. Success in controlling weeds--variable.
3. Wildlife--entirely dependent on habitat. No direct chemical effects on record. Generally least destructive.
4. Water--no biological effect if used according to report EPA 910/ 9-77-036.
5. Human environment--slight risk of falling dead trees, no demonstrable chemical hazard.
6. Costs/Benefits--human resources maximized in planting, minimized in application. Very low evergy cost. Uniquely selective--successful where desirable species are present.
7. Over-all utility--maximum versatility, safest and lowest costs. Improves utility and safety of other practices.

Herbicides solve some problems, but leave some. They are by far the safest method, and have the least effects on soil, water and wildlife. But the crossword puzzle on the next page shows that they usually leave some weeds. They can be selective among weeds as well as between crops and weeds. But they can make other methods work better, and there are some circumstances where they work perfectly alone. "No-till" cultivation of trees is relatively more energy-efficient and soil protective than is no-till farming in relation to intensive mechanical cultivation. But isn't fire more "natural"?

Fire Without Herbicide

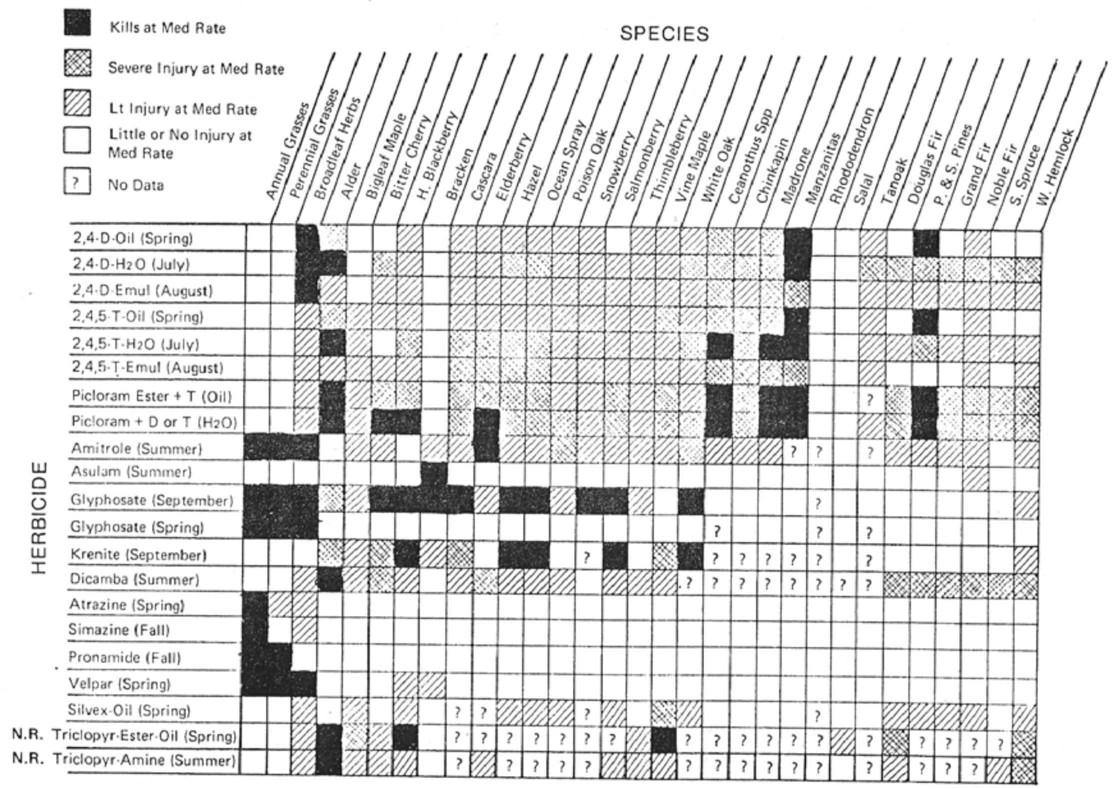
1. Innate site productivity--no effect or slight loss. Partly available for planted species.
2. Success in controlling weeds--complete top kill, stimulates sprouts, herbs, "fire type" shrub germination.
3. Wildlife--maximum short-term negative impact, mid-term favorable for terrestrial species. Long-term dependent on forest cover.
4. Water--short term chemical changes, some siltation in steep terrain.
5. Human environment--moderate to high hazard in preparing fuel (slashing) and burning. Maximum smoke.
6. Costs/Benefits--high human resource need, high energy cost, high risk of escapement, inconvenience of smoke, risk of not being able to burn, low success.
7. Over-all utility--low.

Fire is a natural phenomenon, but it is not very selective. Brush fields and stands of low-grade trees are not usually of natural origin, either, and fire is very difficult to use without very expensive and hazardous preparation of the brush field as fuel. And like other hand-cut brushfields, every charred stump may sprout. The burning of green fuel is also very smoky. So there is merit to a combination of herbicide and fire.

Fire With Herbicide

1. Innate site productivity--no effect or slight loss, mostly available for planted species.
2. Success in controlling weeds--complete top kill, weak sprouting. Stimulates herbs, "fire type" shrubs.
3. Wildlife--maximum short-term negative impact, mid-term favorable for terrestrial species. Long-term dependent on forest cover.

SUSCEPTIBILITY OF FOREST SPECIES TO REGISTERED HERBICIDES



4. Water--short-term chemical (ash) changes, moderate siltation in steep terrain.
5. Human environment--moderate to high hazard in preparing fuel (slashing). Minimum smoke.
6. Costs/Benefits--very high labor requirement, high medical cost, high energy cost. Low risk of escapement, high risk of not being able to burn. Success ratio high.
7. Over-all utility--excellent is coastal brush fields, limited on low-productivity sites because of cost.

The addition of herbicide to prepare an inflammable area surrounded by a green perimeter reduces the chances of a fire escaping. It also reduces the sprout problem and thus improves prospects for growing trees. It is still non-selective and requires very costly and hazardous fuel preparation.

Each of the methods has some good features and some weaknesses. All are used for a constructive purpose--the return of a productive forest out of a "thistle patch".

So the forester must make his decision about a method on a multi-factor basis. He can line up his evidence on the options as I have done in Table 2 showing "Comparisons of northwesters vegetation management alternatives."

The forester will always be faced with people who disagree with his decision. Whatever choice he makes, he must be able to defend. So when he lines up his alternatives, the quality of evidence must be equally good for every choice. But the quality of evidence is viewed differently by each onlooker, especially regarding safety.

There is a long and near-perfect safety record for herbicides. The few accidents have been mechanical. There is a long record of crippling injuries and deaths among woods workers using cutting tools. To allege that alternatives to herbicides are safer ignores this record. It is not possible to prove or guarantee perfect safety. Indeed, perfect safety does not characterize any of the alternatives.

There is much more scientific infromation about the growth of conifers in forests that have been treated with herbicides than about those that have been cut or burned without treatment. And for good reason. It is not very practical to put limited resources to the study of details of methods that have been abondoned because they are not effective or practical--they left the brushy "thistles".

So the forester must make his choice and stick with it on the best evidence. If there is pressure to change his methods, he has an obligation to require documented evidence that an alternative is safer or more effective, or has a significantly more favorable effect on water or wildlife than the method of his choice. Dependence on poor methods or no methods in the past has left the woods in their present weed-infested condition.

References

1. Newton, M. 1973. Forest rehabilitation in North America: Some simplifications. J. Forestry 71(3):159-162.

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Table 2.

COMPARISON OF NORTHWESTERN VEGETATION MANAGEMENT
ALTERNATIVES WITH CONTINUED HARVEST OF FOREST PRODUCTS

Method	Human Safety	Timber Growth Potential	Water	Wildlife	Risk of Failure	Overall Utility
No Vegetation Control	Safe	Low	No effect	No effect	None	Poor
Hand Cutting	High risk ($12.85-51.40)[1]	Low to High	No effect	Adverse for birds fav. for rodents	High	Poor
Bulldozer	Moderate risk ($9.00-18.00)	Moderate to High	Some turbidity	Adverse for bird, rodents	Med-Low	Good, Limited
Utilization	High risk ($12.85-51.40)	Unknown	No effect	Adverse for birds, fav. for deer	Unknown	Unknown
Fire W/O Herbicide	High risk ($13.53-52.76)	Low to Moderate	No effect	Adverse for birds, rodents; fav. for deer	High	Poor
Fire W/ Herbicide	High risk ($13.53-52.76)	High	No effect or slight temp. inc.	Adverse for birds, rodents; fav. for deer	Low	Fair-Exc.
Herbicide Only	Safe ($0.11-.21)	Low to High	No effect	Fav. for birds, rodents, deer	Low-High	Fair-Exc.

[1]Risk expressed as medical cost per acre, Oregon State Accident Insurance Fund rates of: Power saw operator, $32.13; firemen, $6.21; crop duster pilot, $46.62; batchman, herbicides, $4.46; bulldozer operator $32.13 per hundred dollars payroll.

PUBLICE EDUCATION AND THE PERCEPTION OF RISK
(RISK IS A FOUR-LETTER WORD)

Ralph E. Whitesides[1]

Recently a power company in western Oregon, which buys and distributes electricity from a variety of sources, received a letter from a concerned parent. The power company was in the process of contructing a substation in a rapidly developing residential area and the site of the new substation was near an elementary school. The concerned parent had written to express anxiety over the proximity of the substation to the school and the subsequent radiation levels that children and teachers in the school would be exposed to each day. The radiation in question emanated from the electricity *stored* in the station that originated from a nuclear powered electric generating plant. In the eyes of at least one parent the risk association with electricity generated from a nuclear plant was too great to justify placement of a power substation so close to a public school.

Risk is a tricky word. It can be used as a noun or a verb and in almost every case danger or loss to someone or something is implied. People, however, only respond to hazards that they perceive. If perception is not adequate, or is inaccurate, then efforts made to protect people from a potentially dangerous situation may be misguided. It is the way that risk is perceived which dictates action to correct and a multitude of factors other than "facts" are associated with assessment of risk. The word "risk" has been used by so many, so often, that using the word in proper perspective has been lost in many cases. As an expert witness called to testify before a jury of typical Americans let us suppose that you are asked if there is a risk involved in the use of herbicides. Your answer can only be yes, because you know there is some possibility that the efficacy of the treatment might be reduced for some reason. The herbicide user than runs a risk of not getting acceptable weed control. The thought of risk to the public safety does not enter your mind because you are aware of the toxicology of the herbicide and you know it to be quite safe.

The members of the jury, however, may see the same situation from an entirely different angle. Without further discussion, the risk the jury comprehends is the potential damaging effects to human life with no thought to possible non-performance of the herbicide as a possible risk. Risk becomes a word that is used by some to define events with serious consequences to human health but may be viewed by others as innocuous. The use of a word or phrase signifies certain things depending upon how it is perceived. For example, in the middle 1600's a piece of artillery, a cannon, was developed which was called a "monkey". The story is told that the term "monkey" continued to be applied to cannons or cannon parts for the next 200 years. In the 1800's the Australian gunners are credited with the development of a phrase used to describe the temperature. Cannon balls made out of iron were stacked on a platform near the cannon. The platform was made of brass and was known as a "brass monkey" (apparently remnant of the old cannon called a monkey). When the temperature dropped to extremely cold levels the brass monkey would contract more rapidly than would the iron cannon balls stacked on it and as a result the surface area of the brass monkey was reduced to the point that the cannon balls would roll off. Imagine the graphic picture this painted in the mind of an Australian gunner when his mate came inside and said it was so cold outside that the cannon balls had been frozen off of the brass monkey. With time, something

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was apparently lost from the original meaning of this phrase and although the phrase may still be used it is certainly not used in the same context that an Australian gunner might have used in writing home to mother. In many respects using the word "risk" is much the same, there can be a variety of interpretations but at the present time whenever the word is used an explanation is usually required.

Risk is used as a yardstick to measure safety where public policy is concerned. Citizen concern about issues such as pesticides creates a demand for correction of perceived problems. Public policy issues are often controversial (as indeed the herbicide issue has been) when one group acts to cause consequences that other people or groups wish to influence or avoid. When dealing with a public policy problem there is rarely a single "best" solution. Neill Schaller, deputy director for Extension, SEA/USDA has said: "...The point is that we cannot expect to be loved when we deal with controversy." When evaluating risk (without-a-doubt one of the most controversial topics around) there is a golden moment in educational development when the public is aware of the problem but before people have taken fixed positions concerning the proper solution.

Scientists are not immune to partial feelings regarding risk, however, they have an obligation to report scientific fact and if their results are biased by some non-scientific fact they should be honest and state it that way. Eugene Rabinowitch (biophysicist) expressed it as follows:

> "In adversary proceedings in which science or one of its applications (such as technology, medicine or psychiatry) are involved, both sides enlist the cooperation of experts--scientists for the prosecution and scientists for the defense, scientists for the government and scientists for the opposition. This procedure makes a mockery of science; in fact, it often comes dangerously close to its prostitution.
>
> Juries, parliaments and electorates, when called upon to judge between contesting claims, often are unable to judge the arguments of their scientific experts rationally, and often rely on the impression the competing experts make on them, on their formal credentials, and on the forensic quality and vigor of their presentation.
>
> In the controversy over nuclear bomb tests, some scientists, called upon by opponents of testing, emphasized the absolute number of radiation-induced bone cancers and leukemias to be caused by continued testing in the atmosphere; while other scientists, called upon by advocates of testing, stressed the low number of expected victims, compared to the general incidence of these malignancies. The first group of scientists used the data to claim that continued testing in the atmosphere would be criminal, while the second group used the data to argue that there is no reason to discontinue the tests. Laymen, including legislators, concluded that one cannot trust scientists: some of them say, 'Stop tests--they are too dangerous;' others, 'Go on, you will not notice the difference.' Yet, as scientists, the adversary experts did not disagree on the facts of the situation; they disagreed only on moral conclusions which they derived from these facts--a disagreement in which the judgement of scientists is no more, while no less, valid than that of any other citizen cognizant of the facts.
>
> Scientific experts called upon in litigation or in political controversies should not be used as partisan assistants in the adversary process, but as impartial investigators to provide an agreed upon summary of the relevant facts as well as the logical derivations from

> these facts. If needed, the summary should clearly present differing interpretations of the scientific evidence and differing moral or political conclusions . . .
>
> Scientists, psychiatrists, physicians and technologists should be asked to analyze a problem, and to render their conclusions, without advance presumption as to what point of view they are to defend. If, at a certain point, their conclusions begin to be affected by extra-scientific reasons, they must have sufficient intellectual honesty to state: 'Up to this point I spoke as a scientist; from here on I will speak as a politically, ethically or ideologically committed citizen . . .'
>
> Scientists will not always be able to make this distinction clearly; but, at least society must not encourage them to behave unscientifically, to conceal their bias, or to resort to untruth or suppression of a part of evidence."

Why should these comments about scientific bias concern us? According to a report in the December, 1979 edition of 'Chemtech', the risks of technologies are viewed differently by experts and lay people. The report continued:

> "It would be comforting to believe that these divergent risk judgments would be responsive to new evidence so that, as information accumulates, perceptions would converge. Unfortuantely, this is not likely to happen. Risk perception is derived in part from fundamental modes of thought that lead people to rely on fallible indicators such as memorability and imaginability.
>
> Research indicates that people's beliefs change slowly and persist even in the face of contrary evidence. Initial impressions can influence the interpretation of subsequent evidence. New evidence appears to be reliable and informative if it is consistent with one's initial belief, contrary evidence is dismissed as unreliable, erroneous, or unrepresentative. Thus, intense effort to reduce a hazard may be interpreted to mean either that the risks are great or that the technologists are responsive to the public's concerns. Likewise, opponents of a technology may view minor mishaps as near catastrophes and dismiss the contrary opinions of experts as biased by vested interests. From a statistical standpoint, convincing people that the catastrophe they fear is extremely unlikely is difficult under the best conditions. Any mishap is seen as proof of high risk, whereas demonstrating safety requires a massive amount of evidence."

The media plays a significant role in determining the assessment of risk by the public. Where public safety is concerned the media should feel a responsibility to educate honestly and without bias. Sensationalism, however, is often the keyway to success for reporters and consequently bias and radical movements frequently get more "coverage" than the more methodical and less flashy scientist. The influence of the media was most dramatically impressed on my mind not too long after the October 2, 1979, Public Proadcasting Systems NOVA program "A Plague on Our Children" which was relevised nationwide. An undergraduate student stopped by my office to visit and in the course of our conversation we began discussing pesticides. He had seen the NOVA program and was very distressed that pesticides of any type were still being used. It was his contention that all petrochemicals are dangerous (based on his viewing of the NOVA program) and their use should be terminated. As we discussed this contention further, I noted that he was wearing shoes with a synthetic rubber sole, pants made from a polyester fiber and was carrying his books in a backpack made of synthetic material. When we discussed the origin of these materials it became obvious that we had a clear-cut case of the "brass monkey syndrome" on our hands. He had heard the term petrochemical on the NOVA program and had associated pesticides with petrochemicals which imparted an increased risk in using any petrochemical. To learn that other products are also derivatives of the petrochemical industry was a blow to the crusading spirit.

Next, the conversation turned to a discussion of the development of pesticides that have chemistry similar to naturally occurring compounds. The student felt that chemical compounds closely related to natural compounds found in plants would be safe and effective. He was surprised to learn of the hormonal effect exhibited by the phenoxy herbicides and further surprised to realize that these "hormone type" herbicides are the herbicides under attack by environmentalists. Another case of the "brass monkey sundrome" where natural is viewed as having little risk while synthetic is a high risk connotation. I was pleased with the exchange of information that was possible with the student who was part of the teachable crowd that has not yet decided to join an adversary group. I was not pleased when I realized the influence that NOVA wields when they present educational information from a strongly biased point of view. That is simply not responsible journalism.

As professionals in agriculture we should do our utmost to maintain a credible position by remaining unbiased when speaking as scientists and professionals. The objective is to put facts into the hands of the people before they develop a bias from the teachings of an adversary group. When our biases creep in and take over our emotions (usually known as anger and frustration) we should admit that we are interpreting the facts from a biased point of view. Don Paarlberg (professor emeritus at Purdue University) and the Farm Journal Magazine (mid-February, 1980) sum the risk controversy up when they say that the pesticide dilema will remain unsolved until "farmers admit that food safety is a legitimate consumer concern and consumers admit that absolute safety is not for this world." Until that day risk will remain a four-letter word thought by some to mean Rebuttable Information from Scientific Knowledge.

MEASURING AND COMMUNICATING CROP PRODUCTION LOSSES DUE TO WEEDS

M. W. Wiese[1]

It is generally accepted that hail storms, drought or unseasonable frosts can reduce or destroy crop yields. When production constraints such as these overshadow all others, one can readily surmise the reason for, and perhaps even the magnitude of, the resultant yield loss. However, production losses in agricultural crops are rarely so definitive.

The Yield Loss Complex: Crop yields are an expression of the collective impact of numerous production variables (vis., pests, practices, weather). Simalarly, losses are an expression of numerous production constraints whose effects are interrelated and normally difficult to perceive (collectively or individually). Yet, losses, be they subtle or obvious, are

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primary determinants of profit margins. Furthermore, they are the economic justification, the reason to be, for crop sciences and for most crop research programs and personnel.

Crop losses form bases for numerous decisions made by growers, researchers, administrators, extension personnel, granting agencies and consumers in general. Growers, for example, must weigh the return from each investment made in crop production. They need to know the margin of success or failure associated with selecting a cultivar, a time to plant, or a pesticide program.

Similarly, most administrators, researchers, fieldmen, extension personnel, industry representatives and other crop experts observe the crop field and, perhaps, the commodities market in order to surmise yield excesses or shortages and reasons for their occurrence. However, there remains little agreement, and perhaps less knowledge about the relative impact of different production constraints.

Our current information about crop losses comes primarily from opinions (hopefully from experts). There exists only minimal amounts of loss information from field experiments, questionnaires and ground and aerial surveys. Furthermore, the available information nearly always adresses a single production variable (insect, weed, hail storm). How shall we consider such information or use it to reduce losses or improve yield efficiency when we know that the crop field is a complex ecosystem where many factors act simultaneously to endanger, reduce and determine yields.

The crop field is a system, or more specifically, an agroecosystem. It was real and imaginary boundaries in which production variables act. These variables are those with which we already deal (weeds, etc.) and are the stimuli that provoke responses in crop performance. Many of these responses, reflected in plant growth, appearance or yield, for example, are recognizable and measureable. Yield, the material we gather from the system, is one response we measure exhaustively. Yet, who has definitive data on the importance of weeds, for example, as they may affect crop yields relative to other constraints like moisture, temperature, poor management, insects, or disease?

Currently, we can credibly catagorize only a few obvious yield constraints on a quantitative basis. This circumstance is a paradox indeed, since crop losses are the usual reason for initiating extension programs and corrective agricultural research. Are we currently working on the problems that most limit yields and/or reduce production efficiency? Where do weeds rank as production constraints?

Assessment of Crop Yields and Yield Constraints: Since credible crop and loss assessments could serve a very practical purpose and a very broad audience, research on loss measurement must be refined where it now occurs and initiated where it does not exist. In this light, a new program, perhaps the first of its kind in the United States, was initiated in 1978 at the University of Idaho. Crop performance is being reevaluated in an attempt to explain variations in yield that occur from year to year, field to field and over regional production areas. Various industries, agencies and scientists and nearly 100 growers currently contribute to the effort. For tactical reasons, the study is focused initially on the cultivated Palouse and on dryland spring peas as a model crop.

During the 1979 growing season, approximately 100 dryland spring pea fields in northern Idaho (Latah and Nez Perce Counties) and eastern Washington (Columbia, Whitman and Spokane Counties) were closely observed from planting through harvest. At approximately two-week intervals, field crews visited each field and collected detailed records on more than 40 different production variables known or suspected to influence pea seed yields. Additional items of information covering field history and practices, such as herbicide and fertilizer use, and the rates, dates, and method of application were documented from grower interviews. Collectively, the data, recorded in field books and transferred to computer files, described the:

1. Crop plant: variety, seed quality, growth rate, emergence, population, maturity, yield;
2. Soil: type, moisture, temperature, nutrients, pH, density, slope, depth;
3. Pests: insect and weed populations, disease severity, pest damage;
4. Weather: accumulated precipitation and growing degree-days;
5. Practices: pesticide and fertilizer applications, tillage operations, seeding, harvest, previous crops.

Because of the comprehensive scope of the project, sampling from and survey of the entire area of 100 different fields at biweekly intervals was not feasible or possible. Instead, an accessible and representative 10,000 square foot area was designated for data collection in each field. All repeated field visits were made to this same site.

Weeds as Production Constraints: In dealing with weeds as specific variables influencing crop plant and yield development, several methods of assessment and density measurement were reviewed. It is important that the assessment reflect the prevalance of weeds in the crop and their impact (competition or interference) on crop yield.

In an attempt to accomplish this purpose, weed infestations were assessed quantitatively and qualitatively during each field visit. Thus, weeds were evaluated 4 to 7 times at each site during the growing season. Quantitative assessments involved visually rating weeds collectively as percent of the total vegetative biomass produced in the field. This procedure is calibrated by comparing the visual ratings with the collective fresh weights (exclusive of roots) of weeds and pea vines in one or more 1 square meter areas.

Qualitative weed assessments involved visually rating the portion of the total weed biomass attributable to individual weed species. Like the visual apportionment of the total vegetative biomass in the field between weeds and peas, this apportionment of the total weed biomass between weed species can be refined by comparison with the actual fresh weights (exclusive of roots) of each contributing weed species.

The rating system, while subject to refinement, is rapid and minimally subjective. It can be applied to many field sites within a given day. Especially important at this point, is that is appears to describe the weed-crop interaction when used in overall yield models. Thus far, it also appears that the description of the impact of weeds on pea seed yields is improved when all weed ratings for a given site are reduced statistically to a principal component value.

Currently, the relationship of weed infestations to pea seed yield (Table 1) is still being explored enroute to defining the percentage seed loss that weeds collectively inflict. One approach involves the relationship of pea vine weight to seed yield. In 1979, mean total vine dry weight per acre at post-flowering growth stages (Table 1) was related to mean seed yield/acre ($r=0.474$, $p=0.0001$). This relationship will be further evaluated in the 1980 crop, as will any association between yields and the percentage of principal component value(s) of the total vegetative biomass in pea fields that is attributable to weeds.

Table 1. Herbicide use, weed infestations and yields of pea seed and vines in 93 Palouse dryland spring pea fields in 1979.

Herbicide(s)	Number of Fields	Mean Post Flowering Weed Score[a]	Mean seed Yield	Mean Vine Yield[b]
		(%)	(lb/A)	(lb/A)
None	8	24	1666	3109
Trifluralin	5	6	1788	3280
Trifluralin, dinoseb, triallate	22	9	1861	3479
Diallate, dinoseb	1	12	1861	3126
Trifluralin, triallate	22	13	1670	3080
Triallate, dinoseb	20	13	2056	3545
Dinoseb	5	15	2210	5203
Trifluralin, 2,4-D	1	15	1212	2390
MCPA	3	21	1322	3525
Trifluralin, barban, dinoseb	1	22	2875	5~~9~~343
Triallate	3	26	1164	2815
Barban, MCPA	1	35	1694	2101
Trifluralin, MCPA	1	42	1321	1680
	93	14	1820	3426
Any single herbicide	16	16	1767	3840
Any two herbicides	45	14	1810	3217
Any three herbicides	23	10	1915	3734

[a]Percent of total vegetative biomass produced.

[b]Dry weight of vines and seed.

Communicating the status of weeds: During the course of crop development, abbreviated summaries of crop and pest status, for example, were generated in response to requests for information. Such information was communicated in person, via telephone or through the mail as dictated by availability and convenience. As soon as possible after harvest, all collected information describing the status and performance of the 100 field sites was summarized and distributed to cooperating growers, and to research, industry, agency, extension and administrative personnel with an expressed interest in the 1979 dryland spring pea crop. Separate data sheets, printed by computer, were provided for each field site in the study. Each printout listed mean or frequency values for all variables measured in an individual field, over all county fields, and over all sites in the five-county production area (Table 2). The display was intended to communicate the status of variables in, and the performance of, each field relative to other fields in the area.

The portion of the printout relative to weeds (Table 2) showed that weeds, over all field sites, comprised 12% of the total vegetative biomass produced during the entire growing season. The major weed species contributing to this overall infestation were wild oats (*Avena fatua* L.) 18%, pennycress (*Thilaspi arvense* L.) 17%, lambsquarters (*Chenopodium album* L.) 15%, wheat (*Triticum aestivum*) 10%, henbit (*Lamium amplexicaule* L.) 8% and other species 32%. Wheat appeared frequently as a weed by virtue of being the previous crop in nearly all the pea fields studied.

Table 2. Segment of a computer-generated summary describing weeds and herbicide used in an exemplary field (L12) relative to other dryland spring pea fields in the Palouse.

GROWER: Name: ______________________

Address: ______________________

SURVEY ITEM	GROWER'S FIELD	COUNTY FIELDS	ALL FIELDS	COMMENTS
	L12	LATAH		FIELD LOCATION: NORTH OF GRAVEL PIT
PESTS:				
WEEDS	4	10	12	MEAN SEASONAL PERCENTAGE OF TOTAL VEGETATION
MAJOR WEEDS	WHEAT FANWEED	FANWEED WILD OATS LAMBSQUARTER WHEAT DOG FENNEL	WILD OATS FANWEED LAMBSQUARTER WHEAT HENBIT	IN ORDER OF OCCURENCE
CHEMICAL APPLICATIONS:				
HERBICIDES:	AVADEX BW	22 of 26	67 of 96	NUMBER OF FIELDS GIVEN TRIALLATE
	TREFLAN	19 of 26	63 of 96	NUMBER OF FIELDS GIVEN TRIFLURALIN

Herbicides were employed in 85 of 93 fields with complete herbicide information. Within herbicide-treated fields, weeds comprised 14% of the total post-flowering vegetation compared to 24% in fields not receiving herbicides (Table 1).

Herbicide-treated fields received from 1 to 3 different chemicals. Combinations of triallate (Avadex BW) [*S*-(2,3,3-trichloroallyl)diisopropyl thicarbamate], trifluralin (Treflan) (α,α,α-trifluoro-2,6-dinitro-*N*,*N*-dipropyl-*p*-toluidine), and/or dinoseb (Sinox W) (2-*sec*butyl-4,6-dinitro phenol) were most frequently used. Weed scores and pea seed yields were related to the number of chemicals applied (Table 1.).

In addition to summarizing the status of weeds and herbidice practices, the computer-printed reports (Table 2) summarized the status of more than 40 other production variables by field site, by county and for the entire production area. Any differences or similarities in yield and in values assigned to the various production variables, therefore, were displayed relative to other fields. Available within weeks after harvest the summary aided the identification of actual and possible constraints to seed yield in each field. Many recipients of the summaries indicated that the information would find immediate service as a management guide for optimizing yields in their 1980 pea crop.

THE INFLUENCE OF SELECTED HERBICIDES ON THE DEVELOPMENT OF *RHINOCYLLUS CONICUS*, AN INSECT USED IN BIOCONTROL OF MUSK THISTLE

R. D. Lee and J. O. Evans[1]

Musk thistle (*Cardus thoermeri* Weinman) is a serious problem in rangeland, overgrazed pastures and waste areas in the state of Utah. It is believed to have entered the state in the early 1960's and has since spread at an alarming rate. A survey in 1970 reported 13,000 acres infested with musk thistle (6). A similar survey in 1979 reported 38,000 acres of this weed in Utah (7).

Musk thistle described as a biennial or a winter annual, reproduces entirely by seed. Most seed germinates in the fall or spring but may germinate at any time when moisture is sufficient since there does not appear to be a dormancy mechanism in musk thistle achenes (10). The weed develops rapidly into a rosette or vegetative stage. If the seed germinates in the fall, it will overwinter in the vegetative stage, and bolt and flower the following spring or early summer. If it germinates in the spring, it remains in the rosette form during the growing season and winter, then in the spring of the second year it will bolt and flower. Some of the rosettes of the biennial can reach diameters of 0.5 to 1.0 meter in diameter.

The stem of musk thistle is erect and branched and has spiny leaves running the length of the stem. The leaves are relatively flat and regularly lobed, spines long, and relatively few (1). The abscence of pubescence on the leaves helps to distinguish *C. thoermeri* from *C. nutans* which has pubescence on the leaves but not to the extent that *C. macrocephalus* does. The flowers of musk thistle are composite, large, flat, nodding and purple in color and are surrounded by the involucral bracts which are abruptly narrowed into a short point. The flowering pattern of musk thistle is determinate, starting with the terminal head and progressing down the stem, branch to branch (9). This allows the plant to flower for 2 to 3 months until adverse conditions cause its death.

The taproot is large and fleshy and hollow near the surface of the ground. A full grown musk thistle plant can range from 0.5 to 3.0 meters tall, having from 10 to 100 plus seed heads. It has been estimated that a musk thistle produces up to 120,000 seeds per plant (7). The germination percentage ranges from 81 to 90% (5,8), with 69% germinating the first year and 20% the second year; the rest being either lost or germinating at a later time (11).

The weevil, *Rhinocyllus conicus* Froel., native to Southern and Central Europe and Northern Africa, was first introduced into the United States in 1969 by the USDA Biological Control of Weeds Laboratory, Albany, California as a potential biological control agent after being carefully screened so as not to become a pest of beneficial crops (2,3).

R. conicus overwinters as an adult and becomes active in the spring

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engaging in a period of feeding. There is a period of mating followed by the oviposition of the eggs on the involucral bracts of the flower head. A female can oviposite from 100 to 150 eggs. After the eggs are deposited the adults die. After 6 to 8 days the eggs hatch and the larvae burrow through the bracts into the flower receptacle and damage or destroy the developing achenes inside the seed head. This larval stage lasts about 25 to 30 days, and is the main process by which control is obtained. The larvae pupate and form pupal cells, which also cause seeds to adhere to the cell and not be available for dispersal (4,12). Following the pupation period, the adults will emerge for overwintering. It should be noted that the weevil's life cycle is such that only those terminal and few secondary heads which are present of the time of oviposition are infested with the weevil, leaving heads which develop later to do so unmolested.

Musk thistle can be controlled with chemicals. It has been shown that 2,4-D [(2,4-dichlorophenoxy)acetic acid], dicamba (3,6-dichloro-*o*-anisic acid), and picloram (4-amino-3,5,6-trichloropicolinic acid) all give good to excellent control when applied in the spring while the plant is still in the rosette stage. When the plants are in the late bud stage, the control ranged from 50 to 100%. The poorer control was observed with 2,4-D and lower rates of dicamba (13).

Chemical applications have to be repeated to eliminate new plants that emerge from seed. Often times, the area as well as the cost of the application become factors to consider in connection with the possible regulatory pressures. All these may make the use of herbicides difficult. For these reasons, biological control would be a good alternative in many situations.

The first release of *R. conicus* in Utah was in June of 1975 on an infestation of musk thistle just below the Deer Creek Reservoir. Eggs were oviposited and the weevil were observed to complete their life cycle inside the seed heads and also overwinter through the winter of 1975 and emerge in the spring of 1976. No releases were made in 1976. Ten new sites were established in 1977. In 1978, five additional sites were selected and in 1979, 8 new weevil releases were made. The total releases in Utah are 24 (Figure 1).

Cell counts were taken the fall of 1978 and 1979 to determine whether the weevil had increased in numbers. Figure 2 shows the mean number of cells per terminal head at all the release sites. Site 1 is the 1975 release and sites 2-11 were released in 1977. That site #5 was not recorded in 1978 will be explained later. The weevil have increased in number at all sites where they have not been under extreme stress such as in sites 10 and 11, where the thistles were grazed by horses or cut and burned while the weevil were developing inside the seed head. Sites 12 through 16 were released in 1978 and all showed an increase in number of cells per terminal head, except 14, which we cannot explain. Sites 17 through 24 were released in 1979. Site 20 was disked before counts could be made in 1979.

The weevil appears to be established in Utah and they are increasing in number. The weed is not standing still to await the increase of the weevil, instead, it is increasing at an alarming rate and may parallel the increase of weevils. There are new acres of rangeland being infested each year and we are currently losing additional acres of valuable forage. It was determined that we should study integrating chemical and biological controls.

On June 28, 1978, an experiment was initiated on site 5 near Heber City involving the use of selected herbicides interacting with *R. conicus*. The thistles were in the pre-bud to early-bud stage at the time of herbicide application. One-third of the plants were sprayed with 2,4-D at

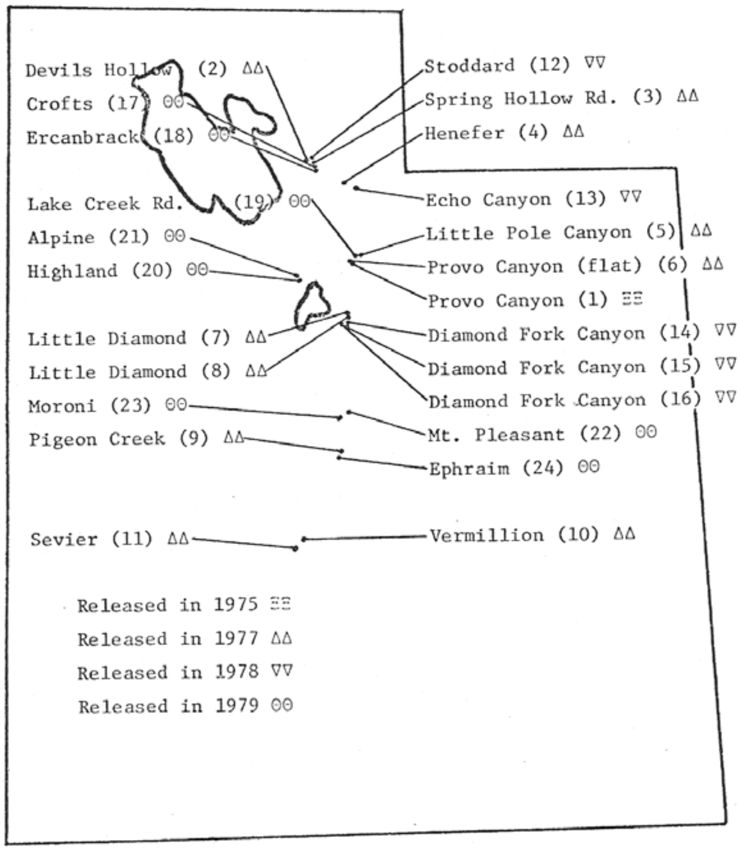

Figure 1. Rhinocyllus conicus release sites in Utah.

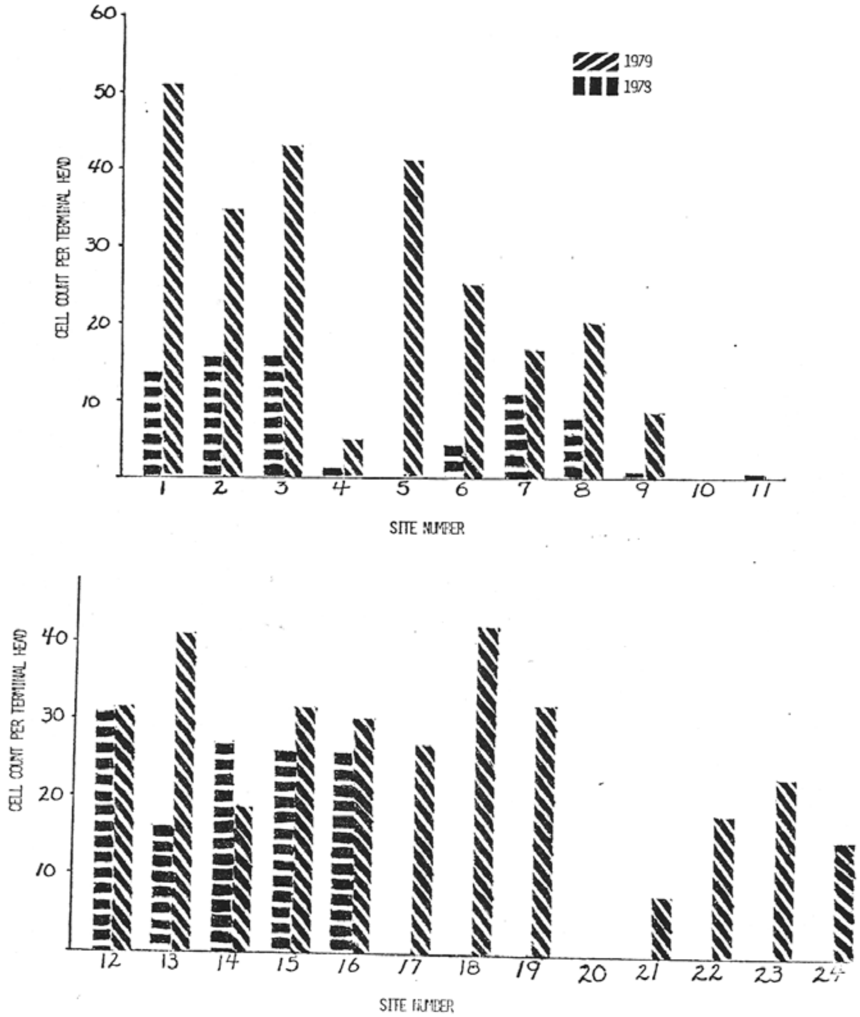

Figure 2. The mean number of cells per terminal head for the years 1978 and 1979 at all release sites in Utah.

4.48 kg/ha, the center one-third of the site served as an untreated control and the other third was treated with dicamba at 0.56 kg/ha. One week after the plants were sprayed, terminal heads were bagged with cloth bags to isolate the heads to be counted. The bagged seed heads were collected from mature plants and the cells were counted together with numbers of dead larvae, pupae, and adults.

The mean cell counts and deal larvae counts for the two treatments were not significantly different from the control (Table 1). Plants sprayed with the 4.48 kg/ha 2,4-D had a significantly higher humber of dead pupae and adults than did the dicamba at 0.56 kg/ha, but neither treatment was significantly different form the control. Dicamba at 0.56 kg/ha appears to be safer on developing weevils than is 2,4-D.

TABLE 1. EFFECT OF HERBICIDE TREATMENT ON NUMBER OF CELLS, DEAD LARVAE, DEAD PUPAE, AND DEAD ADULTS AT THE HEBER CITY SITE IN 1978.

Treatment[b]	Rate (kg/ha)	# Cells	# Dead Larvae	# Dead Pupae	# Dead Adults
2,4-D	4.48	19.8 a	0.84 a	2.34 a	4.70 a
dicamba	0.56	20.6 a	0.48 a	0.75 b	1.33 b
Control	--	16.2 a	0.60 a	1.24 ab	2.62 ab

[a]The cell, dead larvae, dead pupae, and dead adult counts are the average of 50 terminal heads. Values within a column followed by the same lower case letter are not significantly different at the 0.05 level.

[b]Plants were sprayed on June 28, 1978, at which time the terminal heads were in the pre-bud to early-bud stage.

In 1979 a replicated trial was established to evaluate different dosages and mixtures of 2,4-D and dicamba. On June 28, 1979, site 1 below Deer Creek Reservoir was divided into two blocks with 4 treatments and a control in each block. The treatments were 2,4-D at 2.24 kg/ha, 2,4-D and dicamba at 2.24 and 1.12 kg/ha respectively, 2,4-D and dicamba at 1.12 and 0.56 kg/ha respectively, and dicamba at 0.56 kg/ha. The plants were in the late-bud to early-flower stage when treated. The heads were again bagged and collected at the end of the growing season. The cell counts were made along with dead larvae, pupae, and adult counts. The results, given in Table 2, showed that the 4 treatments were not significantly different from each other or the control.

The conclusions of the study are:

1. The weevil have become well established in Utah with their populations increasing at a rapid rate in most areas of the state.
2. The herbicides tested did not decrease the reproductive capacity of *Rhinocyllus conicus* developing on natural infestations of musk thistle.
3. The furture control of musk thistle can involve the integration of chemical control and biological control involving the *R. conicus* weevil.

TABLE 2. EFFECT OF HERBICIDE ON NUMBER OF CELLS, DEAD LARVAE, DEAD PUPAE, AND DEAD ADULTS AT THE PROVO CANYON SITE IN 1979.

Treatment[b]	Rate (kg/ha)	# Cells	# Dead Larvae	# Dead Pupae	# Dead Adults
2,4-D	2.24	20.47	0.20	0.50	2.84
2,4-D + dicamba	2.24 + 1.12	16.76	0.29	0.61	2.10
2,4-D + dicamba	1.12 + 0.56	18.07	0.21	0.39	2.44
dicamba	0.56	19.11	0.27	0.74	2.23
Control	--	21.36	0.27	0.37	3.06

[a]The cell, dead larvae, dead pupae, and dead adult counts are averages of 35 terminal heads taken from two blocks. The F values showed no significant difference, therefore no further analysis was done.

[b]Plants were sprayed on June 28, 1979, at which time the terminal heads were in the early flower stage.

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METZNERIA LAPPELLA L., A SEED PREDATION INSECT OF COMMON BURDOCK (*ARCTIUM MINUS*)

M. J. Pleskac, P. K. Fay and W. Morrill[1]

Abstract: A seed-boring larva, (*Mentzneria lappella* L.) was found in Montana in 1979. Burdock burs were collected from 15 locations in the state and larvae were found in burs from all but one collection site. The number of larvae per bur ranged from 0 to 5.5 with an average of 2.8. Seed predation by larvae ranged from 0.3 to 44.6 seeds per bur for a range of 4% to 82% damaged seeds per bur respecticely. Laboratory studies indicate *Metzneria* collected from some locations may have a parasite load which would diminish the effectiveness of the insect.

An average of 13,000, 16,000, and 50,000 seeds were produced per plant at three locations in the state. Despite the effectiveness of the insect, burdock continues to be a troublesome weed for cattle producers because of the high number of seeds produced per plant, and the effective seed dissemination system (cattle) used by burdock. Insect-infested burs will be distributed throughout the state in an attempt to augment the natural population of *M. lappella* L.

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THE SUSCEPTIBILITY OF CANADA THISTLE (*CIRSIUM ARVENSE*) ECOTYPES TO A RUST PATHOGEN (*PUCCINIA OBTEGENS*)

S. Turner, P. K. Fay, E. L. Sharp, B. Sallee, and D. Sands[1]

Abstract: *Puccinia obtegens* is an autecious rust pathogen with potential as a biological control agent of Canada thistle. The pathogen occurs world-wide and has, on occasion, caused localized epidemics on Canada thistle. More often, the pathogen is found on an occasional plant among uninfected plants. Research is being conducted to determine the condistions needed for wide-spread disease establishment.

A major constraint of plant pathogens for use as biocontrol agents is genetic resistance of host-plant ecotypes to the pathogen. Ten ecotypes

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of Canada thistle, differing in leaf shape, were collected in Montana, planted in the greenhouse, and inoculated with spores of *P. obtegens*. While sporulation was observed on all the ecotypes, the degree of infection varied indicating host-resistance may be a factor limiting rust infection.

INFLUENCE OF A RUST (*PUCCINIA CHONDRILLINA* Bubak & Syd.) ON THE FLOWERING, SEEDING, HEIGHT AND BIOMASS OF RUSH SKELETONWEED (*CHONDRILLA JUNCEA* L.)

T. M. Cheney, G. A. Lee and W. S. Belles[1]

Abstract: Rush skeletonweed is a deep rooted perennial that infests 3.5 million acres of range and crop lands in Idaho. This weed reproduces vegetatively and by seed. Studies were initiated during the summer of 1979 to study the effect of *Puccinia chondrillina* on rush skeletonweed in areas where the rust infestation had been established for two years, one year and four months previously. Rust reduced the nember of flowers, seeds and plant height with all establishment periods. The greatest reduction in seeds, number of flowers per plant and plant height was observed in areas where the rust had been established for two years, one year and four months, respectively. Greenhouse studies showed a significant reduction in dry root weight of rush skeletonweed after infection with *P. chondrillina* for seven weeks. Dry leaf weight was significantly reduced after five weeks of infection. Total dry weights were significantly reduced after seven weeks of infection.

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SOURCES OF VIABLE SEED LOSS IN BURIED DORMANT AND NON-DORMANT POPULATIONS OF WILD OAT (*AVENA FATUA*) SEED IN COLORADO

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

Abstract: The persistence of viable wild oat (*Avena fatua* L.) seed in soil is a function of seed dormancy. The degree and type of dormancy in any one population is dependent on environmental conditions prior to and following seed shedding. This experiment was designed to investigate the effect of soil depth and duration of seed burial on dormancy and viability of wild oat harvested and planted in Colorado and compare these data with similar studies conducted in environmentally different regions. Populations of seed shed in August 1977 and after-ripened seed shed in August 1976 were placed in 113 mesh polypropylene packets and planted in October 1977 at 6 soil depths and left undisturbed. Data presented were accumulated after 1, 2, 4, 6, 9, 12, 18, and 24 months burial at soil depths of 1, 3, 5, 10, 15, and 30 cm. At soil depths below 10 cm, decreases in the viable population occurred primarily by germination in dormant and non-

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dormant populations. Both populations were completely depleted after 9 months burial. At soil depths above 5 cm, viability loss was the primary component of population depletion. Acquisition of induced dormancy by the initially non-dormant population was observed only at soil depths less than 5 cm. These data will be discussed with reference to moisture and temperature conditions during the experimental period.

EFFECT OF DEPTH AND DURATION OF BURIAL ON SEED DORMANCY AND VIABILITY OF KOCHIA (*KOCHIA SCOPARIA*)

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

Abstract: Kochia [*Kochia scoparia* (L.) Schrad.] is a troublesome annual weed in several western states. A single plant can produce thousands of seeds which are mechanically incorporated into the soil seed reserve. A 3 year field experiment was designed to investigate the effect of soil depth and duration of burial on seed dormancy and viability of kochia. Populations of freshly harvested and after-ripened seed were placed in 113 mesh polypropylene packets, planted at 6 soil depths, and left undisturbed. Data presented were accumulated after 1, 2, 4, 6, 9, 12, 18, and 24 months burial at soil depths of 1, 3, 5, 10, 15, and 30 cm. Depending on depth of burial, 0.5 to 5% of both seed populations remained viable after 24 months. In general, the rate of dormancy release and viability loss increased as burial depth increased. Initially dormant populations lost viability at a slower rate than did initially non-dormant populations. Non-dormant populations acquired an induced dormancy but the two populations did not differ statistically in viability or degree of dormancy after 24 months burial at any soil depth.

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EFFECTS OF GLYPHOSATE ON SEEDS OF CANADA THISTLE [*CIRSIUM ARVENSE* (L.) SCOP.]

W. J. Schumacher, G. A. Lee and W. S. Belles[1]

Abstract: Canada thistle continues to be a problem in crop and noncrop areas of the northern United States and adjacent Canada. This perennial weed reproduces vegetatively and by seed. Studies have shown that glyphosate [*N*-(phosphonomethyl)glycine] is most effective for the control of Canada thistle when applied after the plants have reached the bloom stage. Applications made after achene formation has been initiated, may effectively control established plants, but future infestations may not be curtailed because of achenes produced. This study was initiated to determine the subsequent effects of glyphosate on Canada thistle seed morphology, germination and seedling establishment. Glyphosate at 1.1, 2.2 and 4.5 kg/ha was applied when Canada thistle plants were in three stages of growth: bud, bloom (soft dough) and late bloom (hard dough). Plants were treated in the

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field and achenes from plants treated at the latter two growth stages collected after application. No achenes were collected from plants treated at the bud stage because of inhibition of plant development. Achenes were germinated in a growth chamber and in the greenhouse. Germination and seedling establishment were significantly reduced as glyphosate rates increased. The bloom stage application had the greatest decrease of seed weight, germination and emergence.

ABSORPTION AND TRANSLOCATION OF ^{14}C-DICLOFOP-METHYL IN WILD OAT AND BARLEY

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

Abstract: The absorption, translocation and distribution pattern of ciclofop-methyl [methyl 2-[4-(2,4-dichlorophenoxy)phenoxy]proanoate] in wild oat (*Avena fatua* L.) and barley was investigated. Differential absorption appeared to be the basis of selectivity of dichlofop-methyl between susceptible oat and tolerant barley. Translocation and distribution of this herbicide appeared similar in test species.

Introduction

Diclofop-methyl is a new promising selective herbicide for wild oat control in cereal grains. Most experimental work with diclofop-methyl has been conducted to determine its field efficiency and little in known concerning its mode of action or its developmental affects on either sensitive weedy species or the tolerant crops.

Whether foliar applied herbicides are active against weeds or not is often related to their tendency to be absorbed and translocated in the plant after treatment (1). Boldt and Putnam (2) observed differential uptake of diclofop-methyl among several species and very little movement from the treated spot. However, Brezeanu et al. (3) reported that adsorption and translocation of ^{14}C-diclofop-methyl were similar in wheat and wild oat.

The objective of this study was to follow the absorption, translocation and distribution patterns of diclofop-methyl in susceptible oat and tolerant barley to see if differential uptake and movement is the basis of selectivity among these species.

Materials and Methods

Wild oat and barley were grown in a growth chamber programmed for 27C day and 22C night temperatures and 16 hour photoperiod with 3000 microeinstein of photosynthetically active radiation from a mixture of fluorescent and incandescent lamps. For foliar application, the plants were treated at the two-leaf stage of growth. A 12-μl droplet of water solution containing 0.2 μCi of ^{14}C-diclofop-methyl (specific activity 2.0 mCi/m mole) which was uniformly labeled at 2',4'-dichlorophenoxy ring, was applied to a 0.2 cm^2 area on the adaxial surface of the second leaf about 2 cm from the leaf base and contained within a lanolin ring. Triton X-100 was added to treatment solutions to a final concentration of 0.5% (v/v).

For root treatment, the plants were washed and transferred to foil-wrapped flasks containing 50 ml of Hoagland's half-strength nutrient solution (5) and 0.4 μCi of ^{14}C-diclofop-methyl.

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Four replicate plants were used for each treatment. After periods of 2, 4, 8, 24, 48 and 72 hours following herbicide application, the treated leaves were washed in 3 ml methanol and divided into three segments, above, below and containing the treated spot. The remaining parts of the plant were divided into shoot and root. For root treatment, the plants were divided into shoot and root only.

For radioactivity determination, each segment was digested separately by the method described by Reid et al. (7) and Long (6). A mixture of 0.4 ml of 60% $HClO_4$ and 0.8 ml of 30% H_2O_2 was added to glass scintillation vials containing the tissue, the vials were sealed tightly and placed in an oven at 80C for 3 hours. After cooling to room temperature, 15 ml of Beckman's Ready Solv Hp was added to each vial as scintillation cocktail. Sample sounts were made in a liquid scintillation spectrometer.

For translocation studies, the method of autoradiography was adapted from Crafts and Yamaguchi (4). After 2, 4, 8, 24, 48 and 72 hours, duplicate plants were harvested, pressed and oven dried at 80C for 48 hours. The dried plants were subjected to autoradiography in a dark room using no safe light. A Kodak no-screen x-ray film was used. After 6 weeks, the films were developed with Kodak liquid x-ray developer at 20C for 5 minutes, transferred into a 1% acetic acid stopbath, and the films were fixed in Kodak liquid x-ray fixer at 27C for 8 minutes. The films were washed in running water for 15 minutes and dried over night. No safe light was used.

Results and Discussion

Leaf absorption: It appeared that uptake of diclofop-methyl continued with time. There appeared to be two phases of absorption as shown in Figure 1, a rapid initial absorption followed by a much slower absorption rate.

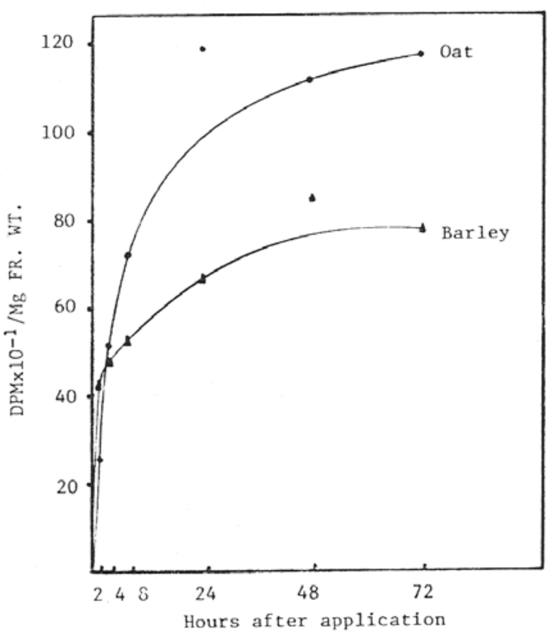

Figure 1. Time course of ^{14}C-diclofop-methyl absorption by wild oat and barley.

Wild oat accumulated more herbicide as compared to larley. Leaf uptake of ^{14}C-diclofop-methyl by wild oat and barley was different and wild oat absorbed significantly higher amount of the herbicide on the fresh weight basis. This differential absorption could account for the herbicidal selectivity among these species.

The complementary autoradiographic studies revealed that diclofop-methyl is not very mobile in either species. About 80% of the applied dosage remained on the leaf surface and from the 20% absorbed amoung only about 2% moved out of the treated area in either xylem or phloem. In this study, there was no detectable differences in translocation and distribution of ^{14}C-diclofop-methyl among wild oat and barley.

Root absorption: Although wild oat absorbed a greater amount of root applied ^{14}C-diclofop-methyl than barley, the analysis of variance failed to show statistically significant differences among the species as shown in Figure 2. In this study, very little diclofop-methyl was absorbed by roots of either species as compared to leaf absorption indicating that roots are not the most favored site of uptake for this herbicide. Only 0.15% of applied radioactivity was discovered in the roots and 0.15% in the shoot.

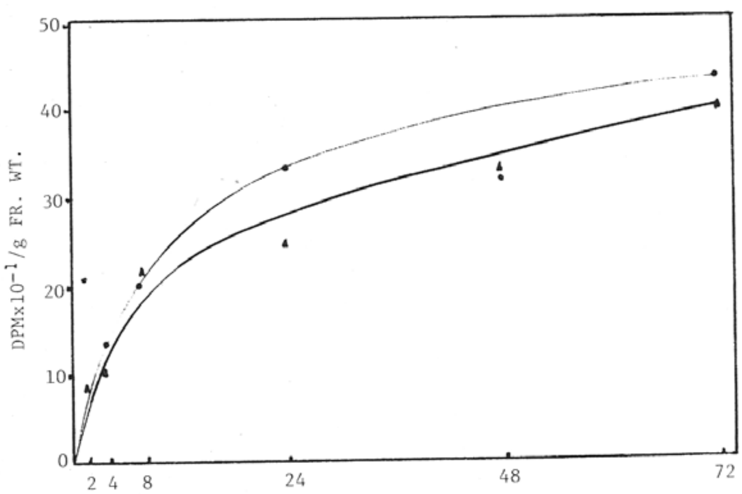

Figure 2. Time course of ^{14}C-diclofop-methyl absorption by roots of wild oat and barley.

Summary and Conclusion

The results of these experiments indicate that dichlofop-methyl is not mobile in these species. Only a small percentage of the applied dosage moved from the site of application to other plant organs. On the other hand, translocation and distribution of this herbicide appeared similar in the test species. This clearly indicates that, diclofop methyl exerts its action at the site of uptake which is the green leaves. Differential absorption appears to be the basis of the selectivity of diclofop-methyl between wild oat and barley.

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DIFFERENTIAL LIGHT RESPONSE OF PHOTOSYNTHESIS BY TRIAZINE RESISTANT AND SUSCEPTIBLE *SENECIO VULGARIS* BIOTYPES

J. D. Sims, S. R. Radosevich and A. J. Stemler[1]

Abstract: Studies were conducted to determine a physiological basis for the competitive differences between *Senecio vulgaris* biotypes which are resistant and susceptible to triazine herbicides. Net carbon fixation of intact leaves of mature plants was higher at all light intensities in the susceptible biotype than in the resistant biotype. Oxygen evolution in continuous light measured in stroma-free chloroplasts was also higher at all light intensities in the susceptible biotype than in the resistant biotype. Oxygen evolution in response to flashing light was measured in stroma-free chloroplasts of both biotypes. The steady-state yield per flash of resistant chloroplasts was less than 20% that of susceptible chloroplants. Susceptible chloroplasts displayed oscillations in oxygen yield typically observed in normal chloroplasts, while the pattern of oscillations in resistant chloroplasts was extremely modified. The pattern of yield as a function of flash number in the resistant biotype was markedly damped. Modification of the herbicide binding site which confers resistance has altered the oxygen evolving mechanism, making it much less efficient. This lowered efficiency in the light capacity for carbon fixation is the resistant biotype.

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ENHANCED METABOLISM OF ATRAZINE BY CORN (*ZEA MAYS* L.)

J. J. Jachetta and S. R. Radosevich[1]

Abstract: Photosynthesis in corn was inhibited (25%) by atrazine [2-chloro-4-(ethylamino)-6-(isopropylamino)-*s*-triazine] after 2 hour root exposure. Subsequent full recovery of photosynthesis required 21.4 hours after removal from the herbicide. Recovery of photosynthesis from a second and third atrazine exposure required only 10.3 hours and 4 hours, respectively. Atrazine degradation studies were conducted, during which corn plants were exposed to either one, two or three successive 4 hour atrazine (10 μm) treatments with a 12 hour recovery period following each treatment. These studies revealed increased rates of metabolism of atrazine during each recovery period. An increased level of GS-atrazine was found following the first 4 hour atrazine treatment and 12 hour recovery. The enhanced production of GS-atrazine was maintained throughout subsequent exposures and recoveries. An inverse correlation (R^2=0.992) was found between the increase in GS-atrazine production following each 4 hour atrazine exposure and the time required for corn plants to recover from atrazine induced photosynthetic inhibition (25%). Enhanced detoxification of atrazine by corn plants pretreated with atrazine was indicated. No enhanced tolerance to other herbicides was observed from atrazine pretreatment. This phenomenon is similar to that described for the enhanced detoxification of several insecticides in animal systems.

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DIFFERENTIAL METABLISM OF METOLACHLOR BY *CYPERUS ROTUNDUS* AND *CYPERUS ESCALENTUS*

H. Buckwalter[1]

Abstract: Analysis of tuber and leaf tissue of *Cyperus rotundus* L. and *C. esculentus* L. for metolachlor [2-chloro-*N*-(2-ethyl-6-methylphenyl)-*N*-(2-methoxy-1-methylethyl)acetamide] was done by gas chromatography using flame inization detection with nitrogen as the carrier gas. The plant materials used for analysis were grown under greenhouse conditions. The potting soil used was a sandy clay loam, (pH 7.7, O.M. 0.49%). The treatments were preplant incorporated to a depth of three inches at 3 lb ai/A, 6 lb ai/A and 12 lb ai/A, respectively. Five to ten tubers per pot were then washed in warm tap water and placed 0.5 inches below the soil surface and exposed to each treatment rate for 5 hours, 25 hours and 125 hours. It was found that both plant species metabolize 80% or more of the metolachlor to which it was exposed, and the metabolite(s) is polar. There is evidence that the metabolite(s) of metolachlor by *C. rotundus* and *C. esculentus* are different, the nature and properties of the metabolite(s) are still under study.

A methanol mixture of metolachlor (116.72 g metolachlor per l) was prepared and 0.5 ml of this mixture was added to separate, prepared samples of air dried tubers and leaves. This technique facilitated the

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positive addition method for analysis and comparison to the treated and untreated tubers.

Partitioning of the methanol filtrate with hexane was done for all samples prior to analysis on the gas chromatograph.

COST OF CONTROLLING MATURING WESTERN JUNIPER TREES

James A. Young, Raymond A. Evans and Greg Cluff[1]

Abstract: A cost evaluation was conducted of four alternatives for improvements of maturing western juniper (*Juniperus occidentallis* Hook.) woodlands. The alternatives were: (a) the use of picloram (4-amino-3,5,6-trichloropicolinic acid) to kill the trees with no further treatment with a total cost of $31.00 per acre; (b) picloram with sufficient limbing and/or removal of trees to allow passage of a rangeland drill for seeding at a cost of $179.00 per acre; (c) mechanical clearing and burning of the trees at a cost of $237.00 per acre; and (d) wood harvesting and slash disposal at a cost of $832.00 per acre. The picloram and limb, mechanical, and wood harvesting treatments provide mechanically seedable sites, but of considerable different quality. The mechanical treatment required a large capital investment, while the wood harvesting treatment required a large amount of labor. Based on equivalent energy values the wood harvesting operation would produce a profit for the landowner who could afford to invest the labor. For a specific woodland a combination of treatment would be most cost effective.

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COMPARISON OF FOLIAR AND SOIL APPLIED HERBICIDES FOR CONTROL OF GREASEWOOD AND SALT RABBITBRUSH

Raymond A. Evans, Bruce A. Roundy, James A. Young and Greg J. Cluff[1]

Abstract: Foliar- and soil-applied herbicides were compared for control of greasewood [*Sarcobatus vermiculatus* (Hook.) Torr.] and salt rabbitbrush (*Chrysothamnus nauseaosus* ssp. *consimilis* Greene) growing in a saline/alkali area of central Nevada. Foliar herbicides included:

(1) 2,4-D [(2,4-dichlorophenoxy)acetic acid] low volatile ester at 1, 2 and 3 lb/A at five dates.
(2) 2,4-D at 2 lb/A plus picloram (4-amino-3,5,6-trichloropicolinic acid) at 0.5 lb/A at five dates.
(3) 2,4-D at 3 lb/A with a diesel oil carrier as a dormant spray.
(4) 2,4-D plus 2,4,5-T [(2,4,5-trichlorophenoxy)acetic acid] in a 1:1 mixture at 3 lb/A.
(5) 2,4,5-T at 3 lb/A.
(6) silvex [2-(2,4,5-trichlorophenoxy)propionic acid] at 3 lb/A.
(7) triclopyr [[(3,5,6-trichloro-2-pyridinyl)oxy]acetic acid] at 3 lb/A.
(8) dicamba (3,6-dichloro-*o*-anisic acid) at 3 lb/A.

[1]SEA-AR, USDA and University of Nevada, Reno, NV 89512.

Soil-applied herbicides included:

(1) karbutilate [*tert*-butyl carbamic acid ester with 3(*m*-hydroxy-phenyl)-1,1-dimethylurea] at 1 and 2 lb/A.

(2) tebuthiuron [*N*-[5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl]-*N*, *N*'-dimethylurea] at 0.5 and 1 lb/A.

(3) buthidazole [3-[5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl]-4-hydroxy-1-methyl-2-imidazolidinone] at 1 and 2 lb/A.

The herbicide treatments were applied in small plot areas measuring 20 by 20 feet during winter and spring of 1978. Data was collected one year later. The soil-applied herbicides were found to be much less effective for control of the two brush species than the foliar-applied herbicides. Of the foliar herbicide treatments, 2,4-D and 2,4-D plus picloram applied on June 1 pruduced the highest brush mortality (96% for greasewood, 89% for salt rabitbrush). Greasewood exhibited a hypersensitive reaction and immediately dropped its leaves with 2,4-D concentrations above 1 lb/A. Carefully timed application of 2,4-D at 1 lb/A gave simultaneous control of both species.

A COMPARATIVE EVALUATION OF PHYTOTOXICITY OF SEVERAL HERBICIDES TOWARD SALTCEDAR (*TAMARIX RAMOSISSIMA* Ledebour)

Phil Peterson, J. O. Evans and C. J. Hurst[1]

Abstract: During the summer of 1978, trials were established at five locations throughout Utah to compare the response of saltcedar to several new herbicides and the standard treatment, silvex [2-(2,4,5-trichlorophenoxy)propionic acid]. Various types of applications were made including foliar spraying of young and old plants, cut stump applications, burn regrowth and cut stump regrowth treatments.

During 1979, the trials were evaluated and the data tabulated so as to compare the results of the various herbicides with silvex.

The purpose of combining chemical spraying with various mechanical control measures was to reduce the possibility and extent of herbicide effects on non-target species. By lowering the plant canopy or by spraying directly onto cut stumps, the volumn and drift of the herbicides examined was reduced.

[1]Utah State University, Logan, UT 84322.

CONTROL OF CALIFORNIA CHAPARRAL SPECIES WITH 2,4-D AND DICHLORPROP

R. R. Johnson, K. W. Dunster and R. A. Fosse[1]

Abstract: Various ester and amine salt formulations of 2,4-D [(2,4-dichlorophenoxy)acetic acid], dichlorprop [2-(2,4-dichlorophenoxy)propionic acid] and combinations of both were applied at a rate of 4.5 kg/ha to brush regrowth near Coulterville, California. Applications were made with a hydraulic sprayer and handheld brush gun. Treatments were applied on April 18 and June 19 in 1978 and June 6 in 1979. Evaluations in April

[1]Union Carbide Agricultural Products Co., Springhouse, PA, Fremont, CA, and Manteca, CA.

and June 1979 indicate that the April applications of 2,4-D and dichlorprop were more effective for controlling chamise (*Adenostoma fasciculatum* H.& A.) and mansanita (*Arctostaphylos* spp.) than the June applications, and that the June applications were more effective than those in April for controlling black oak (*Quercus kelloggii*), interior live oak (*Quercus wislizenii* A.DC.) and poison-oak (*Toxicodendron quercifolium*).

CONTROL OF YELLOW NUTSEDGE BY TARPING THE SOIL WITH CLEAR POLYETHYLENE PLASTIC

M. J. Hejazi[1], J. D. Kastler[2] and R. F. Norris[1]

Abstract: Tarping the soil for 2, 4 or 6 weeks with 1 mil clear polyethylene was tried as a control for yellow nutsedge (*Cyperus esculentus* L.) tubers during July and August, 1979 in Davis, California. Maximum temperatures for untarped and tarped soil respectively were 44 and 48C at 4 cm deem, 35 and 43C at 8 cm deep, and 31 and 39C at 16 cm deep. The maximum quantity of tubers killed was 26%; this would be insufficient to provide effective yellow nutsedge control. Laboratory tests, conducted to determine thermal death points of the tubers at various temperatures, indicated minimal kill of tubers at temperatures of 45C or below. Mortality was 67% in 32 days at 50C, and was 100% after 6 days at 60C. Following removal of the tarps, monitoring of the annual native weed population on the field test site showed a decrease in seedling emergence of 70 to 80% in plots that had been tarped.

Introduction

The use of clear polyethylene tarps was initiated in Israel as an inexpensive, nonchemical method to control soil-bourne plant pathogens (4). When clear plastic tarps were spread over moist soil under conditions of high solar radiation, temperatures underneath the tarps became lethal to many soil-borne pests (5). Soil thermal conductivity can thus extend several centimeters deep. Plant pathologists studying this method to control certain plant pathogens noticed that weeds were reduced in the tarped plots (4; G. S. Pullman, personal communication), but no research has been published to date about this aspect of soil tarping.

Yellow nutsedge is considered to be one of the worst weeds in the world (3) and is a serious pest in many commercial fields, nurseries, and home gardens in California. It is propagated by thizomes and tubers (2,3). Control is difficult and depends on the destruction of underground rhizomes and tubers, and the prevention of seed production.

Tarping was investigated as an alternative to mechanical weeding or chemical control of yellow nutsedge for potential use by home gardeners and in high-value crops; weed control could also be an additional beneficial effect of tarping when used to control pathogens or nematodes in commercial fields.

Materials and Methods

Laboratory tests. Laboratory tests were conducted to determine the thermal death point of the yellow nutsedge tubers. The yellow nutsedge tubers

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used in these studies were purchased from Valley Seed Services in Fresno, California and were originally obtained from Georgia in 1978. Three temperature regimes established were as follows:

Regime 1. 40C day and 35C night
Regime 2. 50C day and 37C night
Regime 3. 60C day and 40C night

Day and night temperatures were changed every 12 hours. Regimes one and two were replicated 3 times, and regime three only twice. Each replication consisted of 50 tubers in a 15 by 15 cm nylon mesh envelope. The envelopes were buried in greenhouse flats filled with sterilized, moist sand and covered with 1 mil clear polyethylene. The flats were placed in a growth chamber with automatic temperature controls (regime 1) or in an oven with temperatures changed manually (regimes 2 and 3). Tubers is regime 1 were harvested every 3 days for 27 days; tubers in regime 2 were harvested after 1, 2, 4, 8, 16, and 32 days; those in regime 3 were harvested after 3 and 6 days. Upon harvest, tubers were sliced in half and the cut surfaces treated with 0.25% solution of 2,3,5-triphenyl tetrazolim chloride (tetazolium red) (1). Tuber viability was judged according to the color reaction; pink to red were judged alive and colorless were judged dead.

Field experiment. A field experiment was started July 7, 1979 on the University farm at the University of California at Davis. The soil was Yolo fine sandy loam with high native populations of mallow (*Malva* sp.), common purslane (*Portlulaca oleracea* L.), several annual grass species, and scattered additional weed species.

A split-plot design was used with four replications. Each replication consisted of 50 yellow nutsedge tubers in nylon mesh bags. Plots were 3.0 by 4.0 meters. Main plots were tarped with 1 mil clear polyethylene for 2, 4, or 6 weeks, or left untarped for 2, 4, or 6 weeks. Sub-plots were the depths at which the tubers were buried, either 4, 8, or 16 cm. The field was leveled, preirrigated and disced, after which a border was prepared around each plot by tractor. Three holes were dug in the center of the plots, one at each depth, and each hole received one envelope of tubers. A colored plastic ribbon was attached to the envelope to aid in locating it. A multichannel thermocouple recorder (Bristol model 581, type J) was used to measure and record soil temperatures at each of the three depths, as well as that of the ambient air. After the polyethylene tarps had been placed by hand, a second irrigation was applied underneath the plastic of the tarped plots. After 4 weeks, the tarps of the 6-week treatment were replaced because they have become translucent, brittle and were tearing. These plots were irrigated again at that time. Upon completion of the respective tarping treatment, the tubers were exhumed, washed, sliced and treated with tetrazolim red to determine their viability, as in the laboratory tests.

Following the removal of the last polyethylene tarps, all plots were rototilled at 2 depths; approximately 5 cm or approximately 20 cm, maintaining a spli-plot design. All plots were then irrigated. Summer annual weeds were counted after 21 days. Analyses of variance were performed on data from the field trial for nutsedge tuber viability, and for number of annual weeds emerging.

Results and Discussion

Growth chamber/oven studies showed that yellow nutsedge tubers were resistant to heat in the range of 40 to 50C (Figure 1). At 40C very few tubers were killed, even after 27 days. Under the 50C day regime the percent mortality increased with time, but it was evident that tuber mortality at this temperature required prolonged exposure and had only reached 60% after 32 days. Under the 60C day regime tuber kill was rapid; 6 days were sufficient for 100% mortality.

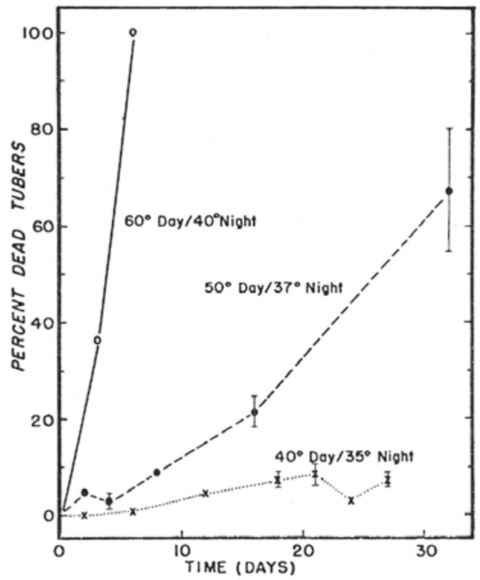

Figure 1. Influence of temperature regime on the viability of yellow nutsedge tubers. The regime used was 12 hr day and 12 hr night. The vertical bars about the data points indicate the standard deviation (where no bars are visible the range is within the size of the symbol used to indicate the data point).

The highest temperature recorded in the field was 53C at 4.0 cm deep under the plastic tarp; the average maximum temperature achieved at this depth was 48C (Table 1, Figure 2). The maximum temperature achieved decreased with increasing soil depth, and the range between highest and lowest temperatures also decreased with increasing soil depth. Tarping the soil only elevated maximum temperatures by about 4 to 5C at 4.0 cm deep (44C untarped and 48C tarped), but elevated temperatures at 16.0 cm deep by 8C (31C untarped to 39C tarped) (Table 1). Temperature near the maxima were only maintained for a few hours, but it can be seen that tarping did prolong the high temperature conditions in the soil (Figure 2).

Tarping the soil with clear ployethylene plastic significantly (P= 0.05 level) increased the mortality of yellow nutsedge tubers in comparison with those in untarped soil (Table 2). The maximum quantity of deal tubers was only 26% after six weeks of tarping, which would be insufficient to provide practical control of yellow nutsedge. Mortality was also signifi-

Table 1. Influence of polyethylene tarping on mean maximum and mean minimum soil temperatures for 6 weeks from July 8 to August 18, 1978 at Davis, CA. Standard deviations are provided for each mean.

Condition	Soil depth (cm)	Average high temp. C	Average low temp. C
Ambient air[1]	-	37 ± 4	14 ± 2
Tarped	4	48 ± 4	26 ± 3
	8	43 ± 3	29 ± 3
	16	39 ± 3	31 ± 3
Untarped	4	44 ± 4	19 ± 2
	8	35 ± 3	23 ± 2
	16	31 ± 2	25 ± 2

[1] Shade temperature, approx. 20 cm above soil.

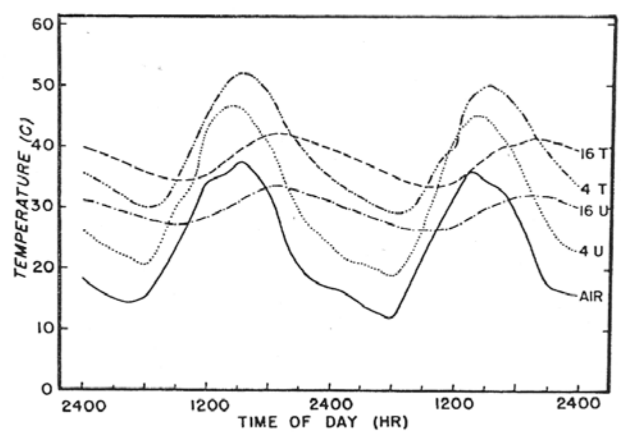

Figure 2. Example of actual measurements of temperatures obtained for a 48 hr period, based on ambient air temperature maxima near the long term average. 'T' and 'U' indicate tarped and untarped respectively; 4 and 16 refer to the depth in the soil at which the temperature was being recorded, in cm; 'air' refers to the ambient shade air temperature.

cantly greater in both tarped and untarped plots after 6 weeks than after 2 weeks (P = 0.05 level), but the maximum control achieved was still not biologically significant. From the data for thermal death point for nutsedge tubers, and for the temperatures achieved in the soil it is readily apparent that the temperature elevation in the soil was insufficient or of too short a duration to kill enough yellow nutsedge tubers to be of practical value.

Table 2. Percent of dead yellow nutsedge tubers in tarped and untarped field treatments. Standard errors are provided for each mean.

Length of time (weeks)	Depth of tubers (cm) 4	8	16	LSD (0.05)
		TARPED		
2	6.5 ± 1.3	3.0 ± 0.6	4.0 ± 0.8	3.8
4	19.5 ± 1.5	9.5 ± 2.1	9.5 ± 2.5	
6	26.0 ± 4.8	17.5 ± 5.6	14.5 ± 2.1	
		UNTARPED		
2	2.0 ± 0.8	2.5 ± 0.5	3.0 ± 1.3	
4	7.5 ± 0.5	9.5 ± 2.8	9.5 ± 1.5	
6	15.0 ± 4.2	13.5 ± 2.5	19.5 ± 1.5	
$LSD_{(0.05)}$	3.8			

The native annual weed polulation was reduced by about 80% after 6 weeks of tarping when compared to weed populations in untarped treatments (P = 0.05) (Table 3). Six weeks of tarping provided significantly higher levels of mallow control than 4 or 2 weeks of tarping (at P = 0.05 level), but variability in seedling numbers precluded verification of this observation on other species. Shallow rototilling may have resulted in lower native weed seedling emergence than did deep rototilling but variability masked any statistical significance. It appears that grassy weed species were more readily controlled by the tarping method when compared to the other annuals found in this field; purslane appeared to be unaffected by the conditions achieved in this experiment (Table 3). These data conclusively showed that the overall native weed population was reduced by tarping; further work will be needed to fully evaluate responses of individual species.

Conclusions

Yellow nutsedge tubers appear to be relatively resistant to heat damage at the temperatures found in clear polyethylene-covered soil in Davis during the summer months. The maximum percent of tubers killed (26%) is insufficient to provide control of the weed. Thus, covering the soil with clear polyethylene cannot be considered a practical method for control of yellow nutsedge.

However, this method did result in about 80% reduction of native annual weeds emerging after 6 weeks of tarping and thus may be a safe, practical method of weed control for home gardeners. It could be an additional benefit to the grower of a high-value commercial crop who might use soil tarping with clear polyethylene to control soil-borne pathogens or nematodes.

Table 3. Influence of tarping with clear polyethylene on emergence of weed seedlings following removal of the tarps.

Weed(s)	Cultivation depth	Weeks tarped 0	2	4	6	mean
	(cm)			(#/m^2)		
Grasses	5	21.6	0.8	1.5	0.5	0.9
	20	14.2	1.5	2.5	0.8	1.6
	mean	17.9a	1.1	2.0	0.6	1.2b
Mallow	5	67	23	19	9	17
	20	99	18	22	11	17
	mean	83a	20	20	10	17b
Purslane	5	4.0	3.8	1.2	3.8	2.9
	20	5.3	8.8	2.8	9.5	7.0
	mean	4.6a	6.3	2.0	6.6	5.0a
Total	5	98	30	28	15	24
	20	98	31	33	26	30
	mean	98a	30	31	20	27b

Means within a species followed by the same letter do not differ significantly at P = 0.05 level according to Duncan's Multiple Range test.

Acknowledgements

We gratefully acknowledge provision of the land, and all necessary land preparation, by the UC Davis Student Experimental Farm. We also thank the departments of Agronomy and Range Science, and Plant Pathology for provision of growth chamber space and polyethylene sheet respectively, and Mr. D. Paige for provision of the multipoint thermocouple temperature recorder.

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"CDA" CONTROLLED DROPLET APPLICATION FROM MECHANIZED AGRICULTURAL SPRAY EQUIPMENT

Frank X. McGarvey and Michael Wenner[1]

Abstract: Controlled droplet application has shown to be an economical method of herbicide application for field and orchard weed control. Rate reduction of active ingredient has been demonstrated with contact herbicides (up to 50%). The amount of total spray solution (herbicide and water) has been reduced to 3 to 6 gallons or less without drift.

The reduction of total spray per acre is a tremendous savings for the farmer in time, energy and money.

[1]Micron West, Inc. 9821 Katy Frwy, No. 66, Houston, TX 77024

A VERSATILE TRACTOR SPRAYER FOR HERBICIDE RESEARCH

G. R. Rohde and P. K. Fay[1]

Abstract: A field sprayer mounted on a 17-horse power diesel tractor has been tested in Montana for one season. The tractor sprayer utilizes an air compressor driven by a power take off for the spray propulsion. A number of interchangeable components makes it a versatile sprayer for weed research:

1. Spray tank modules--ten 2400 ml tanks, four 10,000 ml tanks or one 25 gallon tank can be used.
2. Quick change spray booms--a 6', 10', or 24' boom can be used.
3. A windscreen--a canvas windscreen permits spraying in winds up to 20 MPH.
4. Electronic spray volume monitor--allows accurate applications without frequent calibration.
5. Rope wick applicator--a front or rear mounted rope wick applicator can be attached to the tractor.
6. Herbicide incorporation--the diesel tractor can be used with a rototiller or a harrow for incorporation of herbicides.
7. Fast fill and rinse--the air compressor allows for rapid rinsing of the spray tanks after use. Quick release tops permit rapid filling of the 2400 ml and 10,000 ml tanks.

[1]Agron. Tech. and Asst. Professor, Plant and Soil Sci. Dept., Montana State University, Bozeman, MT 59717.

There are problems with the sprayer:

1. Transportation--the tractor must be transported on a trailor by a pickup truck.
2. Wheel tracks--the tractor wheels cause some crop injury and must be correctly spaced for row crops. The tractor cannot be used when wet soil conditions prevail.
3. Spray agitation--the sprayer does not have an agitation system to maintain herbicides in solution or suspension.

SURVEY OF WEED COMPLEXES IN ALFALFA SEED FIELDS IN IDAHO

C. A. Calpouzos, G. A. Lee and C. D. McNeal[1]

An Integrated Pest Management Program was initiated in 1976 for alfalfa seed growers to effectively deal primarily with entomological problems. The program was a (federally funded) pilot project at the inception but growers have assumed the financial responsibilities of the program through a per acre assessment. In previous years, the program consisted of field scouts monitoring seed alfalfa fields for insect populations and determining the economic threshold for those populations. Insecticide recommendations (which least impacted the beneficial pollinators and parasites) were provided by the University of Idaho Extension Entomologist. In 1979 the IPM Program was expanded to include weeds since undesirable plants are a major factor in reducing yeilds and quality of alfalfa seed and increasing processing costs. In order to better assess the weed communities common to the alfalfa seed production areas and current weed control practices, a survey was conducted during August in south central and southwestern Idaho. The purpose of the survey was to determine weed species present, intensity of weed infestations in seed fields, and chemical and mechanical control measures utilized by producers.

Materials and Methods

The weed survey was conducted during the first two weeks of August, 1979. The Treasure Valley and Magic Valley of central and southwestern Idaho, the largest acreage of alfalfa grown for seed, were locations selected for conducting the survey. Growers already involved in the IPM project were contacted for information regarding their weed control practices. A survey form was developed to determine (1) what weed species the grower felt were a problem in seed alfalfa fields during the past season; (2) the age of the alfalfa stand; (3) the herbicides used, if any, in the establishment of the alfalfa stand; (4) the herbicides currently used in the established alfalfa stand; (5) type of mechanical weed control used, if any. Each grower was interviewed in person or by telephone to obtain information regarding the previously mentioned five questions.

After gaining the producers permission, each seed alfalfa field was visited and surveyed for weed community composition and intensity of weed infestations. A map of each field was developed to record the results of the survey. Data on weed species and area infested was determined visually.

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[1]Field Scout, Seed Alfalfa IPM Program, 1979, and student U of I; Professor of Weed Science, Plant & Soil Sciences Department; IPM Coordinator, Department of Entomology, respectively, College of Agriculture, University of Idaho, Moscow, ID 83843.

By walking through the entire field, all of the species present were noted. Each weed species was then surveyed for its population intensity and its extent or area of infestation. The intensity of infestation was indicated by one of three categories: intense, moderate, and occasional. Intense depicted dense clusters of a weed species and occasional indicated populations of three or less plants per square meter. The extent or area of infestation was presented as a percentage of the field which a weed species was present. If a weed species was only found along the perimeter of the field, a special notation for that species was made.

Most of the alfalfa seed fields were surveyed after irrigation had been stopped. The weeds were mature and many of the species had set seed. The Treasure Valley aflafla crop was about two weeks ahead of that of the Magic Valley.

Results and Discussion

Thirty-seven growers participated in the initial IPM Alfalfa Seed Crop Weed Survey conducted in 1979.

Weed species present in alfalfa seed crop. Forty-three individual weed species were detected in the 122 fields surveyed. Prickly lettuce (*Lactuca serriola* L.) and kochia [*Kochia scoparia* (L.) Schrad.] were found in 64% and 62% respectively, of the fields observed (Table 1).

Table 1. Weeds present in over 25 percent of fields surveyed.

Weed species	% of fields with weeds present[a]
Prickley lettuce	64
Kochia	62
Redroot pigweed	48
Sunflower	42
Lambsquarter	40
Barnyardgrass	32
Wild Oats	31
Canada thistle	31
Green foxtail	27
Salsify	25

$^a\% = \frac{\text{number of fields with weed}}{\text{122 (total number of fields)}}$

Redroot pigweed (*Amaranthus retroflexus* L.), wild sunflower (*Helianthus annus* L.), and common lambsquarter (*Chenopodium album* L.) occurred in 48, 42 and 40%, respectively, of the alfalfa fields. Annual grasses such as barnyardgrass (*Echinochloa crus-galli* L.), wild oat (*Avena fatua* L.) and green foxtail [*Setaria viridus* (L) Beauv.] were present in 32% or less of the fields surveyed. Canada thistle (*Cirsium arvense* L.) was the perennial noxious weed most frequently infesting the seed fields.

Population intensities and percent of the field infested was estimated for each weed species encountered. Over 40% of the time, prickly lettuce and kochia infested more than 75% of the total field (Table 2). Common lambsquarter, barnyardgrass and green foxtail were also found to intensely infest large areas of alfalfa fields. Correlation of weed problems found in fields with problems indicated through grower interviews was poor. Of the 10 most prevalent weed indentified in alfalfa seed fields, only kochia, wild sunflower and Canada thistle were acknowledged as problem species by growers. However, the growers expressed greater concern about hairy

Table 2. Population intensities and areas of infestation of problem weeds.[a]

Weed	Population Intensity	% of Fields[b]	Area of Infestation	% of Fields[c]
Prickly lettuce	Intense	19	100-75% of field	42
	Moderate	15	75-50% of field	24
	Occasional	53	50-25% of field	16
Kochia	Intense	10	100-75% of field	47
	Moderate	13	50-25% of field	12
	Occasional	63	25-5% of field	27
			perimeter	10
Redroot pigweed	Intense	4	100-75% of field	24
	Moderate	17	75-50% of field	12
	Occasional	57	50-25% of field	10
			25-5% of field	45
Sunflower	Intense	8	100-75% of field	8
	Moderate	12	75-50% of field	14
	Occasional	33	50-25% of field	13
	Several plants	30	25-5% of field	57
Lambsquarter	Intense	6	100-75% of field	31
	Moderate	8	75-50% of field	16
	Occasional	65	50-25% of field	12
	Several plants	20	25-5% of field	13
Barnyardgrass	Intense	12	100-75% of field	40
	Moderate	16	75-50% of field	21
	Occasional	60	25-5% of field	19
Wild oats	Intense	7	100-75% of field	15
	Moderate	20	75-50% of field	15
	Occasional	56	50-25% of field	18
			25-5% of field	28
			perimeter	10
Canada thistle	Intense	34	100-75% of field	9
	Moderate	9	75-50% of field	12
	Occasional	25	50-25% of field	9
	Several plants	20	25-5% of field	31
Green foxtail	Intense	0	100-75% of field	42
	Moderate	41	75-50% of field	9
	Occasional	48	50-25% of field	9
			25-5% of field	35
Salsify	Intense	0	100-75% of field	29
	Moderate	17	75-50% of field	6
	Occasional	47	50-25% of field	12
			25-5% of field	35

[a]These are two different measures of weeds present and should be interpreted independently of each other.

[b]Percentage of fields (of the total with the weed) showing the pattern of infestation (stand density).

[c]Percentage of fields (of the total with the weed) showing the area in which the weed was found.

Table 2. (continued)

Note: Besides the categories shown, other categories were used to show intensity and area of infestation. Because these percentages were insignificant they were not included; therefore, the percentages do not equal 100.

nightshade (*Solanum sarachoides* Sendt.) and dodder (*Cuscuta* sp.), which were found only occasionally and in limited areas of the fields. In the growers' opionion, hairy nightshade was a problem because ruptured fruit impeded the operation of the harvest equipment, and dodder was a problem because separation of the seed requires difficult and expensive cleaning operations.

Weed control measures utilized. Out of 37 growers surveyed, only four producers did not use either herbicide or mechanical means to control weeds. The fields of the four growers not employing weed control practices were the most intensively and extensively weed infested fields surveyed.

Chemical weed control. Thirty three growers indicated use of 15 different herbicides during the 1979 growing season (Table 3). There were 102 fields of the 122 fields surveyed which recieved a herbicide treatment.

Table 3. Herbicides used on alfalfa seed fields.

Herbicide	% of fields to which the herbicide was applied
Trifluralin	40[a]
EPTC	15
Benfluralin	11
Profluralin	9
Diuron	9
Metribuzin	8
Amitrole	6
2,4-DB	6 and spot-spray
DCPA	4
Alachlor	3
Bentazon	2
Simazine	1
Hexasinone	1
Glyphosate	1 and spot-spray
Dyrene	spot-spray only
No herbicide	8

a $\% = \frac{\text{number of fields herbicide was applied}}{\text{102 (total number of fields using herbicides)}}$

Some growers used more than one herbicide on the same field. The most frequently used herbicide was trifluralin (α,α,α-trifluoro-2,6-dinitro-*N*,*N*-dipropyl-*p*-toluidine). Whenever diuron [3-(3,4-dichlorophenyl)-1,1-dimethylurea] was applied, it was always used in conjunction with trifluralin. Dyrene, glyphosate [*N*-(phosphonomethyl)glycine] and 2,4-DB [4-(2,4-dichlorophenoxy)butyric acid] were used mainly to spot-treat certain weeds such as Canada thistle. Although several of these treatments are not registered on alfalfa grown for seed, Table 3 indicates the types of herbicide uses revealed during the course of the survey. Since the ten most prevalent weeds were found several months after applications of trifluralin, EPTC (*S*-ethyl dipropylthiocarbamate), profluraline [*N*-(cyclopropylmethyl)-α,α,α-trifluoro-2,6-dinitro-*N*-propyl-*p*-toluidine], and trifluralin + diuron, results indicate that these herbicides may be weak on those specific species. The herbicides were selected by growers to control target species that were less prevalent. Fields treated with simazine [2-chloro-4,6-bis(ethylamino)-*s*-triazine] and alachlor [2-chloro-2',6'-diethyl-*N*-(methoxymethyl)acetanilide] tended to have few if any weeds present.

Mechanical weed control. Growers who utilized mechanical weed control in their alfalfa seed production practices utilized only three different cultivation tools (Table 4): Triple K, spring-tooth harrow and row cultivator.

Table. 4. Mechanical control of weeds used on alfalfa seed fields.

Mechanical control	% of fields where mechanical control used[a]
Tripple K	34
Row cultivator	31
Spring-tooth harrow	8
No mechanical control	27

[a] $\% = \frac{\text{number of fields using mechanical control}}{\text{102 (total number of fields using weed control)}}$

There is no distinct difference between the spring-tooth harrow and the row cultivator when considering how they control weeds, but the tools were reported separately because the growers surveyed made the distinction. Even though the Triple K was the most popular means of mechanical control, only the growers in the Magic Valley used it. Ninety-four percent of the fields which received a mechanical treatment were located in the Magic Valley. Fifteen of the 33 growers using a herbicide utilized an additional mechanical operation to control weeds.

Summary and Conclusions

The 1979 IPM Alfalfa Seed Crop Weed Survey was conducted on 122 fields controlled by 37 growers. Forty-three individual weed species were identified with prickly lettuce and kochia occurring in 40% of the fields and infesting 75% or more of the total area.

Chemical weed control was used by 33 growers and only 4 producers used no herbicides. Seventeen different herbicides were used in alfalfa seed fields in 1979. Trifluralin was the most commonly selected herbicide. Since several species were commonly found in many fields treated with herbicides, there appears to be a weakness in tactics for broad spectrum weed control.

Forty-six percent of the growers using herbicides used both chemical and mechanical means of controlling weeds. The Magic Valley growers utilized mechanical control measures to a greater extent than producers in the Treasure Valley area.

The results of this study provides a basis for further developing effective weed control tactics in alfalfa seed production. It is apparent that growers readily accept weed control as a management tool but weed problems acknowledged by producers do not correlate well with weed species in the fields.

PERENNIAL WEED CONTROL WITH THE ISOPROPYLAMINE SALT OF *N*-PHOSPHOSOMETHYL GLYCINE

C. R. Hunt[1]

Abstract: The commercial formulation of the isopropylamine salt of *N*-phosphonomethyl glycine (IPA glycine) was first registered for the control of perennial weeds in industrial and non-agricultural uses in April, 1974. Since that time the commercial formulation has been registered for 26 perennial weeds and 8 woody brush and tree species.

The development of specialized equipment permits the selective control of tall growing weeds in cotton and soybeans.

Selective weed control utilizing specialized equipment in other areas such as ditchbank weed control, pasture, and other crops needs to be explored.

[1]Res. & Development Specialist, Monsanto Agr. Products Co., Great Falls, MT.

KIKUYUGRASS RENOVATION

David W. Cudney, V. A. Gibeault, R. L. Baldwin and J. R. Breece[1]

Abstract: Kikuyugrass (*Pennisetum clandetinum* Hochst. ex Chiov.) ia a warm-season grass which has invaded turf in the California coastal regions. A system of herbicide treatment, renovation and the use of competitive turf species in combination with preemergence herbicide application was evaluated in San Diego and Ventura Counties. In this system, glyphosate [*N*-(phosphonomethyl)glycine] was used as a pretreatment in kikuyugrass-infested turf followed by renovation. Kentucky bluegrass (Flyking), perennial rye (Derby) and tall fescue (Alta) were established. Siduron [1-(2-methylcyclohexyl)-3-phenylurea] was applied in four different treatment regimes to each of the turf species. Evaluations were made on each of these control practices alone and in combinations. It appears that all of the treatments, that is: glyphosate, renovation and seeding with a competitive cool-season grass (tall fescue or perennial rye), accompanied by preemergence treatments with siduron, were necessary to give maximum reduction in reinfestation of kikuyugrass.

[1]Extension Weed Scientist and Extension Environmental Horticulturist, Department of Botany and Plant Sciences, University of Calfornia, Riverside, CA and Farm Advisors, Cooperative Extension Service, Univ. of California, respectively.

CONTROL OF SUBMERSED AQUATIC WEEDS IN IRRIGATION CANALS WITH FLURIDONE

N. Dechortez[1]

Abstract: Field studies were conducted to evaluate the efficacy of fluridone [1-methyl-3-phenyl-5-[3-(trifluoromethyl)phenyl]-4(1*H*)-pyridinone] as an aquatic herbicide in irrigation canals. Both the aqueous suspension (4AS) and the pelleted (5P) formulations of fluridone were applied to the canal bottom at rates of 4 and 8 lb/A. Treatments were made in December and in March prior to the irrigation season. Fluridone was more effective when applied in December. Excellent control was obtained throughout the irrigation season when 4 lb/A of fluridone 5P was applied to bare soil. The presence of plant material of degris at the time of treatment reduced the herbicidal activity of fluridone. The March applications of fluridone did not inhibit the growth of aquatic weeds during the irrigation season. This lack of control may have been related to the amount of rainfall deposited on the treated area after an application and before the water was turned into the canal.

[1]Biologist, USDA-SEA, Botany Department, University of California, Davis, CA 95616.

THE PLACE OF THE WEED MANAGER IN TODAY'S CROP MANAGEMENT SYSTEM

Harold M. Kempen[1]

Abstract: The increasing complexity and sophistication of irrigated farming in California's San Joaquin Valley is cause for specialized weed management personnel. Agriculture shows a marked tendency for tying production of fruits and vegetables from different regions of the state to their shipping operations. Since cost of production can range from $1,000 to $4,000 per acre, managers must provide detailed attention to many aspects of management beside production. Therefore, they are increasingly utilizing the services of agronomists, soils specialists, entomologists and nematologists. Weed consultants are as needed as the widely used entomologists but are reluctant to enter this service because of litigation hazard. Yet they offer good cost/benefit returns as regulations increase, species shift, herbicide and labor costs increase, and interactions between herbicides, insects, crop selection, irrigation and fertilization occur.

The need for monitoring of weeds present, applications of herbicides, and performance of applied herbicides is evident. Watching for new, serious weeds is impossible without a weed specialist who knows his species.

Experience has shown that prediction of weeds in fields is not easily done in irrigated agriculture. Also, experience shows that preventative weed management programs, rather than economic weed management programs, are preferred on annual weeds as well as perennials. In part, this is because plenty of opportunities exist for occasional weeds to go to seed (delayed harvest due to poor prices, adverse weather, adverse insect or disease problems, and recently excess regulations).

[1]Farm Advisor, Univ. of California Cooperative Extension, Bakersfield, CA

HERBICIDAL CONTROL OF CANADA THISTLE [*CIRSIUM ARVENSE* (L.) SCOP.]

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

Abstract: Field experiments were established in two locations in 1976 and 1977 to compare the effectiveness of before- and after-frost applications of glyphosate [*N*-(phosphonomethyl)glycine] for Canada thistle control. The effect of before-frost applications of combinations of glyphosate + dicamba (3,6-dichloro-*o*-anisic acid) or 2,4-D amine [(2,4-dichlorophenoxy)acetic acid] was also studied in the 1977 experiments. After-frost applications of glyphosate at 2.0 + 4.0 lb ai/A gave control equal to better than before-frost treatments. Glyphosate at 2.0 lb ai/A + dicamba at 0.25, 0.5, 0.75 and 1.0 lb ai/A generally improved Canada thistle control compared to glyphosate at 2.0 lb ai/A alone. Results with 2,4-D (amine)-glyphosate combinations were variable and generally less effective that the dicamba-glyphosate combinations.

[1]Asst. Professor, Res. Associate and Professor of Weed Science, respectively, Dept. of Plant & Soil Sciences, Univ. of Idaho, Moscow, ID.

CROP TOLERANCE TO BUTHIDAZOLE UNDER TWO MOISTURE REGIMES IN NORTHERN IDAHO

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

Abstract: Studies were established in Moscow and Lewiston, Idaho to determine the influence of incorporated and surface applications in the fall and spring on the dissipation, crop phytotoxicity and efficacy of buthidazole [3-[5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl]-4-hydroxy-1-methyl-2-imidazolidinone] applied at 0.28, 0.56, 1.1 and 2.2 kg/ha. Atrazine [2-chloro-4-(ethylamino)-6-(isopropylamino)-*s*-triazine] at 0.56 kg/ha was used for comparison purposes. Surface treatments of buthidazole applied in the spring resulted in the best weed control at the Moscow location. Opposite results were obtained at the Lewiston site where the temperature is higher and the rainfall is less. Crop phytotoxicity was not evident with the 0.28 kg/ha treatment at the Moscow fall applied area. All other buthidazole treatments resulted in increasing damage with increasing rates. All treatments applied in the fall at Lewiston resulted in some measure of crop phytotoxicity. Spring applications at both locations were more severe. Crop phytotoxicity was less severe during the third growing season with the exception of the 2.2 kg/ha treatments. Of the three crops studied, barley showed the best tolerance to buthidazole.

[1]Graduate Assistant, Assistant Professor and Professor of Weed Sciences, Department of Plant and Soil Sciences, University of Idaho, Moscow, ID.

THE INFLUENCE OF HIGH DOSES OF HERBICIDES UPON SUGAR BEETS AND RESIDUES IN PLANT AND SIOL

Tadeusz Banaszkiewicz[1]

Abstract: Field and pot experiments were conducted in 1974-1977 on clay and peat in the northern part of Poland. The following herbicides were used: lenacil [3-cyclohexyl-6,7-dihydro-1*H*-cyclopentapyrimidine-2,4(3*H*, 5*H*)-dione] at 0.8, 1.6 and 2.4 kg/ha and pyrazon [5-amino-4-chloro-2-phenyl-3(2*H*)-pyridazinone] at 4.8 and 6.4 kg/ha. There was a decrease in yield of sugar beets under high doses of the herbicides on mineral soil. In pot experiments on high organic soil lenacil was harmful for beets whereas pyrazon applied post-sowing stimulated their growth. Lenacil also reduced the potassium and calcium and increased sodium content in the roots. Pyrazon increased the root sugar and calcium and decreased leaf protein. No significant changes in chemical composition of the crop were observed under any of the treatments in field experiments. The decomposition of lenacil in the plants was fast while pyrazon remained in the roots until the end of their growth. Phytotoxicity of the herbicides lasted longer in a low-moisture soil. Lenacil, contrary to pyrazon, persisted longer in both soils.

[1]Adjunct, Institute of Plant Protection, Agricultural and Technical Academy, Olsztyn, Poland. Currently visiting scientist, University of Idaho Research and Extension Center, Aberdeen, ID.

"OLD TIMERS" SECTION

Retired workers who were instrumental in establishing weed science in the western United States were invited to attend a "reminiscing" session during the 1979 annual meeting in Boise, Idaho. The following reports were received after Volume 32 had gone to press and were unable to be included with others reports of the "Old Timers" Section.

ALDEN S. CRAFTS

Dr. Crafts was born June 24, 1897 in Fort Collins, Colorado; son of Henry Alonza and Elizabeth Dunscomb (Bleakley) Crafts. His formal higher education and professional career has been at the University of California. He received the B.S. degree in 1927 and Ph-D. degree in 1930. He was appointed an Assistant Botanist in the Botany Department at Davis in 1931, advanced through the normal ranks to Botanist and Professor of Botany in 1946, and became Professor Emeritus in 1964. He has received honors from the scientific community including an honorary degree from the University of California at Davis (LL.D.) and a degree from St. John's College, Oxford University (M.A.) as well as a National Research Council Fellowship, a Fulbright Fellowship, and two Guggenheim Fellowships. He was given the Charles Reid Barnes Award by the American Society of Plant Physiologists. He has been presented with Fellow or Honorary Member status in the Weed Science Society of America, American Association for the Advancement of Science, Western Society of Weed Science, Zoological-Botanical Society of Vienna, and the California Weed Conference. He was a Delegate to the International Botanical Congress in Paris, France, in

1954; Delegate and Vice-Chairman of the Golden Research Conference on Biochemistry in Agriculture in 1955, and Visiting Professor at the Puerto Rico Agricultural Experiment Station in 1947-48. He has served in an administrative capacity for several scientific societies including President of the Weed Science Society of America, President of the American Society of Plant Physiologists and Chairman of their Western Section, and President of the California Weed Conference. He was also Acting Chairman (1959-60) and Chairman (1960-63) of the Botany Department of the University of California at Davis. He is a member of Phi Beta Kappa, Sigma Xi, Phi Sigma, and Gamma Alpha.

After graduating from high school in 1916, Dr. Crafts registered in the College of Agriculture at the University of California at Berkeley; but after his freshman year he said, "I was pretty well fed up on schools--I wanted some practical experience in agriculture." During the several years of practical experience he developed an "appreciation" for weeds. He tested a recommendation for a foliar spray of a dilute solution of sodium arsenite for field bindweed control--it worked. The roots were killed to some depth in the soil--it was translocated; thus, back to college to study botany, chemistry, chemical weed control and how things move in plants. In 1927, the same year he obtained his B.S. degree, Dr. Crafts published his first scientific paper on the translocation of arsenic in plants (Plant Physiol. 2:503-506) with P. B. Kennedy.

He has developed an outstanding international reputation as research scientist in plant physiology and weed science. His primary life-long research interest is the mechanism of translocation in plants, especially the translocation of those materials that move in the phloem. He is a world authority on this subject. He pioneered the research on the now common technique of using radioactive compounds in conjunction with autoradiography to examine their translocation in plants. He has written over 100 original papers on his research investigations that have been published in major scientific journals, as well as several review papers and numerous popular articles. His great capacity for writing has resulted in the publication of ten books on weed control, mode of action of herbicides, water relation of plants, and phloem transport in plants, often co-authored with a colleague.

Dr. Crafts has been an inspirational teacher of farmers, college students, emerging scientists, as well as established scholars. Many of his students have become leaders in California agriculture, while others have developed outstanding reputations in the world scientific community through their original scientific research. Although he was always available for consultation with graduate students on their research problems, he made them think for themselves and perhaps stumble here and there before succeeding to instill independent self-confidence rather than leading them all the way by the hand. He has befriended many a student by allowing them to live in his home.

Although Dr. Crafts retired from the University of California System at the mandatory age of 67, he has continued to play an active role as a scientist. He has written three books, participated in state, national, and international scientific meetings, acted as a consultant, served as an expert witness, and inspired his colleagues. He is currently working on a history of the Western Society of Weed Science.

OLIVER ANDREW LEONARD

1911-1975

Oliver Andrew Leonard was born in Pullman, Washington on January 5, 1911. His childhood was enriched by time spent on the family homestead in Idaho among the fir, pine, and cedar trees. His love for plants, exceeded only by his love for family and mankind, shaped the course of his personal and professional careers. Oliver was never to be far removed from the plant community, which provided both the arena for his research and that unique peace of mind that comes from close association with the wonders of nature.

Dr. Leonard received his B.S. and M.S. degrees from Washington State College in 1933 and 1935, respectively. His interest in additional education in plant physiology took him to Iowa State College, where he obtained the Ph-D. degree in 1937. During this period he became a student of translocation in plants, a topic he continued to research throughout his career. Upon leaving Iowa State, he was appointed an instructor at Texas A & M College from 1937 to 1939, and a plant physiologist at the Mississippi Agricultural Experiment Station from 1939 to 1950. While in Mississippi he not only continued his research on translocation but expanded his interest to weed control. These two areas of research were complementary, since most effective herbicides of that time were translocated in higher plants and their phytotoxic symptomology indicate the pattern of translocation. In 1950 Oliver Leonard joined the Botany Department at the University of California at Davis to conduct research on the control of woody plants on rangeland and continue his translocation research. Dr. Leonard was a pioneer in the discipline of weed science. He was one of the first scientists to investigate the use of herbicides for weed control in cotton and to use radioactive herbicides to study translocation in plants. His contributions toward the development of methods for the conversion of chaparral to productive rangeland are particularly noteworthy. In addition, he worked on weed control in vineyards and control of roots in sewers. In all these investigations, he had that rare down-to-earch ability of blending basic and applied research into a program that improved the lifestyle of mankind and also made noteworthy scientific contributions. He was a balancing force in the controversy concerning the environmental implications of the use of pesticides in agriculture.

Dr. Leonard wrote more than seventy papers on his research findings which were published in scientific journals. He also prepared numerous popular articles for use by the general public. He was a member of several professional societies, including the American Botanical Society, the American Society of Plant Physiologists, the American Society for Horticultural Science, the California Weed Conference, Sigma Xi, the Society for Range Management, the Western Society of Weed Science, and the Weed Science Society of America. He served on numerous committees in several of these societies and was secretary, vice president, and president of the California Weed Conference. He was a charter member of the Save the Redwoods League.

In addition to the receipt of three National Science Foundation grants for research on translocation in plants and numerous other grants to support his weed science research, his scientific accomplishments are attested to by the many honors that were bestowed upon him, including: Fulbright Fellowship; National Institute of Health Fellowship; United Nations Food and Agricultural Organization consultant visiting Zambia on forestry and Kenya on range physiology; German Senior Scientist Fellowship; and Fellow of the Western Society of Weed Science.

Dr. Leonard retired from the University of California in June, 1974 to enjoy life on his acreage among the redwood, fir, and bay trees on Sonoma County.

WILFRED W. ROBBINS

Dr. Wilfred W. Robbins was born on May 11, 1884, in Mendon, Ohio. He was the son of a midwestern farmer and grew up on a farm, an experience which he valued highly throughout his life.

Dr. Robbins was an undergraduate at the University of Colorado, where he received his A.B. degree in 1907. He continued his studies and was awarded the Master's degree in 1909. From 1908 until 1919, he was successively instructor of biology, instructor in botany and forestry, assistant professor and botany and botanist in the Experiment Station; and professor of botany and botanist in the Experiment Station at Fort Collins, Colorado. During these years, he developed and published his well-known book *The Botany of Crop Plants*, the first edition of which appeared in 1917. During these years, he conceived and developed new and revolutionary ideas on classroom teaching. He nurtured the philosophy that botany and agriculture are disciplines with many common interests that could be interrelated in a common curriculum. Dr. Robbins went to Chicago for his Ph-D. training; he received this degree in 1917.

Dr. Robbins moved to Davis, California, in 1922, where he spent 29 years as chairman of the botany division of the College of Agriculture. There, in collaboration with Professor Richard M. Holman, he wrote the famous *Textbook of General Botany*, a book which dominated the field of elementary botany teaching for over three decades. In the preface of this book, which appeared in 1924, Holman and Robbins express the conviction that both general students and agricultural students should profit more from a broad survey of the field, related wherever possible to agricultural practices and problems, and by the use of economic plants for illustrative material, than from highly specialized courses aimed at specialized aspects of botany. The strength of this belief is shown by the immense popularity of their book, the fact that it went through a whole series of revisions, and that most of the texts that have appeared since have adopted, at least in part, this same conviction.

Dr. Robbins was an enthusiastic and inspiring teacher in the classroom, on the lecture platform, and through his publications; and in his teaching he brought purpose into the lives of generations of students. He believed in botany as a science and as a discipline, and he believed in agriculture as a way of life. He believed in work and he believed in play; and he had the happy talent of being able to see and inject play into his own work and into the work of others, and so, while teaching with vigor, he was able to lighten the labor of the classroom to a point where learning became a pleasure. Scores of his students look back with nostalgia on their work in his classes; his spirit lives long in their memories.

Dr. Robbins developed an interest in weeds and poisonous plants during his early years in Colorado, and in 1930 he was able to initiate a program of weed research in California that has been a foundation for this important and growing field. He established the first classroom instruction in weed control as a scientific discipline, and as senior author of the first two editions of *Weed Control* was responsible for the introduction of this subject into many college curricula. By means of Extension lectures and correspondence he spread his enthusiasm and interest throughout the western states. He was interested in and instrumental in the formation of the Western Weed Control Conference, established in 1938.

In 1948 Dr. Robbins traveled extensively in South America, lecturing under the auspices of the Office of Foreign Agricultural Relations of the United States Department of Agriculture, giving over eighty lectures and conferences. In recognition of his contribution to South American agriculture, the University of Montevideo made him an honorary professor.

During the last years on the campus at Davis, Dr. Robbins served on many committees concerned with the welfare of students. In collaboration with Professor T. E. Weier he wrote a new modern textbook of botany. And he took a major part in the second revision of *Weed Control*. Probably no other single person has had a greater influence in the establishment of weed control as a science and as a discipline than has Dr. Wilfred W. Robbins. His personality and leadership are ever fresh in the memories of those who worked with him in this worthy endeavor.

MINUTES OF THE WESTERN SOCIETY OF WEED SCIENCE BUSINESS METTING
Salt Lake City, Utah
March 20, 1980

President Larry Burrill convened the meeting at 8:10 a.m. with about 86 members in attendance. 265 members and 40 graduate students were registered. Eleven wives signed for the ladies program.

Minutes were approved as published in the 1979 Proceedings.

Lowell Jordan presented the report on election of honorary members and fellow. Bill Anliker of CIBA-Geigy was elected Fellow of the Society. Lowell reminded the members that names of individualts suggested as honorary members or fellows should be send to Dick Comes, USDA-SEA, Prosser, WA by June1, 1980. No honorary members were elected in 1980.

CAST Activities. Lowell Jordan submitted the following report on CAST activities: The CAST Board of Directors met July 24-25, 1979 at St. Louis, MO and on February 27-28, 1980 at Washington D.C. The Cast Executive Committee met at the same time as the Board and also on October 25-26, 1979 at Kansas City, MO. The board members met in forums to discuss all aspects of CAST operations, procedures, and issues related to funding and credibility. Considerable time was devoted to revision of the CAST "Policies and Guidelines" which guide the organization's activities.

Task forces were authorized to prepare reports on "Significant Issues in the Structure of Agricultural Mechanization," "Aerial Application of Pesticides," "Soil Erosion," and "Production of Fuel Grade Alcohol from Agriculturally Derived Biomass." CAST will sponsor Telephone Dial-ogue on Food Safety on March 20-21. The program will bring over 20 distinguished scientists to Washington, D.C. to answer any questions concerning food, nutrition and agriculture, including Weed Science.

CAST publications for the year included: "Directory of Environmental Scientists in Agriculture," "Aflatoxin and Other Mycotoxins: An Agricultural Prespective," "Foods from Animals: Quantity, Quality and Safety," and "Impact of Government Regulations on the Beef Industry" and "Review of the Recommendations in the California 'Report on Environmental Assessment of Pesticide Regulatory Programs'." Several CAST papers were released concerning CAST, its credibility and service to agriculture.

Membership in CAST increased to 129 supporting members, 186 sustaining members, 127 subscriber members, 4 associate society members, and 3,585 individual members, as of February, 1980. The number of member societies is 25. The Society of Range Management discontinued its membership because of financial reasons. The Board of Directors has approved a membership drive to have each individual member bring in one additional member in 1980.

The CAST Board of Directors approved a budget of $339,320 for the 1979-1980 fiscal year. Most of the funds are supplied by the supporting members, but no supporting member is allowed to contribute in a manner or to the extent that it gains control of CAST or any of its activities. All CAST dues were increased by 20% in 1980 to cover increased operating costs and inflation.

The attacks on CAST by its critics are a definite sign that the organization has become a major influence concerning issues related to food and agriculture in the United States. An internal review of CAST concerning its policies, procedures and publications is making CAST fundamentally more solid financially, procedurally and creditably.

Financial Statement. The Treasurer-Business Manager report was presented by LaMar Anderson. He reported that the Society has the equivalent of a little over one year's operating expense in reserves and savings. Publications (Research Progress Reports and Proceedings) are paying for themselves. Other operating expenses are being paid by registration fees.

Western Society of Weed Science Financial Statement
March 10, 1979 - March 10, 1980

Income:	
Registration, Boise Meeting (282)	$4,464.00
Dues, members not attending Boise meeting (117)	574.00
Luncheon tickets for partners	65.00
1979 Proceedings sales	2,844.30
1979 Research Progress Report sales	2,221.98
Sale of older publications	286.50
Payment of past due accounts	40.00
Advance order payments	64.50
Interest on savings	422.33
Total fiscal year income	$10,982.61
Assets, March 10, 1979	9,943.69
	$20,926.30
Expenditures	
1979 Annual meeting incidental expenses	295.43
Meeting room rental, Boise	576.80
Graduate student room subsidy	354.60
Guest speaker expenses	191.75
1980 annual meeting incidental expenses	523.52
Luncheon, 1979 annual meeting	1,375.29
Business Manager honorarium	500.00
Dues, CAST	480.00
1979 Research Progress Report	2,396.97
1979 Proceedings	2,047.06
Refunds	43.50

Office supplies	100.90
Newsletter printing costs	118.18
Postage	704.75
Total expenditures	$9,708.75
Assets	
Savings certificates	7,500.00
Checking account balance	3,667.55
Cash on hand	50.00
	$11,217.55

Finance Committee. The finance committee report was presented by Harvey Tripple. He reported that the accounting procedures and records were in excellent order. It was suggested that the chairman of the finance committee assist LaMar Anderson in the financial affairs of the Society. It was recommended that the Society continue to increase reserves and savings up to the equivalent of two years' operating expense. Rick Chase will be chairman of the financial committee for 1980-1981.

Site Selection. Harvey Tripple presented the site selection committee report. The 1981 site will be the Hilton Inn in San Diego, March 17-19. 1981. The 1982 site was changed from Phoenix to Denver because of hotel problems in Phoenix. It was suggested that outgoing chairman of the committee serve as a committee member to assist the new chairman with problems associated with site selection. Harvey asked for an advisory vote on the days of the week for the meeting. He reported that hotels would prefer a Monday-Wednesday or Wednesday-Friday schedule. The membership expressed a strong preference for the current Tuesday-Thursday schedule with a Wednesday-Friday schedule preferred to Monday-Wednesday. Also, Harvey asked for an advisory vote on which weeks in March meetings should be held. Membership expressed a preference for the first and second week over the second and third week.

Sites have been selected and contracts signed for 1982, 1983 and 1984 as follows:

March 9-11, 1982	Stouffer's	Denver, CO
March 8-10, 1983	MGM Grand	Las Vegas, NV
March 12-14, 1984	Sheraton	Spokane, WA

Room rates for the selected hotels cannot be quoted until one year in advance. From conversations with the various convention directors, we can expect room charges to go up 10% or $2-3/year. The following are the 1980 convention rates and forcasted charges (unconfirmed)

		1980 rates	forcasted rate for meeting year
1982	Stouffer's	$46-53	$55-63 (single, double)
1983	MGM Grand	42-42	51-51
1984	Sheraton	31-37	39-45

Hotels have been personally inspected for suitability by either Mr. Procnow or Mr. Tripple and will satisfactorily meet the needs for our society.

During the selection process, four hotels were visited in Denver, six in Las Vegas and three in Spokane, Seattle and Portland. In addition, an equal number were considered by telephone and rejected because of price or unavailability of dates.

As a result of committee efforts, it is suggested that several changes be made to facilitate the site selection procedure:

1. The site selection committee should be responsible for selection of hotel and contract signings to ensure that the city selected has a facility capable of handling the society.
2. Change the beginning day of the meeting to Monday if necessary. Some hotels will not book a convention in the middle of the week. Site selection committee should have this flexibility if necessary.
3. Move the meeting dates to first or second week of March. Farming and plot season begins in March for many of the members and they are unable to attend at this late time of the year.
4. Outgoing Local Arrangement Committee Chairman should be an automatic member of the Site Selection Committee.

WSSA Report. Harold Alley reported that WSWS was honored by having Virgil Freed awarded Honorary Membership and Lowell Jordan elected a Fellow of the Weed Science Society of America.

The 1981 meeting of WSSA will be February 17-19 at the Dunes in Las Vegas.

The 1980 (Twentieth) meeting of the Weed Science Society of America was held February 5-7, 1980, at the Sheraton Centre, Toronto, Canada.

The Board of Directors of WSSA met with incumbent President J.R. Hay on February 4, with the final board meeting being held with the new President W.D. Carpenter on February 7, at which time the new Board members assumed their duties. New Officers and Board members of WSSA are:

President	W. D. Carpenter
President-Elect	D. E. Davis
Vice President	T. J. Sheets
Secretary	J. D. Nalewaja
Treasurer	G. H. Bayer
Member-at-Large	G. A. Buchanan
SWSS Representative	H. R. Hurst
NCWCC Representative	A. G. Dexter
WSWS Representative	H. P. Alley
CWC Representative	W. J. Saidak

In addition to the WSSA members Virgil Freed and Lowell Jordan, the following were elected to Fellowship in WSSA: John D. Bandeen, Stanford N. Fertig, Chester L. Foy and Robert A. Peters. James V. Parochetti recieved the Outstanding Extension Worker Award, Dr. Allen F. Wiese the Outstanding Research Award, Dr. Robert E. Frans the Teacher Award, P. E. Brewer, C.J. Arntzen and F. W. Slife the Outstanding Publication Award, and Mr. John K. Soteres from Oklahoma State University the Outstanding Graduate Student Award.

Major actions of the Board were as follows:

1. WSSA withdrew its offer to print the Proceedings of the 9th International Plant Protection Congress as it did not meet their requirements.
2. Established a committee to develop a procedure for site selection which would provide continuity and better negotiations for lower prices.
3. Voted not to consider summer meetings on college campuses at this time.
4. Approved Les Mathews for the Honorary Member Award in 1981.
5. Established an award for the best paper in Weeds Today.
6. Established having three outstanding paper awards from Weed Science.
7. Approved publication of a supplement to the Weed Science Journal which would contain Soceity Terminology, names of common weeds, and a complete list of herbicides with pronunciation guide.

8. Requested a review of the Constitution and operating procedures.
9. Decided not to pursue certification of Weed Scientists at this time.
10. Increased the cost of reprints by 25% to the authors. The first 100 reprints will now cost $37.50 and each additional 100, $7.50.
11. Approved publication of 5000 copies of the crop lossses from weeds and weed bibliography which was prepared by the Losses Due to Weeds Committee. A copy would be provided each member and remainging copies would be offered for sale.
12. The International section was established as a regular section of the annual meeting program.

Nominations Committee. Gary Lee presented the nominations committee report. A total of 134 ballots were cast and the following were elected as WSWS officers for 1980-1981:

President-elect	Alex Ogg
Chairman-elect, Research Section	Peter Fay
Secretary	Don Thill
Chairman-elect, Education and Regulatory Section	Stan Heathman

Claudia Powers-Evans, representing the 40 graduate students attending the meeting, expressed thanks to the Society for the financial assistance given.

Resolutions. Larry Morrow reported for the Resolutions Committee, Vern Stewart and D. Shaner.

Resolution #1: Local Arrangements and Program.

WHEREAS, the facilities and arrangements for the 1980 annual meeting of the Western Society of Weed Science are of satisfactory quality and well organized, and

WHEREAS, the organization and content of the program have been on good quality,

THEREFORE BE IT RESOLVED, that the membership of the Western Society of Weed Science in conference assembled express its appreciation to Chairman L. A. Jensen and members of the 1980 Local Arrangements Committee and to the staff of the Hotel Utah and Chairman L. E. (Jack) Warren and members of the Program Committee.

Larry Morrow moved that the resolution be adopted. The motion was seconded and passes unanimously.

Resolution #2: Agricultural stabilization and conservation service, (ASCS) subsection ACP (agricultural conservation practices) policy and guidelines that do not allow for the control of certain undesirable plant species as an accepted agricultural conservation practice.

WHEREAS, certain undesirable plant species are detrimental to our national and renewable resources, are detrimental to sound conservation, and contribute to soil erosion, pollution, and loss of crop and rangeland production, and

WHEREAS, ASCS has a policy and guidelines that do not allow for cost-share in the control of certain undesirable plant species under the ACP program, and

WHEREAS, the control of certain undesirable plant species should be an integral part of cropland and rangeland ecosystem management programs on the local, state, and national level,

NOW, THEREFORE BE IT RESOLVED, the Western Society of Weed Science urges that the U.S. Department of Agriculture and the Agricultural Stabilization and Conservation Service recognize that the management of undesirable plant species is an ecologically sound and economically proven conservation practice and should be reinstated as a part of the Agricultural Conservation Practices program.

Larry Morrow moved that the resolution be adpoted. The motion was seconded and passed by majority vote.

Resolution #3: Amendment of P.O. 90-583, The "Carlson-Foley Act of 1968."

(Summary) The Western Society of Weed Science recommends that Section 3 of P.L. 90-583 of the "Carlson-Foley Act of 1968" be deleted in its entirety and be replaced with the following:

"The departments or agencies of the Federal Government shall implement and pursue an effective program for the control of designated plants on lands under their jurisdiction."

Larry Morrow moved that the resolution be adopted. The motion was seconded and passed unanimously.

Resolution #4: Environmental Protection Agency (EPA) action regarding registration-cancellation hearings on 2,4,5-T and silvex.

(Summary) The Western Society of Weed Science urges the findings and conclusions of the Scientific Advisory Panel and others mentioned above, that hearings regarding suspended and still authorized uses of 2,4,5-T and silvex be promptly expedited, and that the recently suspended uses of 2,4,5-T and silvex be reinstated, and that in the future EPA and other appropriate agencies give greater consideration to findings, information, and opinions of qualified scientific panels in pesticide impact assessment activities.

Larry Morrow moved that the resolution be adopted. The motion was seconded and passed unanimously.

Constitution Amendment. And addition to the Society constitution was distributed to the membership. The addition was regarding the election to a 3-year term of the CAST representative. It read as follows:

Article IV - Officers and Executive Committee. Section 7. The Executive Committee may select a Society Representative to the Council for Agricultural Science and Technology (CAST) to serve as they may direct. The Representative to CAST shall serve 3 years, beginning after the CAST winter meeting at which the election is announed.

It was moved, seconded, and unanimously accepted that the addition be added to the Society constitution.

Research Section Report. Bob Callihan reported that the 1980 Research Progress Report contained 195 reports and 374 pages making it the second largest report published by WSWS. Bob indicated that many reports had been submitted without following the published guidelines for camera-ready copy. This increased the editing work for the chairman. He encouraged members to follow the guidelines more carefully. Phil Olsen of American Hoechst, Post Falls, ID will be the chairman for 1981.

In the interest of saving time, individual Research Project reports were not presented at the meeting but are included, in full, herein.

Project 1: Perennial Herbaceous Weeds: G. F. Hittle Chairman. Paul M. Ritty, Dow Chemicals; Bob Hunt, Monsanto; and Larry Wittsell, Shell Development Co.; lead a panel discussion of "What is industry doing to help us solve our perennial herbaceous weed problem?" Several issues were brought to light by the panel.

1. Government intervention. It takes forty percent (40%) of the industry research and development budget to meet government regulations and requirements. Monitary cost of developing new herbicides is estimated at fifteen to twenty million dollars; with no assurance that the materials will be sold or EPA will even allow registration.

2. Industries need more information from the public as to size of the problem, value of the problem, so that universities or USDA can assess the problem and then industry review the impact and determine if it can be solved, which means price is an important consideration. Industry needs a return on their investment.

3. Industry is looking at new application techniques such as rope applicators, etc., to cut down on the cost per acre on perennial herbaceous weed control and use herbicides more effectively.

4. Overall cooperation is needed between industry, universities, public agencies, to bridge the gap between users and researchers.

5. How does industry devise a screen to determine which herbicide will work or perennials? Various techniques are being used by industry. Past efforts have been directed towards annual weeds. Industry cannot assure that screening a herbicide on annuals will provide a good herbicide for perennial weed control.

Gus Foster, Velsicol Chemical Corp., Fort Collins, Colorado was elected Chairman-Elect for 1982; Ralph Whitesides will serve as chairman.

Project 2: Herbaceous Weeds of Range and Forest: W. S. Belles, chairman. Approximately 50 people attended the session. Ron Vore of the University of Wyoming was elected chairman-elect for 1981-82. Steve Cockreham of Elanco is 1980-81 chairman.

It was generally agreed that we have some good control methods for weeds on forest and range, but in many cases these methods are not being used. Reasons for lack of acceptance or utilization of these programs were pointed out and discussed.

In many cases, the cost of control programs includes their acceptance. Speakers from Oregon and Idaho pointed out that when there were cost-share programs, people took advantage of them. Now that these programs have stopped most of the control efforts have also been stopped.

Oregon has implemented a successful control program for the eradication of rush skeletonweed. Dave Humphrey of the State Department presented information on their program. Work was coordinated with all appropriate agencies. It was emphasized that once the necessity and potential success of the control program was pointed out to concerned individuals, including those with strong environmental concerns, the spray program was accepted.

Orrie Baysinger presented information on a weed survey conducted last year in Idaho. This survey was made with funding from APHIS and was designed to map new and exotic weeds. The results were made available to appropriate personnel so weed control practices can be utilized to contain or eradicate these weeds.

Speakers from Wyoming emphasized the need of controlling a weed before it becomes a major problem. They also emphasized the need to work with all agencies and with politicians to sell a program. It is important to know the organizational structure of your state so one can know with whom to work in order to get cooperation.

A U.S. Forest Service representative pointed out that the Forest Service is only an agency hired to work for the public. Weed control work is dictated by appropriations and Congress. We need to identify benefits of a control program and present the information to the Forest Service; preferably two years in advance.

In summary, there was general agreement that there is a need to document success stories and use these success stories to sell programs to the appropriate agencies and concerned people. It is necessary to work with politicians; their support is crucial. Antipesticide people must be worked with, they cannot be ignored.

Project 3: Undesirable Woody Plants. W. B. McHenry, chairman. Roy R. Johnson was elected project chairman for 1980-81 (chairman-elect David Wattenbarger resigned prior to the 1980 conference) and Mike Newton was elected chairman-elect for 1981-82. Twenty-seven people attended.

A panel of three woody plant control specialists, Drs. Ed Davis, USFS, Arizona; Tom Johnsen, USDA-SEA, Arizona; and Steve Radosevich, University of California; discussed physiological factors influencing the optimum application timing of foliage-applied herbicides on woody species. The panelists related from their respective research experience how optimum soil (and plant) moisture and temperature conditions characterize the timing "window" necessary to maximize efficacy.

Greenhouse and field investigations by Davis in Arizona on shrub liveoak (*Quercus turbinella*) indicate that timing is best after initial spring growth ceases and particularly if a second growth phase occurs. Like many oaks, shrub liveoak is among the more tolerant species to 2,4,5-T.

Johnsen reported that gambel oak (*Quercus gambelii*) is best treated after cessation of leaf growth but prior to "hardening". Lower application rates of 2,4,5-T [(2,4,5-trichlorophenoxy)acetic acid] or silvex [2-(2,4,5-trichlorophenoxy)propionic acid] of 1 - 2 lb ai/A or less applied in late August (20 gpa) may provide longer-lasting suppression, up to 60% five years after application, than higher rates. Fosamine [ethyl hydrogen (aminocarbonyl)phosphonate] is promising at 4 to 8 lb ai/A applied in mid-September if the oaks are not moisture stressed.

Interrelationship of photosynthesis rate, and presumably transport, with moisture stress and conifer tolerance was discussed by Radosevich. Conifer selectivity is highest with phloem-mobile herbicides when photosynthesis activity is low. This same relationship appears to occur with chamise (*Adenostoma fasiculatum*) as well.

Project 4: Weeds in Horticultural Crops. The group convened at 1:30 p.m. on March 19, 1980 at the Hotel Utah in Bonneville #1. Dr. Garvin Crabtree, Oregon State University, chairman of the research section, conducted the meeting. Business conducted included the election of a chairman-elect for 1981-82. Dr. William T. Cobb, Elanco Chemical Company, was elected and accepted the position. Dr. Charles Stanger, Oregon State University Malheur Experiment Station, Ontario, Oregon is the chairman for 1980-81.

Dr. Crabtree introduced the topics for discussion and the discussion leaders. Topics for discussion were: 1. Thiocarbamate herbicide extenders 2. Nightshades and 3. Special planting techniques: relationships with weed control. Discussion leaders included: 1. Don Thill, PPG, and Chuck Prochnow, Stauffer Chemical Company; 2. Dr. Alex Ogg, USDA-SEA, Prosser, WA and 3. Dr. Harold Kempen, University of California.

Each discussion leader introduced his topic with a short presentation using slides, then entertained questions and received comments from the floor. The information given was informative and interesting as indicated by the amount of discussion from individualts within the group that attended the meeting.

A total of 50 individuals were in attendance. The meeting was adjourned at 3:00 p.m.

Project 5: Weeds in Agronomic Crops. N. E. Humburg, chairman. Fundamentals of weed competition in annual and perennial agronomic crops and the relationship of these to short-term and long-term research projects were discussed in a lively floor debate.

1. With rising production costs, grower questions will likely center around the cost of weed control versus the economic return for that control. Weed competition studies are needed to help answer those questions.
2. The goal of weed science is to develop effective management tools that can be used at the production level. Weed competition data can be invaluable in the determination of economic points of diminishing return for the control of weeds in specific crops, the development and verification of crop growth models, and the quantification of annual and perennial weed density tolerances.
3. Weed competition data, for maximum applicability, must be couched in terms of actual cropping systems. Weed competition should not be based on an isolated weed in an artificial environment but should be viewed in context with the total and normal agroecosystem.
4. Short-term projects serve to define specific questions that can best be answered by longer term projects. The value of each type cannot be dismissed. The challenge will be to find funds and land that can be obligated for longer-term projects.

Richard Gibson will serve as the chairman for the 1981 meetings and Pat Rardon was elected chairman-elect.

Project 6: Aquatic and Ditchbank Weeds. Lars Anderson, chairman. The topic of the session was "Hydrilla in the West." The program opened with brief (8-10 minute) presentations of the following subjects:

1. History and description of Hydrilla infestations in California. Mr. Les Sonders (CDFA) gave an account of the locations where Hyrilla has appeared and presented slides showing the extent of infestation. Hydrilla has been detected as far north as Lake Ellis near Marysville, CA. The EPA sponsored a $2.75 million program to restore Lake Ellis.
2. The general biology and reproductive capacity of Hydrilla was described by Lars Anderson (USDA), with accompanying slides of the vegetative plants, tubers and turions. The variety of vegetative reproductive mechanisms, which include the production of overwintering tubers, makes this plant extremely difficult to control with contact-type aquatic herbicides.
3. Mr. Jim McGee from the Army Corps, Jacksonville, Florida district, described the history and current extent of Hydrilla infestations in

Florida. Despite many years of control operations, Florida continues to spend $10-12 million annually for only partial contol of Hydrilla.
4. Chuck Rivera of Elanco Company reported on the results of Florida and Panama Canal field testing of the new aquatic herbicide fouridone [1-methyl-3-phenyl-5-[3-(trifluoromethyl)phenyl]-4(1*H*)-pyridinone] for the control of Hydrilla. Extensive studies were conducted in Gatun Lake (Panama Canal Zone) with applications of 0.84 to 6.72 kg/ha. Rates of 1.7 kg/ha or higher controlled Hydrilla. In these and other tests in small ponds, no adverse effects on fish have been observed.
5. The Hydrilla control operations in California during the past 2-1/2 years was summarized by Mr Don Dixon (formerly California Food and Agriculture). Following a meeting of a Hydrilla Task Force in 1977, the use of the organo-copper aquatic herbicide Komeen (copper-ethylenediamine complex) was recommended. To date, two applications to the All-American Canal and primary canals have been made. Some control was obtained, but regrowth has occurred. A total-system treatment is scheduled for May 1980. The objective of these treatments is to reduce Hydrilla biomass and to curtail tuber production. A major problem is that water in the Imperial Irrigation District is multi-use: potable, irrigation, fisheries. This limits the use of herbicides to only copper-containing types, which do not directly affect tuber viability.
6. The proposed federal cooperative Hydrilla control and research program in the west was discussed by Lars Anderson (USDA-SEA, Davis, CA). The Departments of Agriculture and Interior are in the process of formalizing a joint effort to fund Hydrilla control research which will encompass chemical, ecological, water management, biological control. The overall project is being coordinated with California state, county agencies and the Imperial Irrigation District.

The session was concluded with questions and comments from the audience, followed by the T.V.A film "Menace on the Move" which described the potential for spread of Hydrilla.

The chairman for the 1980 meeting is Mr. Nathan Dechoretz (USDA-SEA, Davis, CA.). The chairman-elect is Dr. Chuck Rivera (Elanco, Fresno, CA).

Project 7: Chemical and Physiological Studies. Chairman J. Wayne Whitworth called the project meeting to order at 3:30 p.m. is the Bonneville #3 room of the Hotel Utah, Salt Lake City, March 19, 1980. There were 65 in attendance in the meeting who signed the roll. The four subject areas listed in the program were presented to the group and a number of people participated in the discussions that followed.

It was pointed out that only two papers were submitted on this project for inclusion in the Research Progress Report, whereas, there were 11 pepers presented in this subject matter area. The oft repeated comment was that it was related to the fact that abstracts don't count as a publication--an old inane excuse.

Comments concerning possible new approaches to mode of action studies indicated that life cycles of plants, competitive effects of other vegetation, and other ecological considerations should be evaluated along with just the work that is done with the herbicides alone. Most of the "magic additives" offered to improve herbicidal activity were considered by those commenting to differ mainly in price. The chairman asked for comments on special additives such as seaweed extracts that may have been offered and none were received. One participant commented that Amway had been pushing their surfactant for use in herbicide applications but declined to reveal its composition. A discussion then followed on taking microclimate data that might be useful in understanding the interrelationship between this factor of the environment and herbicide activity. Some investigators reported that only a few of the data they had taken in great detail had shown any correlation. Then as the discussion faded onto the subject of how useful were these basic research studies, a fieldman for one of the states commented that he would surely like to know how some of this information could be used as he felt we were still not improving our knowledge for better control of weeds under field conditions.

One of the interesting comments by industry on the availability of radioactive labelled herbicides for basic research investigations by universities and USDA was that when the company completed their research, they discarded the material if there were no calls for the labelled material by others. It was also the general feeling that labelled herbicides were still generally available from the commercial companies if they had enough to satisfy requirements for investigating metabolic breakdown products, and if a well planned outline was submitted by the investigator.

At 4:35 p.m. there was no interest in additional discussion and the meeting was adjourned. Steve Radosevich, University of California, Davis, is chairman for 1980-81. Lowell Jordan is chairman-elect for 1981-82.

Larry Burrill turned the business meeting over to the new president, Jack Warren, who adjourned the meeting at 9:20 a.m.

WILLIAM L. ANLIKER
1980 Fellow

William L. Anliker was born April 22, 1933 and raised on a farm near Tonsaket, Washington. He attended Washington State University and graduated with an M.S. in Agronomy in 1957.

Bill joined Firestone Tire and Rubber Company's Plantation Divison in Liberia West Africa and worked for 7 years as a Plant Physiologist owrking in weed control and latex yield stimulation. The last 3 years in Liberia were spent as Manager of Firestone's Botanical Research Department.

Bill's next employment was with Diamond Alkali's (now Diamond Shamrock) International Division as New Products Development Manager with responsibility for all areas outside the United States and Canada.

CIBA Agrochemical Company was joined in 1966 as a Research and Development Representative in the 13 western states, working out of Vancouver, Washington where Bill and his wife Joan still have their home.

Presently Bill is employed by CIBA-GEIGY as a Senior Scientist in R & D with responsibilities in Washington, Oregon, Idaho Hawaii and Alaska.

Bill have been involved in the Western Society of Weed Science for a number of years, serving on several committees and offices, and was President in the 1975-1976 term. Other professional involvement includes the Entomological Society of America, American Registry of Professional Entomologists, CAST, and several state weed associations.

FELLOWS AND HONORARY MEMBERS OF THE WESTERN SOCIETY OF WEED SCIENCE

HONORARY MEMBERS

Dick Beeler, 1976
Dale H. Bohmont, 1978

FELLOWS (FORMERLY HONORARY MEMBERS)

Robert B. Balcom, 1968
*Walter S. Ball, 1968
Alden S. Crafts, 1968
F. L. Timmons, 1968
D. C. Tingey, 1968
Lambert C. Erickson, 1969
*Jesse M. Hodgson, 1969
Lee M. Burge, 1970
Bruce Thornton, 1970
Virgil M. Freed, 1971
W. A. Harvey, 1971
*H. Fred Arle, 1972
Boysie E. Day, 1972
Harold P. Alley, 1973
K. C. Hamilton, 1973
William R. Furtick, 1974
*Oliver A. Leonard, 1974
Richard A. Fosse, 1975
Clarence I. Seeley, 1975
Arnold P. Appleby, 1976
J. LaMar Anderson, 1977
Arthur H. Lange, 1977
David E. Bayer, 1978
Kenneth W. Dunster, 1978
Louis A. Jensen, 1979
Gary L. Lee, 1979
William L. Anliker, 1980

*Deceased.

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