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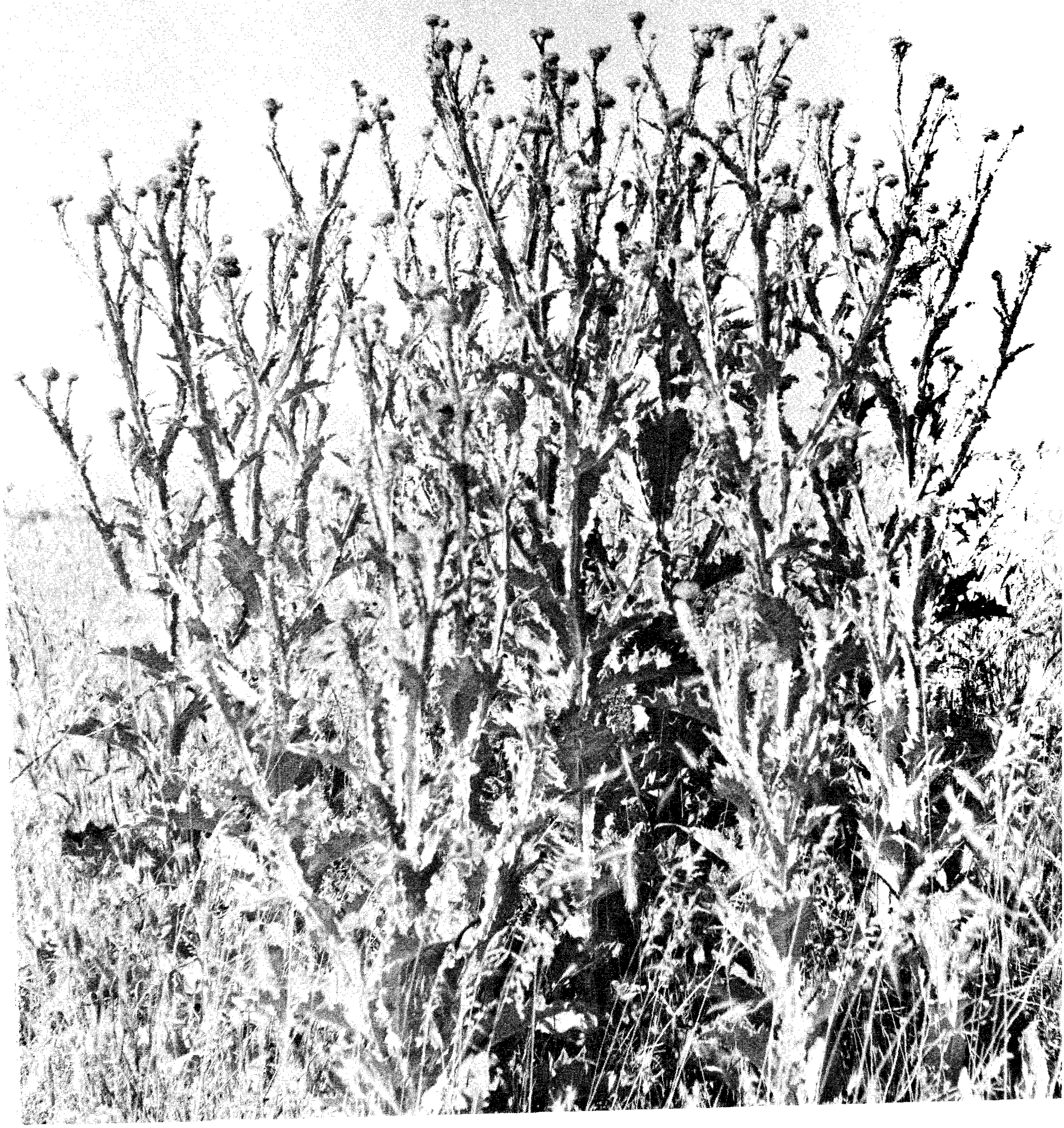

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PROCEEDINGS

OF

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PRESIDENTIAL ADDRESS

WORKING TOGETHER TO REACH OUR GOALS

Lowell S. Jordan[1]

The Western Society of Weed Science has the distinction of being the first conference of its kind in the United States. The society was established to facilitate the exchange of information among all persons concerned with a common interest of controlling weeds. Participation is encouraged by persons representing research, extension, regulation, teaching, and commercial aspects of weed science.

Since the establishment of the conference in 1938 there have been accelerating changes in the science, technology and regulation of weed control. When the conference was young, the study of weeds was largely a by-product of agronomic research. Teaching and extension of the science as a subject was almost unkown. Laws and regulations were primarily restricted to the prevention and eradication of noxious weeds.

The introduction of modern herbicides in the late 1940's radically changed the science of weed control. The vast potential of using small amounts of chemicals to control large numbers of weeds was quickly recognized. Farmers rapidly adopted widespread use of herbicides; agricultural scientists began performing research with weed control chemicals; and chemical companies began to search for new herbicides and to develop them.

During the 1950's work with herbicides was fairly simple. They were applied to weeds with the most convenient equipment. If the weeds were controlled with little crop damage, the herbicide was recommended, manufactured and sold. Inadequate attention was often given to their effects on nontarget organisms or upon the environment. Quality control, during herbicide manufacture, was aften poor. Their application was often rather imprecise and regulations were haphazardly enforced.

During the 1960's herbicides were discovered and marketed more rapidly than supporting basic information could be developed. There was a lack of knowledge concerning the effects of their large scale use on man and his environment. Mistakes were made which resulted in crop losses and lawsuits. Streams and soils became contaminated. Large quantities of a contaminated product were used in an unpopular war.

The real and imagined threat of herbicides to man and his environment resulted in the organization of agencies to regulate their manufacture and use. Environmental pressure groups have forced zealous regulatory agencies to impose unwarranted restrictions upon the use of herbicides. Unwise regulations are often made by uninformed individuals. People are often misinformed concerning herbicides because we do not provide them with adequate, accurate information.

In reality, we do not have enough information to answer all of the valid questions, let alone the invalid questions, concerning herbicides. We are rapidly losing our ability to obtain useful information. We must spend too much of our time and resources defending herbicides and their

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proper use. We spend too much time repeating work that has already been done, duplicating work of others, or performing research that would be better done by someone else.

We are small in numbers and cannot afford to misuse our time and our resources. We must collectively decide what needs to be done, who has the ability to do the job, and how to obtain the resources to get the work accomplished. The "what", "who" and "how" decisions of weed science are rapidly changing.

The capabilities and expertise of each segment of weed science have changed vastly during the last decade. Scientists in industry are now fully capable, and have the facilities to perform the most basic and applied research. Extension workers are assuming more responsibility for applied research at the state level. University and federal research scientists have the most advanced equipment for performing basic research with herbicides. Regulatory agencies have specialists to cope with problems concerning proper application and misuse of herbicides.

However, the various segments of weed science do not exist as separate entities. Each is a part of a unique endeavour - to discover, to develop, to produce and to distribute safe and beneficial herbicides for American agriculture. None of the segments: research, extension, teaching or industry can do the job alone.

To accomplish our goal, all segments of weed science must cooperate with each other. Efficient cooperation results from effective communication. We must effectively communicate to each other our goals, our needs and our abilities. The communicated information must be accurate and useful.

It is within the confines of organizations such as the Western Society of Weed Science that mutually beneficial information can be exchanged. But this can be accomplished only if we work together to achieve our common goal.

Effective cooperation is an opportunity and a challenge. It is also a necessity if we are to fulfill the promise of weed science. Together we can help to safely provide more food and fiber, with less labor and at a lower cost. Our cooperative efforts can help provide a safer, healthier and more pleasant environment in which man can live.

During this conference we have ample opportunities to communicate with each other concerning mutual interests in weed science. General sessions are designed to provide information vital to all segments of the society. Research sections contain reports of the results of public, supported, and industrial research. The project meetings provide the greatest opportunities for exchange of ideas through open discussion and workshops.

The foundation had been laid for what promises to be an outstanding conference. All that is needed now, to fulfill that promise, is our whole-hearted participation and cooperation.

SOME CHARACTERISTICS OF WEED PROBLEMS IN TWO WORLDS

LeRoy Holm[1]

We have two worlds to cover in 30 minutes and we must begin at once. The first is one which is familiar to you. The pores and interstices of this familiar culture are filled with science and with the ways and things which are given birth by the use of the scientific method. And this science begins with the belief that the world is orderly--or that it can be made orderly by human arrangement. We spend a great deal of time and many of our resources in searching for this order. Science means trying things--trying all of the possible alternatives one by one, intelligently and systematically. We throw out those that don't work. We accept those that will work even if they go against our beliefs. We believe that each thing that works adds one more piece in the slow, triumphant understanding of our world. And we count on that! But there are many places in the world that are barren of all these things and of this idea. At the close I shall tell you a story about pesticides and agriculture in one of them.

I want to show you some results of work on the world's weeds which I have been doing with Professor Pancho of the Philippines and Mr. Herberger of the United States. The work is now almost finished and it provides some simple, direct insights into the order in nature that I have just spoken about.

For 15 years we have counted, ranked, and mapped those weeds which are most important, and have tried to bring together into one place the known biology of each of these species. When we began some men were saying that there are 50,000 species of weeds in man's crops, and no one in my acquaintance could name 10 books on weeds. From our work, it is my own view that for food production across the world only about 200 weed species are involved in 95% of man's weed problems. We have listed in our first book more that 300 good books on weeds and at next printing the list will surely be more than 400. We know that in sugar cane, for example, the same major weed species tend to be present wherever the crop is grown in the world, and that this is true in several other crops. There is much else, but this is the order and simplification that I was speaking about. Justice Oliver Wendell Holmes used to tell the new apprentices who came to work with him that "simplicity lies just beyond complexity." What I will show you in a moment seems so simple, now that it is done, that one should have been able to do it in one long night.

I wish to tell you about only one small piece of the work--one which will never appear in the books. The methods and tactics of these 15 years would be boring and tedious in the telling and I wish to ask you, during this discussion, to take on faith that we do know the names of about 80 weed species which are most troublesome in man's fields and waterways--his primary weeds. The secondary weeds number about 120. I expect that this number will be reduced slightly for in the aquatic weeds, in some genera, it is necessary to carry two or three species through a very long screening process before we can decide how many of them are truly world-wide problems.

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We travelled to most of the countries of the world to get the information and we laid up hundreds of thousands of pieces of data on computer files in three places in the world.

When men in a future time venture to write down the names of the primary species again, the addition of names to the present list will require reaching back beyond the somewhat unfamiliar names in Table 1. For the secondary weeds, species with less familiar names than those in Table 2 must be found. Yet, one-half of these are in our own country. In Table 3 we see that about one-third of all the worst weeds are grasses and sedges and two-thirds are broadleaved weeds. The words "annual" and "perennial" are for the temperate zone and have little meaning in the tropics. In Table 4 we see that two-thirds of all these field weeds grow for only one season. A season may be governed by wet and dry periods and not the annual calendar. It is a surprise to some that about two-thirds of all troublesome aquatics are monocots and several are ferns (Table 5). It would not be a surprise that their rather uniform environment allows about three-fourths of them to behave as perennials.

Table 1. Some Primary Weeds of The World

Chromolaena odorata	**Leersia hexandra*
**Cyperus iria*	**Mikania scandens*
Fimbristylis miliaceae	*Monochoria vaginalis*
**Heliotropium indicum*	**Sphenoclea zeylanica*
Ischaemum rugosum	

* occur in the United States

Table 2. Some Secondary Weeds of the World

Asphodelus tenuifolius	**Stachytarpheta jamaicensis*
Coix lacryma-jobi	**Tagetes minuta*
**Coronopus didymus*	**Trianthema portulacastrum*
Momordica charantia	**Ureno lobata*

* occur in the United States

Table 3. The World's Primary and Secondary Weeds

The terrestrial weeds are:	23% grasses
	69% broadleaved weeds
	6% sedges--including many paddy weeds
	2% ferns and fern allies

Table 4. The World's Primary and Secondary Weeds

The terrestial weeds are:	64% Single season weeds
	36% Several season weeds

About 30% of these can behave as either single or several season weeds

If we look now at the 80 weeds of primary importance the picture changes. There is a higher proportion of grasses and there are more perennial weeds (Table 6). With the secondary weeds, on a world basis, and the lot from which many of our next weed problems will come, there is a very high proportion of broadleaved weeds, and also of annuals (Table 7).

Table 5. The World's Primary and Secondary Weeds

Among the aquatic weeds:	60% are monocots
	30% are dicots
	10% are ferns

Only 7% are annuals while 73% behave as perennials.

Twenty% may have either habit.

Table 6. The World's Primary Weeds

35% are grasses

56% are broadleaved weeds

6% are sedges

2 species are ferns

44% are perennials and 56% are annuals.

Table 7. The World's Secondary Weeds

13% are grasses

79% are broadleaved weeds

8% are sedges

1 species is a fern

30% are perennials and 70% are annuals.

What is the source of this plant material? The things we look at now will have more meaning if we remember some things about the Angiosperms that we one learned in botany. There are about 450 families, depending upon whose system you wish to agree with and in which week you chose to count. Some families have hundreds of genera and between 20 and 25 of these genera have more than 2000 species each. There are 20,000 species in the Compositae alone. The orchids, the legumes and the grasses are also very large families. Perhaps the most expressive way to put it is that man has named about one-fourth of a million flowering plants. Thus, our 200 weeds are drawn from much less than one per cent of all the world's species.

In Table 8 we see that only 12 families provide 70% of the world's main weed problem, with 47 families of lesser importance. I may tell you that most of the latter are represented by only one weed species. Thus, only 10% of all the plant families contribute to our weed problem and most in a very small way. From this figure we may see as well that 40% of our weed problem rests in three families, and just two families supply one-quarter of our troublesome weeds.

Table 8. The Important Families of The World's Worst Weeds

Poaceae (Gramineae)	44 species	27% (Poaceae–Cyperaceae)	43% (Poaceae–Asteraceae)	68% (Poaceae–Solonaceae)
Cyperaceae	12 species			
Asteraceae (Compositae)	32 species			
Polygonaceae	8 species			
Amaranthaceae, Brassicaceae	7 each			
Leguminosae	6 species			
Convolvulaceae, Euphorbiaceae	5 each			
Chenopodiaceae, Malvaceae Solonaceae	4 each			

In addition, 47 other families have 3 species or less

Now things begin to become too complex to discuss in brief form. But remarkable things happen as we seek for order and simplification as large amounts of data become available for study. Let us look at one more characteristic. If we look into the world's worst weeds only--the primary weeds--we see that 60% of this weed problem rests within three families. There are only 30 families involved and only six have more than one species (Table 9).

Enough! In taxonomic procedure a phrase, *in sensu stricto*, is used as a constant reminder that the effort should be to group similarities and to define individual families in the narrowest sense. What does it mean that so many of our worst species are so closely related? Surely there are principles here that we should now look for, for they can guide us in everything we do in our work.

Would you like to see some figures on the weed flora of the United States projected against that of all the world's agricultural fields? We have 80% of the primary weeds (Table 10). The primary weeds we have in our fields have the same distribution of types as we find for the world in general and the proportion of single and several season weeds is similar (Tables 11, 12). Because we have a large country which is both temperate and subtropical this should not surprise us. By comparison, India has 80% of the primary and secondary weeds together, but has more than 90% of the primary weeds of the world.

Table 9. Important Families of the World's Primary and Secondary Weed Species

	Primary Weeds (80)		Secondary Weeds (126)	
Poaceae (Gramineae)	30		14	
Asteraceae (Compositae)	12	58%	20	33%
Cyperaceae	5		7	
Polygonaceae	3		5	
Amaranthaceae	2		5	
Brassicaceae (Cruciferae)	1		6	
Leguminosae	2		4	
Concolvulaceae	1		4	
Euphorbiaceae	1		4	
Chenopodiaceae	1		3	
Malvaceae	1		3	
Solonaceae	1		3	
	Plus 18 other families		Plus 33 other families	

Table 10. Primary and Secondary World Weeds Present in the United States

Mainland United States has:	78% of the primary weeds
	66% of the secondary weeds

The United States has 70% of all the world's important weeds

Table 11. Characteristics of the World's Important Weeds Present in the United States

(Primary and Secondary World Weeds)

Those present in Mainland U.S. are:	24% grasses
	69% broadleaved weeds
	7% sedges

Table 12. Characteristics of the World's Primary Weeds Present in the United States

Those present in Mainland United States are:	62% annuals
	38% perennials

What is the kinship of weeds and crops? We have seen a list of just 12 plant families which supply 70% of all our important weeds. In Table 13 you may see the crops which man harvests in greatest quantity. There are 12, they provide 75% of our food, and they are in only five families. And these are five of the same families that supply us with so many of our weeds. It would be easy to over-simplify this relationship but we see in Table 14 the Compositae and Cyperaceae which supply us with about 25% of the world's worst weeds, they are very important families, but there are no major crops found in these families. Perhaps there is here, also, a lesson for us.

Table 13. Plant Families of the World's Major Crops

Poaceae (Gramineae)	-	barley maize millet oats	rice sorghum sugar cane wheat
Solonaceae	-	white potatoes	
Convolculaceae	-	sweet potatoes	
Euphorbiaceae	-	cassava	
Leguminosae	-	soybean	

Table 14. Families of Prinical World Crops and Weeds

	Principal Crops	Important World Weed Species
Compositae (Asteraceae)	0	32
Cyperaceae	0	12
Poaceae (Gramineae)	8	44
Leguminosae	1	6
Convolvulaceae	1	5
Euphorbiaceae	1	5
Solanaceae	1	4

And now, from a very different world, I wish to tell you a story about agriculture and pesticides. This was a brief encounter on an afternoon for which I am grateful, for it helped me to learn an important lesson.

We went to a small island in one of the warm seas of the world and spent our time looking at weeds in several crops. The island had recently become independent, and before this event the farmers had enjoyed a thriving banana export business. There was not much else to trade. After independence they spent a good deal of time in the exercise of freedom but very little in the excercise of responsibility.

Before independence each man was required to spend one full day each week in handpicking insects to keep certain populations down. These were insects which attacked the crops, vectors for virus diseases, etc. But now there was none of this. They had weed problems. The plantations were dirty, they were bushy with undergrowth, and many of their pest control problems were brought together in the frequent refusal of men to go near the trees. The undergrowth provides a haven for dangerous snakes and rodents--a simple fact of life you would have to experience to fully understand. With hand equipment the treatment of any pest or the cutting of weeds required that one move in the proximity of the tree. There had also been a breakdown and failure of habit in the general sanitation of plantations as a whole. It has been demonstrated in rubber, for example, in many places in the world that sanitary procedures beget sanitary habits, and that many other good things happen when buildings, tools, and fields are clean.

As we came, they had lost their prime banana market to a country in the southern hemisphere and their economy was sinking. There was a small agricultural college and on the last afternoon we were asked to come to the library for a discussion with the staff. There was teaching at the school and a small amount of research and demonstration work. I had a small aquaintance with the director, having known some of his family, and I knew what was coming. We were quite sure to hear, as I had heard in many places in the world, about tribal customs, the fear of chemical poisons, the lack of foreign exchange, putting people out of work, etc. But their economy was dying.

I decided not to take part in the discussion but to listen to the staff--and their reasons for letting the economy die. The gist of it was that they were afraid of the chemical poisons and they wanted very much to preserve the village life. What they said was that the chiefs didn't want to bring the chemicals in because they had no place to store them. Children would get into them. Adults might drink them. When our men spray, the chemical will drift onto their skin and much later they will become ill. People will be put out of work. We have no money to buy the pest control materials because our economy is dying. The college people had a special problem. If they convinced a chief, with experiments, to let them teach the men to use chemical 'A', should the next and later pesticide 'B' prove cheaper and more effective, it would be difficult to change. The chief would say they were dishonest--they should have told him about 'B' first. There was more, but this is enough.

Now the real life of this island, whose very foundation was agriculture, had a far different face from the cautious, dark, worrisome fears of the chiefs and intellectuals who did not want to change village life. At 8:30

on any morning all the children were in lovely clean blue and white outfits, with a book bag and lunch, filling the roads as they walked to their schools. They obviously held no fear that a good education might alter village life. There was a radio in every home and hut. We were told that each family yearned for a wooden house and they were striving to get them. Extreme care was in order as you hiked on the roads or crossed the streets for bright yellow Toyotas were as thick as the flies and were behaving in the manner of the organism.

Please remember, village life was to be preserved. A large tourist hotel was under construction. Mothers and fathers and the young people on the island would man that hotel. More were planned. Good and bad habits would come with the association with people from the outside world. They had some hospital facilities and were seeking a larger hospital. They knew, should an epidemic break out, that the outside world would bring help within 24 hours.

But the agricultural leaders and the chiefs did not want to change village life. The tranquility and the cohesiveness of the tribal system in the small village would be shattered, with the spectre of the mad drive for possessions, perhaps drugs, and the fragile, fickle economic life of a people dependent on tourism, and the destruction of old bonds and loyalties. With the armies of change marching over them there were many genuine problems they could discuss--and thus put off making up their minds. As the afternoon drew to a close the director asked for a comment because I had been quiet. I had sensed that their problem was really not about pesticides, and my wisdom and experience could count for little in the complex, dynamic changes that were all about us--but my answer will make the point for you as well. I asked to give my answer with some questions--not about what I had heard--but what I had seen. I reminded them of the drive for knowledge and education--we were seated in a college library. About Toyotas, radios, hotels, and wooden houses--in the face of their constant demand that village life be preserved. I asked:

> Do you really think that a good education would be a bad thing--if everybody had it?
>
> Would good health, and the chance to be made right when you are hurt, be a bad thing--if everybody had it?
>
> Do you really think that if children, the infirm, and mothers and fathers could live and sleep in a wooden house, free from flies--would it be a bad thing just because everybody had it?
>
> Do you really think that sufficient income to buy enough food, would necessarily be a bad thing--if everybody had it?
>
> And finally, with all of the modernity that comes crashing onto this island everyday to permeate almost every aspect of daily life, you are now going to have to decide: do you really think it would be a bad thing for agriculture if all your farmers had a good yield of bananas?

Just as the school books, information on the radio, medical know-how, all originate outside and come into this island, so also has the technology for the healing of your agriculture been worked out elsewhere. You really do not need our advice. What you have to do--is make up your mind!

Now to close. For some of us the ways of these people may seem strange; forever asking questions that they do not want answered, worshipping a frustration which is focused on words such as toxicity and poison because they do not want to decide, and unable to build a bridge to an advanced agriculture while other brides are forming beneath their feet to almost every other corner of their culture.

But for just one final moment could we think together about some similarities of these two worlds. The Western world, and we in America, have generated much of this technology. The sheer volume of innovation and the pace at which we overtake our own difficulties has caused many, including scientists, to become weary and disenchanted with so much progress. One senses fear and foreboding in the attacks on science and technology. Some withdraw--but not too far--for it's nice to have that electricity, brain surgery if a member of your family sould need it, and spices from other lands for one's table.

But we hear more about toxic substances and poisons than the people on the island!

These words scream at us every day from newspapers and television! In agriculture, chemical after chemical is taken away! The registration of new materials, the improvement of this technology, has become a farce! What do you think? Is it more chemistry that we need? Is it more advice that we need? We can get specialists from almost any discipline to testify on any side of any issue on any day.

Or--is there a wholy different kind of decision that we must make?

The nations of the world together lose one-quarter million lives each year to the automobile. For those who can think only in terms of money, the Highway Safety Administration in our own country says the price tag on each traffic fatality is more than one-quarter million dollars, and this is without value on the very life which is lost, for that is incalculable. The cost to society in the United States annually for death, injury, and property damage with the automobile is 35 to 40 billions of dollars. But the real tragedy is that we kill 50,000 of our own people each year with these machines.

In reports of more than one Congressional Committee can be found evidence that two million unnecessary surgical operations are performed each year, resulting in 15,000 needless deaths.

In 1978, factories in your community and mine will make and sell--or give away--13 billion dollars worth of guns to our friends overseas. Each of these machines is designed to kill.

One of the scientists in your own Western region speaks most eloquently about one of the most toxic of all substances--tobacco--and its death toll.

But do you know of anyone on your street, or down your road, who can document an illness, acute or chronic, or a death, from an agricultural chemical used according to recommendations?

In light of the above willful, acknowledged mortality brought about in our society, are we truly asked now to believe that all the talk about toxic substances and poisons in our agriculture is because they are a threat to life itself?

Or--is there a more profound worry and fear about technology in general, with agriculture as the current focus of our frustration. If this is so, and in view of the annual, accepted slaughter which I have cited just above, there are then no facts which will satisfy! If there is no appeal to reason, it has become an emotional issue, and our tactics will have been wrong.

Were the people on the island so different? Those of us who live in a world which is very different from theirs are having the same problem with the words toxicity and poison in our culture. Is it more chemistry that we need? Do you think we need more experiments here in Nevada or in the laboratories in Washington, D.C.? Would more advice from specialists really make any difference anymore?

Or--have we, like the people of the island, been debating when we should have been deciding on a much larger question--what is it that we can and cannot have in the real and practical world that we think we would like to live in.

OPPORTUNITIES AND NEEDS TO INCREASE THE PRODUCTIVE CAPACITY OF RANGELANDS IN THE WESTERN UNITED STATES

Harold P. Alley[1]

The Western United States is noted for production of top quality livestock, its wide open spaces, clear blue skies, clear mountain fishing streams and majestic game animals.

The above are all appealing to people from the heavily populated centers of this country who look upon these areas as the last frontier which should be maintained as it now exists. How many realize this is also an area where millions of acres of rangeland are not producing forage levels approaching their economic or physical potential. An area which is instrumental in the production of livestock, livestock from which the choice steaks, lamb chops, hamburger, etc., originate that are readily available at the supermarkets at reasonable prices. An area that is going to be expected to continue to supply red meat to the ever increasing population.

In attempting to outline the first charge of my assignment which is the needs for increased production on the western rangelands I am going to cite two specific publications. The first entitiled "Opportunities to increase red meat production from ranges of the United State (10) and "Senate Bill 2555" (9) which was introduced into the Congressional Record of the 94th Congress in 1975.

The inter-agency work group report indicated that in 1970, only 28 percent of all rangeland in the west and the great plains was in good or better condition. That is, only 184 million of the 648 million acres exhibited vegetative cover or desirable amount and kind in relation to its potential. If just the western rangeland is considered (Table 1) it should be noted that the situation is even worse. Of the non-forest ecosystem only 17.6 percent is in good condition, 50 percent is fair condition and 32.3 percent in poor condition.

Senate Bill 2555 which was introduced by Senator Haskell in the first sesson of Congress in 1975 and referred to the Committee on Interior and Insular Affairs states, and again I quote "Much of America's western public rangelands is in a deteriorating condition, a condition which threatens the economic livelihood of individual users of such land and the economic stability of neighboring communities which are situated in the vicinity of such land. Only 17 percent of the one hundred and fifty million acres of

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rangelands administered by the Bureau of Land Management is in satisfactory or better condition, 83 percent of such land is producing less than its potential, and 33 percent of such land is in poor or worse condition. The rangeland will continue to decline under present management levels with projections that in twenty five years the productive capability could further decrease as much as 25 percent."

Table 1. Condition of the Rangeland, 1970 (non-forest ecosystems)

Ecogroup	(Millions of Acres)			
	Good	Fair	Poor	Total
Western Rangeland	73.8	209.4	135.4	418.6
Great Plains Rangeland	110.6	102.8	15.5	228.9
Total	184.4	312.8	150.9	647.5
Percent	28	48	24	100

Data source: USDA, Forest Service, Forest Service Report No. 9.

Since 1950 there has been a continual reduction in the quality of land available for agricultural and forestry uses. Land withdrawn from food and timber production is now in urban, transportation, recreation, parks, wilderness, wildlife areas, national defense, industrial, public installations and facility uses. This trend in reduction in land resources available for agricultural purposes is expected to continue (5).

In 1974, for the first time in over 20 years, almost no land was idled from crop production by commodity programs. Thus, another propective source of livestock feeds in no longer available for consideration as a means of increasing livestock production above current levels. Further reduction in land available for grazing can be expected as cropland pasture is converted to cereal and feed grain production. Overall, an increased demand for red meat will have to be met with production from a shrinking land base (2).

Range ecosystems produce forage much of which has no economic possibility for harvest except through grazing of the ruminant animals, cattle and sheep primarily.

While less forage land will be available, the range and other forage producing areas will be called upon to produce enough to compensate for land lost to crop production, plus the amount required in substituting forage for grain in on-going cattle raising and/or fattening systems.

The inter-agency work group has developed low and high range demand estimates for increases production. The projections are aimed at year 1985 but are also extended to the year 2000.

The low demand estimate results in an anticipated increase in range grazing requirements of 18 percent by 1980 and another 6 percent by the year 2000. The high demand estimate is for a 40 percent increase by 1980 and 55 percent by 1985.

Federal permission for grazing on public lands, a vital supplement for range feeding for many ranchers, is being restricted because of competing environmental and recreational demands on public lands. The Bureau of

Land Management, the largest provider of grazing on public lands, is currently enjoined, as a consequence of an environmental suit, from making additional grazing allotments or improvements for grazing until it files seperate environmental impact statements for 212 geographic areas.

In the Western United States, livestock production is a major industry; many ranching operations are dependent upon national forests for economic livestock operations. Some recreationist are becoming increasingly concerned about the presence of domentic livestock in areas of heavy recreation use. The presence of livestock is accused of effecting recreation, wildlife, and scenic values. Ranchers are becoming concerned about their rural way of life and economic situation. Grazing on national forest land decreased by about 10 percent between 1950 and 1975 (7).

In reviewing preliminary area planning programs of the U. S. Forest Service it becomes apparent that the use of these lands for increased or even continued utilization by livestock is in jeapordy. I do not have the time nor do I want to review all of the program projections recently completed by the Forest Service for several areas of the Western United States. However, a couple of extractions from these proposals may help substantiate by original assumption.

As stated in one planning guide, "All national forest lands will be managed with wildlife as a key value. This means that when conflicts arise, which cannot be mitigated at reasonable cost, wildlife will take precedence. In addition state and private forestry cooperative programs will be used to enhance wildlife habitat on private lands." (8)

The energy shortage has caused a shift from aluminum and plastic back to wood products. This will likely take most of the marginal timber land out of the forage production area. The energy shortage may also cause a shift from the high energy-requiring synthetic fibers back to natural fibers. this shift will take land for fiber production, and the production of wool from rangelands will further reduce the land base (2).

In addition to the projected demands just outlined, the increasing land values, shortage of additional rangelands, economic requirements for more efficient production along with game animal relationships, wilderness areas, recreational demands, and environmental implications all point to the need for increased forage production on the rangelands still available. With some of the needs outlined as to why the productive capacity of our rangelands must be improved it comes to that part of the assignment to discuss ways in which improvement can come about.

I have no argument with range scientists' projected improvement programs or ones that have been advocated for many years--such programs as proper grazing management, proper livestock distribution, deferred rotation and rest rotation systems, range fertilization, changes in breeds of livestock or even utilization of exotic animals to make better use of the range roughages, or chemically altering the palatability and degestibility of so called useless range plants. It has been stated that if sagebrush, mesquite, and creosote bush could be changed to forage plants, the forage supply of the west could be tripled (2).

As a weed control scientist, who has conducted considerable research and developed programs for rangeland invaded by low productive or impalatable plant species, I content that vegetative manipulation or weed control is essential for the improvement of range in the poor or fair condition classes.

The Dean of the College of Natural Resources, Utah State University, in an address to the Society of Range Management stated "One of the most obvious ways to improve forage production is through noxious plant control and vegetative type conversion (2)." However, no where in the paper could I find a mention of herbicides as a means to bring this about.

Programs of deferred, rotational or any of the other managerial practices which will assist in returning the productivity of the range to somewhere near its true potential have merit. However, one has to question the feasibility and advocation of these types of programs which require many years before improvement is forthcoming when there are methods available that can do it in a short span of one or two years. Dixon D. Hubbard, the Animal Science Chief of USDA's Extension Service who chaired the 1974 task force study on red meat stated: "The big problem facing implmentation of new beef-production systems is the long term nature of improved range management. It's kind of like planting a pecan tree--you look down the road ten years before you get any nuts" (2).

This is not necessary. My contention is to use those resources and practices which can return the rangeland to its productive potential in a short span of one to two years, then concentrate on the management practices that will maintain the range in good to excellent condition.

This practice, which can assist in increasing the production of rangelands in short periods of time, is utilizing selective herbicides to control those plant species detrimental to the rangeland capabilities.

There are a diversity of problems confronting the development, acceptance, and utilization of range improvement practices. Development of efficient and effective programs has been hampered in the past and will be in the future because:

1. Undesirable vegetation ranges from annual to perennial broadleaf and grass species to shrubs and trees;
2. The economics and longevity of control have not been full exploited;
3. Game management interests are not always in harmony with some programs of range improvement, especially where herbicides are utilized;
4. Large acreages are publically controlled;
5. Restrictions and pressures against programs are brought to bear by organizations far removed from the problem;
6. Lack of interest and adequate research by some range management departments;
7. Herbicides not cleared by the EPA for use on rangelands; and
8. Probably most significant, the climatic conditions and sparce coverage of many of the plants classified as weeds common to rangeland sites.

There are many programs which have been developed, through the utilization of herbicides, that could be a real asset to range improvement. Again in the time allotted it will be impossible to do justice to all states and all programs developed in the western region. Today I am going to limit my discussion to those programs of research and development that I have been involved in and/or am familiar.

Big sagebrush (*Artemesia tridentata*), occupies some 134 million acres of rangeland in the 11 western states--34 million in Wyoming alone (1). Chemical control of this species and the resultant forage production and environmental improvement is used here to show what can be accomplished and the benefits arising from such programs.

Up until the past four years, a capital outlay of approximately $3.00 per acre for herbicide and aerial application costs, forage production could be expected to increase three-fold on herbicide treated rangelands. The program which was initiated over 20 years ago, has been proven to be economically sound and environmentally safe.

There are many ways that one can present information to show the true value of programs. However, the rancher investing monies into the program should be the most logical person to expound upon its merits.

Mr. Wes Hyatt, a rancher in northeastern Wyoming, who operates a ranch which runs 2,250 sheep and 1,000 hereford cattle on 5,313 acres of state-leased land, has 5,680 acres of deeded land and grazing priviledges on 7,802 animal unit months (AUMs) of Bureau of Land Managment Lands, and grazes 916 cows and 2,000 sheep on Forest Service permit land expresses his feeling toward the chemical sagebrush control program as follows: "We were faced with the problem of a range reduction cut. Our ranges were producing less grass each year due to vigorous growth of sagebrush. Our sagebrush spraying program began in 1954. The results have been tremendous. More grass available for forage for our livestock, increased water flow from springs, plus selling more pounds of lambs and calves. Also a piece of mind and good feeling has come from seeing the range once again covered with grass. The old saying 'riding the range with grass touching your stirrups' has become a reality."

To the casual observer, sagebrush infested land may present a pleasant sight. To the livestock man, the picture is not as attractive. He knows that these woody species crowd out more useful plants prohibiting understory growth and leaves the soil bare which is then subject to increased erosion and deterioration of the soil resource. Those prople and organizations who are oriented against the program should realize that with soil erosion reduced, through brush control and management programs there is less sediment to pollute the area's streams, resevoirs and ponds. Sediment laden water reduces the food supply of fish and effects the recreation value. The sagebrush control program has been proven to be a program that, in addition to increasing the productivity of the infested rangelands, reduces erosion, holds the soil in place, conducts water into the soil resulting in clear water springs and stabilizes streamflow.

Another advocate and experienced rancher who has tabulated the benefits of range improvement through sagebrush spraying is Dan S. Budd. The Budd ranch in western Wyoming has been a working cattle ranch since 1878. A recent article in the October 1975 Rangeland Journal (3) further substantiates the value from a rancher's standpoint.

Mr. Budd has measured the vegetative composition of sprayed areas, measured the snow depth and water content, and kept records of calf weight, percentage calf crop and total AUMs over a 15 year period. The following three tables were extracted from his article:

Table 2. Measurements of Increased Production

Measures	1956	1963	1965	1967	1968	1969	1970	1971
Calf Wt. (pounds)	340	340	362	375	370	373	384	390
Calf crop (%)	75	75	80	85	88	89	89	90
Total AUM's			862					1132
Ave. range condition	fair	fair	good	exc.	exc.	esc.	exc.	exc.

Table 3. Effects of Sagebrush Control on Range Improvement and Carrying Capacity

Items Affected	1952-1962	Present
Cows	450 AUM's	1,654 AUM's
Degree of Range Use	Close	Moderate
Range Condition	Fair	Excellent

Table 4. Snow Depth and Water Content (inches)

Date	Sprayed		Unsprayed	
	Snow Depth	Water Content	Snow Depth	Water Content
2-26-65	35.1	12.1	25.1	7.8
4- 2-65	30.6	7.0	21.7	3.9
3- 3-66	21.4	5.3	16.1	3.8
4- 6-66	10.7	3.8	6.5	2.8
3-10-71	36.6	14.8	23.5	6.8
4- 7-71	28.7	11.1	21.2	6.2

Dan Budd's forage production increase and the accrued benefits of snow cover and moisture relationships substantiate research work conducted by the University of Wyoming as early as 1958.

Numerous studies concerning chemical control of undesirable plant speciec on native rangelands have been reported over the years. Somewhat less information is available regarding the long term effects of herbicides, particularly as they influence non-target components of the plant comunity. The long term ecological effects must be know if a herbicide program is to be developed as a method of range improvement.

A recently completed study helps answer some of the posed questions. This study was the evaluation of the vegetative changes on a blue gama range in Southeastern Wyoming which had been treated for control of broom snakeweed (*Gutierrezia sarothrae*).

Where effective control of snakeweed was obtained, the treated rangeland was producing as high as 1,200 lb/A oven-dry forage as compared to only 224 lb/A on the nontreated rangeland five years after herbicide treatment. Of special interest was the plant community response as influenced by the various treatments. The snakeweed infested land which was treated with picloram at 0.5 lb/A or picloram + 2,4-D at 0.5 + 2.0 lb/A was producing equal amounts of blue grama and needleandthread. On sites where a high rate of picloram, 1.0 lb/A, was applied the ratio of blue grama to needleandthread was in a four to one ratio in favor of blue grama (6).

This study indicates that snakeweed infested rangelands can be improved greatly by manipulation of the vegetation through use of herbicides.

However, the vegetative analysis indicates the specific herbicide and rate used may also have a potential as a tool for selective manipulation of rangeland vegetation. In other words, if it is desirous to have euqal amounts of blue grama and needleandthread, one treatment could be used, if a complex of predominately blue grama was desired another treatment could be selected and still obtain effective control of snakeweed.

Many range managers and livestock producers will agree with the USDA-ARS statement, that downy bromegrass is one of the most serious problems on rangelands of the west. Downy bromegrass has been a deterrent to rangeland production since it was first reported by Aven Nelson as early as 1904. Nelson appraised the downy bromegrass problem as, "of all the bromegrass represented in Wyoming, this is decidedly the weediest. I think, in no place, has it been found serviceable as a fodder plant. It seems to be shunned by livestock to such an extent that it may attain maturity almost anywhere. It is not particularly unsightly, but simple a worthless plant" (1).

Dr. Beetle's appraisal feels that this statement is a little strong and states "sheep may lamb well when fed on it in the spring. During this period, often of only two weeks, the grass is equal in nutrient and palatability to anything on the range, but once the grass has passed this stage, absolutely no value remains for the rest of the year." (1)

Vegetative analysis and forage production determinations made in 1974, 1975 and 1976 on range treated in the fall of 1973 is presented in Table 5. In terms of increase in desirable grass production, the atrazine treated rangeland was producing over 3 times greater in 1974, over 3.5 times in 1975, and approximately double in 1976, three years following treatment. The longevity of control, which appears to be about 3 years, and the cost of chemical and application may limit the scope of program.

Table 5. Chemical Control of Downybrome and Resulting Grass Production[1]

	Lb/A Oven-Dry Desirable Grass[2]			Lb/A Oven-Dry Downy Brome		
	1974	1975	1976	1974	1975	1976
Treated rangeland[3]	579	1072	662	0	7	649
Untreated rangeland	183	293	365	348	578	694

[1]Clipped fall 1974, 1975, 1976.

[2]Desirable grasses: sand dropseed, blue grama, needleandthread, Western Wheatgrass.

[3]Atrazine at 1.0 lb/A applied fall 1973.

Ranchers in the Osage country, a vast open prairie stretching from Tulsa into Kansas which is not seriously invaded by woody brush species report outstanding results from spraying for annual and perennial broad-leaved weeds. On one controlled study in this area yearing steers grazing a sprayed pasture gained 27 pounds more in a year than did a similar group on an adjacent pasture that was not sprayed. Even with beef prices as low as 35 cents a pound, the program returned $2.95 per acre at the one animal unit to eight acres stocking rate. The increased gain alone, in a single year, more than paid for the spraying (4).

There are many other programs that have been developed through weed science research. The control of plains pricklypear, fringed sagebrush, poisoness plants, juniper control, and etc., etc., could be discussed.

I hope this presentation has pointed up the need for range improvement and also mentioned a few programs, of the many available that may assist in bringing about this needed improvement.

Our rangelands are being used, in many cases far greater than is applicable to good management practices, by both domestic and game animals along with increases emphasis on recreation and wilderness areas. If we are to maintaim or increase the game populations and increase the number of livestock or pounds of red meat produced per animal unit, all resources and knowledge available for improvement of productivity must be utilized.

"Working Together," the theme of this conference, is essential. In order for the livestock industry, the wildlife and recreation interests, and public agencies to survive, cooperation and understanding of each program and potentials must be realized.

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OUTLOOK FOR FUNDING IN AGRICULTURE RESEARCH

Dale W. Bohmont[1]

A new day has dawned for agricultural research in the form of Public Law 95-113, described as the Agricultural Research, Extension and Teaching Policy Act of 1977. While Land Grant institutions and the U. S. Department of Agriculture have long been looked upon as being important to the nation in developing new information in relation to food and fiber, it was not until the 95th Congress that responsibilities were clearly defined by law. The United States long has been proud of the achievements of the agriculture industry and has given due credit to science and technology as an important part of America's strength in making this country the best fed at bargain prices of any nation in the world.

Yet, few goals were articulated and the actual process of guiding research and fund allocation often relied upon bureaucratic interests and commodity groups. In fact, as recent as 1976, the Secretary of Agriculture, in public pronouncement, was hard pressed to identify goals for the Department of Agriculture.

The Food and Agriculture Act and the associated titles specifically define food and agriculture science as meaning the sciences related to food and agriculture in the broadest sense, including the social, economic and political considerations of agriculture relating to:

1. Soil, water, conservation
2. Processing, distribution, marketing
3. Forestry, including range management and forest production
4. Aquaculture
5. Home economic, human nutrition and family life
6. Rural Community development.

To achieve the goals as identified in the Act, specific guidelines and procedures as well as authorities for funding are projected for a period through September 1982. It only requires the imagination of the scientists to identify significant and essential areas of national priority for funding to be served with fundamental research.

Yet, the Food and Acriculture Act is only one significant source of research funding. Of equal and growing importance is the private sector. This is a key sector that is a heavy user of research information but one often ignored by the federal and state scientist. Productive agriculture research must recognize that numerous other steps must be taken before the consumer can benefit. The requirements 'beyond the farmer's gate' are fundable and provide opportunities on a growing scale. We must bridge the gap between scientific truth and the application of the technology in the production, processing, packaging and marketing activities. Science no longer can afford to assume that researchable topics must only be funded by continued appropriations. Contracts and grants for a specific need are in the forefront of research fund opportunities. Competition and competence is the name of the new game.

Contract research on international food problems will increase in the future. As the population exceeds the food production of the planet Earth,

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[1]Dean and Director, Max C. Fleischmann College of Agriculture, University of Nevada, Reno, NV 89507.

a vital part of reducing the threat of famine will be through the adoption of proven technology from other developed countries. The limitations will not be money as much as it will be scientific leadership.

This is a double challenge because the pressure is very great for immediate success. The time is short and the problems are often compounded by political considerations and government instability.

When one combines the new and positive interest of Congress, the proven need and enthusiasm of industry, and the growing awareness of the developing nations in looking toward agricultural research, the question of funding becomes the secondary issue.

The basic question is really, "Do we have the leadership, imagination and expertise to live up to the expectations of a rapidly changing world?"

The funds are there to meet the demands of high priority and needed research. Are you prepared to meet the challenge?

FEDERAL OUTLOOK ON FUNDING FOR AGRICULTURAL RESEARCH

William G. Chase, Jr.[1]

Other panel members are covering the same topic from the viewpoints of universities and industry. The remarks here will be limited to the outlook as it relates to federally funded research.

I would be nice to lay out a clean-cut set of directives that could be expected in the immediate and near future. Unfortunately, it can't be done. Many things are happening, and it is too early to identify with any certainty their impact.

You are already familiar with the FY-1979 budget. But for a very brief refresher, significant increases in research were provided for human nutrition, human health and safety, crop production efficiency, and conservation and use of land and water resources and environmental quality. Processing, storage, and distribution research were reduced, housing research terminated, and research on tropical and subtropical agriculture was reduced. Program decreases exceeded increases by $1.75 million. For whatever insights the present provides for the future, you decide. But we expect, at this time, that the FY 1980 budget will continue the trend.

From here on, the crystall ball is not so clear. Three major new factors come into play, and hazarding a guess at the total impact of the three is dangerous.

The first factor that clouds the outlook of the future is Zero Based Budgeting. We got into that some in preparing the FY-1979 budget. We will get even deeper in future years. At first cut, this might not seem to be too big to handle. But the fact that the Decision Packages in ZBB become larger at each successive level in the process creates its own trap door. What might seem fully plausible at one level could end up in a decision package at the higher level that would be cut out or drastically reduced.

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[1]Associate Deputy Administrator, USDA-ARS, Western Region, Berekeley, CA.

Another of these is the Food and Agriculture Act of 1977. It lays out eleven areas that will require program expansion or initiation of new programs. The areas are: Improving human nutrition, developing solar energy, conserving resources, managing the environment, controlling animal diseases, using organic wastes, developing new crops, expanding export markets, managing rangelands, helping small farmers, and continuing basic research. The FY-1979 budget reflects to some extent this rearranging or maybe more properly spelling out their priorities in the Act.

The Act of 1977 directed the Department to create a National Agricultural Research and Extension Users Advisory Board and a Joint Council on Food and Agricultural Sciences. The actions and recommendations of these two bodies are sure to exert a strong influence upon the Secretary, the President, and the Congress. We will know more about just what direction this influence will take one members have been appointed and they begin to function.

The third factor impacting the outlook is the creation of the Science and Education Administration in the Department of Agriculture. That brings forth a number of new offices to manage and coordinate research and extension activities that have not previously existed along with new and different authorities, new and different lines of administration, and communication. Again, we won't know the nature or extent of impact this will have until all are in place and functioning.

As you can see, this addresses more of the factors that will determine the outlook than the outlook itself. It would be hazardous enough to guess about the future if the three factors operated independently. But they will not. Since they will be working concurrently and each one influencing the other, we will just have to wait and see.

INDUSTRIAL OUTLOOK FOR FUNDING FOR AGRICULTURAL RESEARCH

W. D. Carpenter[1]

There are four major factors impacting on industrial agricultural research:

1. The competitive impact--As better pesticides and/or pest control systems are developed, the standards in a screening program for the same use become more strict. This, in turn, lowers the probability of success. With fewer candidates from a screening program, some companies may choose to abandon some part of their research effort.

2. Defensive research--A substantial part of the industry research dollar is going to re-proving, re-doing, or providing additional data on currently registered products, formulations, and uses. The overwhelming part of these regulations has been useless--providing no additional information to protect the environment or society--required by regulations generated by non-scientists.

3. The current requirements for registration are hopelessly bogged down. The simplest label change now takes years. This situation, with little hope of improvement in the next few years, will work on the negative

[1]Monsanto Company, St. Louis, MO 63166.

side in terms of corporate decisions on agricultural research.

4. The quality of research based on the above will have an impact on a success ratio of dollars expended. This will eventually have an impact on dollars for research. In addition, the need for industrial research to complement and provide continuity with that research carried out by the land grant colleges and USDA will guide the efforts of industrial research.

EDUCATION AND REGULATORY SECTION PANEL DISCUSSION

Moderator: H. M. Kempen, Cooperative Extension Service, Bakersfield, CA

WHAT HERBICIDE USERS CAN DO ON SPECIAL PROBLEMS

Earl Surber[1]: My concern today relates to alternatives to normal registration processes and my limited personal experiences with these processes on the crops in which I am involved. Crops we grow which have limited scope include pistachios, onions (for dehydration) and garlic.

We have 4,000 acres of pistachios with an investment of $26,000,000 before any fruit is harvested! We have known for several years that weeds will be a problem. After all, almonds and grapes have weeds, so why not pistachios? We also anticipated having navel orangeworm as an insect pest. However, I was informed that anticipated pests don't count until they become a problem. We at least could have gotten residue analyses performed to establish tolerances when the pest presented itself.

The Pistachio Association has initiated a research program to find various projects deemed important. This is purely a voluntary organization; and through good salesmanship, we have about 85% of the 30,000± acres in California as members. Each member is assessed dues on a per acre basis (not enough production yet to assess the crop). A steering committee composed of pistachio growers meters out the very limited funds to projects which gain highest priority. Weed and bug control is very high on our list.

Dr. Art Lange is ramrodding the project on weed control, and his plot work is excellent! We still are having trouble getting materials with which to work. Thanks to his effort and the efforts of Chevron, Elanco and Stauffer, we do have some tools available. Paraquat is available as a contact spray on bearing and nonbearing trees (Calif. only). Oryzalan is available on nonbearing trees only. The material is being submitted for full label, but is encountering difficulty. Napropamide is available on bearing and nonbearing trees in California and Arizona. In some respects, having these tools available has hindered attempts at procuring other materials, because now there are alternative methods to ones which are better.

Paraquat, as a contact herbicide, is weak on some weeds in our area, especially malva and Russian thistle. Therefore, we need an alternative, such as dinitro. Weed oil is a very hazardous material to pistachios. Girdling problems on young almonds occur with weed oil. It is more hazardous on pistachios.

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[1]Crop Protection Specialist, Blackwell Land Co., Bakersfield, CA.

Napropamide alone will not handle all the weed pressure in bearing trees. Therefore, oryzalan, oxadiazon or some other compounds are needed. Some areas of the state can successfully use simazine. Money, work, time and a huge amount of cooperation from state and federal agencies is needed to achieve goals.

Onions and garlic are other crops with problems. As you may know, two fairly good materials, formulations of chloroxuron, were withdrawn from use on onions and garlic. Basic Vegetable Products, Inc. took the bull by the horns. Since a tolerance already was established, they petitioned for their own label for chloroxuron, Basic Onion Herbicide. Basic sells the material only to their own growers. It is my understanding the label is a 24C SLN label. They assume all liability for use of the material.

Statewide experiments have evaluated several materials on onions and garlic. Bromoxynil in garlic has looked very good for Russian thistle control, which in our area and most west side growers, has been one big problem at harvest. I applied a helicopter swath on some onions once. I nearly died three days later when the onions were lodged over in that pass. But at harvest time, there was no apparent difference and no yield difference. Also, there was very little Russian thistle! Attempts have been made to register several materials using 24C and also Section 18 Emergency status. So far the emergency status angle has not panned out.

It seems there always is an alternative to weed management chemicals: the hoe!!

H. Agamalian[1]: Weed control in "minor use crops", continues to be a major concern of producers and weed scientists. The economics of growing specialty crops in the Salinas Valley is dependent upon several factors; inflated land costs, equipment, energy, labor and pest management. Growers recognize that to be competitive with other production regions, they must maintain their quality with minimal increases in cost of production.

The growing of some low margin crops is oftentimes dependent upon whether effective, economical weed control practices are available. A recent example of this is spinach. Some 14,000 acres are grown for processing **in California**. This crop represents low marginal returns to the grower, but is a staple item with the cannery and freezer processors.

The loss of an effective, safe herbicide has resulted in grower apathy to grow this crop. Processors are faced with increased raw product costs, or loss of a high quality district if forced to other production areas.

Methods to Resolve the Problem: Several approaches have been explored by industry and public agencies to obtain a weed control program for this crop.

1. Attempts were made to interest other manufacturers to produce the discontinued herbicide, norea. This proved unsuccessful for economic reasons.
2. Special local need: A petition was developed for phenmedipham and submitted as Section 18 under FIFRA as an emergence use. The results of this petition proved to be negative and the submission was rejected based on toxicity data gaps, no established tolerance, and because "spinach constitutes a significant percentage of the human diet."
3. Section 24C. The use of this regulatory mechanism was utilized to obtain registration of cycloate. This herbicide offered little benefit in the control of major weeds, but had some limited use in spinach producing regions.

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[1]Cooperative Extension Service, University of California, Salinas, CA

At the present time some spinach acreage has shifted to lower costs of production areas, with serious weed problems. Growers are using their "cleanest" fields, hand weeding, and a limited amount of CDEC, although it is limited in its effectiveness as a herbicide.

Manufacturer Label Changes: Assistance through cooperative efforts of proprietary manufacturers has been extremely effective. Examples of this have been label additions to include crop registrations with wettable powder formulations, formerly restricted to emulsifiable concentrates.

Extending preemergence uses to include fallow ground applications, where the registered crop would be planted at a later date. The addition of aerial application to labels formerly restricted only to ground application represents the kind of changes that have been obtained with minimum performance and efficacy data.

The results of these types of label additions under Section 24C have been extremely beneficial to pest control applicators, growers, and regulatory personnel.

Processor/Grower Registrant: The utilization of 24C by groups other than manufacturers or regulatory agencies may become a common practice. The recent registration of chloroxuron by an onion processing company is one illustration of this fact. Another illustration is nitrofen registered for use in strawberry nurseries, by the nursery company. These kinds of registrations raise various types of questions as to the extent of who can use the herbicide under these special local need conditions.

IR-4 Projects: The use of this system to obtain crop tolerance has been in existence for several years. Under the current conditions of pesticide registration, its usefulness is questionable. The long priority list makes it at best a hopeful scheme that eventually will be beneficial.

The procedures of involving university personnel, manufacturers, and grower groups is a good concept. A cooperative project involving the above groups has been underway for four years involving bromoxynil for garlic weed control.

Cultural Practices for Special Problems: There are several methods being used by growers to overcome the lack of effective herbicides. Some of these include stale seed bed techniques with preplant non-selective contact-type herbicides. Preirrigation where practical, followed by minimal tillage prior to seeding may reduce weeds at crop germination. Heavier seeding rates and/or closer row spacing with some crops can provide greater competition with weeds.

The use of crop rotation with those crops having effective herbicide programs will help to reduce weed seed populations in a given situation. Some limitations to this method are economics and herbicides having residual properties limiting the crops used in rotation. Although hand weeding still constitutes a method of weed control, the cost of this practice in low margin crops such as spinach can be an economical diaster to the grower and result in a poor quality product for the processor.

Robert Meyer[1]: Frustrations of growers occur because many herbicides do the job but are not registered. For example, dodder in sugar beets is a serious problem. There is no control for it except spot treatment with oil and burning. Melilotus in beets is serious and is not easily controlled.

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[1]Weed Consultant, Bakersfield, CA

On asparagus few materials are available. Reliable herbicides such as simazine need supplemental herbicides for weeds missed. For example, trifluralin would aid weed control in asparagus but getting it labeled is a slow process.

Sprinkler rows in potatoes (not planted) need a good treatment since no crop shading occurs. Napropamide, oryzalin, linuron, or alachlor work well, but registration is not available or is nebulous in potatoes.

Perennials--bermuda, johnsongrass, field bindweed--are bad in trees and vines and should be prevented. Glyphosate works well but is not registered as yet.

Russian thistle often is severe in trees and vines. In 1977 severe infestations occurred because napropamide didn't control it, and contact herbicides were difficult to time for excellent control. As many as nine applications of a contact herbicide were applied. Oryzalin works well, but the manufacturer is having great difficulties in getting it registered.

Kern County soils are considered "hot" soils. Simazine at over 1/2 lb/A can cause injury on sprinkled grapes and trees. Though good on annuals, Russian thistle cannot be controlled. We attempted to get an emergency registration for oryzalin because of the severe drought where every drop of water was needed to keep trees alive or partially productive. Oryzalin is registered on non-bearing trees and vines.

It was refused! Losses incurred: Vineyards--contact herbicides cost $60/A; oryzalin cost $10/A. On 6,000 acres, that adds up to $300,000---plus loss of yields that obviously occurred!

Jake McKenzie[1]: I'm going to be a "Job's Comforter" today. Job had a rough time for many years. My message to you is that rough times are going to continue. It's too bad that you will have to listen to this tale of woe that I am about to unfold when you might be winning at blackjack across the street.

I was always an optimist when working with EPA, but after seven or eight months trying to set up a pest management division in the largest state, I've become a disillusioned realist. Having served with EPA at San Francisco and now trying to be a lead agency to register products in the state and to work out relationships with the federal government, it really looks like a rough road ahead.

One problem is the need for a House-Senate committee meeting to consider amendments to FIFRA; it has been postponed month after month. How this proposed amendment is worded will have great impact on what happens ahead. Protocols on minor crops must be worked out. The need for pesticide residue tolerances doesn't go away and when you talk about "bureaucratic inertia", the problem is those tolerances. Though we may have some flexibility under FIFRA on certain 24 (c) activities we don't have any on tolerances.

In terms of creative bureaucracy, California stands head and shoulders over other states. We have issued more 24C's than all other states combined. This has made some people happy but others unhappy. One of the last things I did while with EPA at San Francisco was to ask for an audit of the California 24C program; then moved to head up California's system and received it.

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[1]Assistant Director, California Department of Food and Agriculture, Division of Pest Management, Environmental Protection and Worker Safety, Sacramento, CA.

A problem is that we are supposed to follow certain guidelines on safety and environmental assessments, and abide by them or have our authorization taken away. So we are in an interesting situation now. We tell EPA we will continue to do this until Congress addresses itself to the FIFRA amendments. How long we can play this little game, I don't know.

As we look at 24C requests we must concern outselves with tolerances and the lack of another product. We can't define the width and breadth of California as a special local area. So 24C will be continued, but within certain parameters.

Section 18: I was a former weed scientist but now after having my feet under a desk for five years I qualify as a bureaucrat. But I must admire the fancy footwork and imaginative approaches of California weed scientists in requesting Section 18 because of the drought.

The Section 18 approach is very limited; the regulations are very specific. Problems include the residue tolerance and the severity of the problem. Such a registration stipulates a severe problem for which no pesticides are available and that registration will be pursued by data collection. This is rather laughable in that registrations are not happening in Washington. The re-registrations and RPAR programs of EPA have stopped virtually all registration activity. As a result, people are saying, "There must be some way out of this morass", tramp to another part of the morass, trying to make progress. But it can't be done because it's "Catch 22" at its best. The priorities at the regional offices of EPA are to monitor the Section 18 to assure identification of problems, etc.

So we are in an unfortunate situation. The more lenient we are, the less credibility we have with EPA. The more stringent we are, the less credibility we have with those needing registrations. Hence, my plea for sympathy this afternoon.

It will continue this way for some time.

B. Discussion:

Kempen: What is an emergency under Section 18?

McKenzie: A lot of these are public health related and then issuance is relatively easy. But where "crises" developed, we've been burned a couple of times because alternative materials weren't used when they could have been. Weed-controlwise, economic losses due to weeds have not been evaluated yet. Maybe the University should work with us to help evaluate this.

Agamalian: Economic losses are often difficult to quickly define when sudden emergencies occur. Especially when communities are affected by large scale crop loss due to lack of profitability.

McKenzie: Our problem is that to go to the EPA well too often and coming back dry. That's the "Catch 22" situation; we aren't getting registrations, yet we can't use Section 18's to resolve special problems. I feel that we must limit requests for Section 18's for this reason.

Agamalian: Can we request a Section 18 a second time?

McKenzie: You can, but I hesitate to request too many Section 18's because of the credibility problem with EPA. For example, in the Imperial Valley and in Arizona we have a problem where Section 18's were granted, & rotation restrictions for use of synthetic pyrethoids were not followed.

We are on notice on this one because 80 growers are in violation of this permit condition of Section 18.

Kempen: In this case, is there a problem from a scientific point, and second, is EPA now requiring such thoroughness that the regulations turn growers into such "illegal" procedures? Perhaps growers are fed up with federal regulations such as the 160-acre limitation, the bad pest problems and the concern that a conspiracy exists in Washington to "do them in". Maybe this makes them unreceptive of such permit limits to where they decide not to comply. Will this not soon come about?

Meyer: As an advocate for growers, what can be done? The grower who is taking it on the chin is or will be more apt to "go illegal". Is it not a bad situation?

McKenzie: It is. So is the problem of private law suits in Kern County. The "Do Not Use in Kern County" label charges are causing problems of enforcement, but companies want us to keep the growers from subverting registrations.

While this is going on, the Senate-House Committee is not meeting to resolve the problem in EPA. Meanwhile, the problem continues. But we in the state agency cannot bend our regulations. We can't do that.

Kempen: Any suggestions on methodology to correct this situation?

Participant: I believe we should beat EPA over the head with Section 18's until they get off their duff and register some products. Maybe they will get the message and do something.

Kempen: Jake, is there a way to turn around this morass?

McKenzie: One route is to play the "write to your political representatives" game. Secondly, I would like to consider meeting with the weed science community to put together a group to formulate a position to be transmitted to the California Department of Food and Agriculture as to what is an emergency in a "weedy" sense. Also, to put together a group to communicate with EPA and us to give some resolution to these special need problems.

On specialty crops, this has been hassled with for some time. Changes might be ordered, but EPA clearly indicates that if tolerance setting procedures are altered then they wish to evaluate the entire procedure. That boggles the mind.

Kempen: Has anyone in the audience been able to get action in a unique way? Your silence indicates it is a tough problem.

Well, maybe we can work at it, or move to a foreign country. People in other countries are feeling the impact of our inaction on pesticides. Scientists there have commented how this is having severe effects on their registration procedures. Such inaction is tough on us as scientists inasmuch as we like to be productive. That is the name of the game. What we are losing most is our human asset of ingenuity and zest for improving life styles.

VEGETATION MANAGEMENT IN FORESTS

Steve Radosevich[1]: RESEARCH POTENTIALS

I don't wish to go into specifics, but instead wish to present a few of my ideas that may be argumentative and even evangelistic.

Vegetation management is an awakening field. Methods have been present for a long time, but have been suppressed. The excuse may have been economics. In the past, when the resource was used up, mills bought new land. Now as the resource is more limited, it is logical to buy it from the brush.

The potential is huge. There are 28,000,000 acres of forest lands in the western states. Fully one-third is dominated by brush. Brush has increased from 12% in 1920 (before man-made manipulation) to 50% now, due to forest fires, timber cutting and other catastrophic events.

Realistic management schemes must include aspects of the long term eco-system, must consider the successional sequences, harvesting and slash removal, and brush control.

We must look at interactions between brush competition and tree growth and quantify the factors affecting seedling tree survival and growth. We must study tree physiology as it influences response to herbicides.

Educational requirements should address the minimal needs of foresters and forest managers. Few schools of forestry require weed science, including the University of California.

Environmental areas of research can be monumental.

Local information in forests, as on farms, is most important. Outside expertise is of little value in convincing antagonists of "spray" techniques that such a practice is logical. A local forester can do a much better job in community relations if he will increase his awareness effort.

Peter C. Passof[2]: EDUCATION

Abstract. A review of the tools and methodology in chemical weed control in western forests is discussed. Management objectives are separated into three major categories of site preparation, forest rehabilitation and conifer release.

In terms of technology transfer to user groups, adequate opportunities exist. There may be the need to put more attention toward economic analyses that will assist the forest manager in prioritizing projects that will achieve optimum financial gain.

More attention must be directed toward the general public in future extension efforts to overcome common misconceptions. Chemical weed control activities have become controversial because past extension efforts have failed to adequately inform the lay public. This situation will likely change in the immediate future.

I have been asked to discuss two major questions today concerning weed control in forest habitats. The first deals with information that may be very basic or fundamental to this audience. The question simply presented is, "What is available for weed control in forests"?

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[2] Forest advisor, University of California Cooperative Extension, Mendocino County

The second question raised narrows its perspective considerably and deals with subject matter that I not only feel more comfortable with but would like to elicit your comments as well. The question is "How well is this information being extended"?

Let's quickly take a few moments and review the availability of tools and methodology in weed control activities in western forests. For purposes of clarification, it's necessary to separate vegetation management objectives in forestry into some simple categories.

Site Preparation: Let's start with site preparation which is normally the activities of clearing and/or burning undesirable living, woody or herbaceous material following the final regeneration cut in order to prepare the ground for optimum growth of the desired timber trees. The ease of getting this activity effectively accomplished rests on such things as terrain, soil erosion potential, the amount of residual timber remaining in the area and a host of other factors that will affect the final choice.

If annual grasses and forbs actually or threaten to invade the logging site, the use of triazines such as atrazine (2-chloro-4-(ethylamino)-6-(isopropylamino-s-tirazine) and the less water soluble simazine (2-chloro-4, 6-bis (ethylamino-s-triazine) have proven useful. Depending upon the terrain and the amount of acreage, application may be by aircraft, knapsack or boom mounted sprayer. In some instances, the scalping of the established vegetation by tractor blade or a hand planting tool is necessary if grass has advanced beyond the recommended controllable height. Although too new for operational use on California forest lands, asulam (methyl sulfanilylcarbamate) shows promise for controlling bracken fern which can be a serious competitor for many conifers on typical timber soils. Mike Newton of Oregon State University has demonstrated the effectiveness of dalapon (2,2-dichloropropionic acid) in combination with atrazine for weed control, site preparation work.

Obviously what is required in those situations is high tolerance by the newly established conifers and a broad spectrum effectiveness for the competitive species.

Moving away from the problems associated with rapid invasion of herbaceous vegetation in these recently disturbed sites, we often have to contend with stump sprouting from woody weeds cut in the normal logging operation. Here we see the use of cut-surface treatments of products such as the phenoxy compound 2,4-D [(2,4-dichlorophenoxy)acetic acid] or picloram (4-amino-3,5,6-trichloropicolinic acid). A word of caution, however: with many species it is important that the chemical compound be applied to the freshly cut stumps. Delay from initial cutting to application of hardwoods such as tanoak (*Lithocarpus densiflorus*) and madrone (*Arbutus menziesii*) will substantially reduce efficacy of the compound. If too much time occurs, it's very common to witness basal sprouting which then requires additional foliar or basal applications with phenoxy or similar compounds.

Forest Rehabilitation: Unfortunately, if site preparation activities are not followed promptly, all too often remedial weed control activities must eventually be employed to salvage the diminishing productivity of the timber site. Within California we have suffered the consequences of certain land management practices when the assumed objective was to convert timberland into range-grassland but the forces of nature have decided that brush species were more ecologically suitable.

Foresters faced with these problems of the past have had to resort to the next category of weed control activity popularly referred to as forest rehabilitation.

Normally these areas have so little in the way of desirable conifers that the strategy is not really concerned with chemical selectivity. However, chemical agents that might have long soil residual properties cannot be considered because immediately following the elimination or reduction of the brush, a reforestation plan is put into action.

The more common technique is to aerially apply a herbicide in the phenoxy group to get a gradual foliage desiccation and then follow up with a controlled burn to reduce the fuel mass to a manageable state for planting or seeding. The use of dinoseb (2-sec-butyl-4,6-dinitrophenol) in "brown and burn" prescriptions, followed quickly by broadcast burning has proven popular in the Pacific Northwest, but for varied reasons has not been employed in any large way in California.

Conifer Release: In those instances where stands of sapling or small, pole-size conifers have become successfully established but are overtopped by hardwoods, the management objective is to release the conifers so they can resume their optimum growth rates. Complete kill of the overstory brush species, while perhaps desirable is hardly ever accomplished. The upper competing crowns are sufficiently reduced in leaf surface that additional sunlight reaches the understory conifers. The phenoxy herbicides 2,4-D and 2,4,5-T [(2,4,5-trichlorophenoxy) acetic acid] with their critical feature of selectivity are applied by helicopter at 3-4 pounds acid equivalent rates mixed with water and some diesel to produce a spray mix of 10 gallons/acre at an approximate total cost of $15-$20 per acre.

It is this practice of conifer release which has led to the controversy over herbicide applications in northern California forests. In addition to introduced legislation totally making such spraying illegal, several risks surrounding these operations and more studies are being contemplated.

Opponents to aerial applications of phenoxys argue that no assurances can be made against drift which might cause contamination of water supplies. As an alternative to the use of chemicals, it's proposed that the use of manual procedures (chain saw and axe) have the advantage of increased employment opportunities with no risk of contamination. Obviously the question of economics with increased costs contributed to the labor-intensive method comes into play as the dialogue continues between the opposing sides.

Evaluating the Extension Effort: Let's now turn our attention to the second part of the assignment and dwell for a moment on the question concerning how well this information is being extended.

On the surface, certainly no one could accuse the educational institutions charged with the responsibility of extending such information of having failed in their duty. There have been many workshops, conferences, seminars and field trips on the subject of forest weed control in our western states. Publications on new methodology, chemical recommendations, and results from monitoring programs are frequently found in any current review of the literature.

The forest land manager has the ability to go to any number of reference sources or attend educational meetings today and learn what kind of material and method is best suited for his particular forest weed situation. If a deficiency occurs in this area of technology transfer, it may be in the paucity of information on cost/benefit analyses that allows the forester to examine his many options and prioritize them in a manner that will produce the greatest return on investment.

I would suggest that in the development of future research studies within the context of forest weed control that the project leader attempt to consider the needs of the user. Whenever possible a projection of gains anticipated per unit of cost should be presented in the study plan.

Where I believe an obvious deficiency has occurred in the extension role and likely accounts for a vast majority of our problems and controversies today, is in not focusing on the lay public as a potential audience. Not until the situation gets heated up and polarized have we entered into the arena. I am afraid we in the Extension movement have to be guilty of being Johnny-Come-Latelys in sensing that we have a great deal of information to present to citizens who may be interested in the results of weed control operations but who have not formulated an opinion pro or con.

I am not naive enough to believe that a concerted effort directed toward this needed and new-found audience will result in 100 percent acceptance and thus an end to the controversy lies around the corner. Honest differences of opinion are essential to the pursuit of truth and knowledge. However, much of the criticism of herbicide use in forest areas is based on suspicion and plain ignorance. We have a real opportunity to make some improvements in helping folks overcome their unfounded fears.

Some of you may be wondering if this is not the sort of thing that can best be left to the chemical manufacturers or possibly to the industrial users of such products. We're touching into the realm of public relations where special talents have been finely tuned to mold public opinion. True enough, but I have my own hunch that the private sector lacks full credibility among certain segments of the public which can only be mitigated by the neutrality presently enjoyed by educational facilities.

These are difficult and challenging times. Our own U.C. Cooperative Extension Service is being asked to move toward becoming the University's informational delivery system to the general population of California. If we are to become more relevant to society's needs, especially as viewed by a great majority of urban-oriented legislators, we are going to have to do a better job of telling the story to people beyond our traditional audiences. In an optimistic sense we in Extension are feeling much like Astronaut Neil Armstrong emerging into a totally new area of opportunity.

<u>Phil Aune</u>[1]: USAGE

Through our analysis of law suits due to use of herbicides, Region 5 has begun evaluating mechanical and hand vegetation management of plantations, especially the costs. Today I will cover these techniques of conifer release.

Traditionally, the Forest Service has embarked on replanting promptly after a fire on timber cutting. Otherwise, brush would soon move into such areas. Traditionally, 2,4,5-T at 3 lb/A was used with excellent results--very cost effective--from fall applications. In 1976 at the Tahoe National Forest, our total cost, including administration, was $28/A on 2,494 acres.

We are now looking at alternative methods. Strip planted areas were "treated" with Boy Scouts who clipped brush areas. Since all brush species are resprouters, control is very short.

We now have evaluated the "Hydro Ax 500" brush cutter, working like a large rotary lawn mower. A second cutter head is a horizontal hammer shaft, working like a flail going around and around. Third is a "Track-Mac", a clipping device.

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[1] Regional silviculturist, Tahoe National Forest, Nevada City, CA

Our cost data are on the Hydro-Ax. For on-site preparation in oak and manzanita we can be selective and do the job well. Planting in this "mulch" is successful because moisture appears to be conserved.

In established plantations, attempts to do pre-commercial thinning and also vegetation management to release conifers were successful. Thinning to 200 trees per acre was accomplished. The biggest problem is rocks under manzanita. Slopes under 20 percent permit operation; above this heating occurs or maneuverability is impaired. The machine can create a fire, too. The biggest problem, however, is regrowth. Rapid regrowth occurs the next year.

Handclipping three-foot areas was successful, but only temporarily, and needs continuing evaluation.

Herbicides continue to be very cost/effective. Mechanical preparation cost--$17.26/A to prepare for the contract. The contract costs $105.21 and the administration costs $9.54 for a total of $132 for the job. Eighty-two machine hours at 0.6 acre/hour; 32 percent of the hours were for machine down time.

Hand trimming, without slash treatment, cost $185/A. Normally it cost $280/A.

The largest study done was by the Josephine County Forestry Department in Oregon. On 600 acres in three sites, costs from $556/A to $1268/A were incurred for hand treatment. This versus $28/A for usage of 2,4,5-T.

These data are now being utilized for environmental impact assessments. But this does not solve the problem of public attitudes toward herbicide usage, especially the desire by some to have zero exposure.

Brian Sturgess[1]: THE EFFECT OF REGULATIONS

I have been asked to introduce the topic, or to discuss the effect of regulations on the possible use of herbicides, and in particular, the impact of environmentalists on herbicide use. One effect that the pesticide regulation has had on forest land managers is that a closer working relationship with pesticide regulatory officials is essential. This will enable us to reach a coordinated agreement on label interpretations. For years now we have been telling pesticide users to read the labels. Now anti-pesticide people are also reading the labels very closely. They want to see if there is some way that a particular pesticide is not appropriate for a particular use. Most of us realize they want to stop all pesticide programs, no matter what. For instance, the forest service uses labels reading "Do not use in recreational areas". If the environmentalists were of the opinion that all the national forests are recreational areas, accordingly they advise the Environmental Protection Agency that the farm service is misusing pesticides. So the contingent of EPA enforcement people from the regional office in San Francisco met with us to discuss this particular problem and asked us what we felt about it. We had decided that this label meant developed recreational areas with intent for public use and that this label no way intended to preclude herbicide use on disbursed recreational areas, so we came to some agreement there.

Also the label reading "Do not graze cattle on treated areas" has given us some concern. Environmentalists read this to mean at the rate it is being treated you are never supposed to graze cattle on the area. We are asking EPA to come up with some determination on this, but right now we are saying that that restriction only means for one season or one calendar year

[1]Chemical Use Coordinator, Region 5, USDA Forest Service, San Francisco, CA

work period. Now most problem labels are with products containing 2,4,5-T and the associated dioxin contaminent. These labels contain language to the effect that meat animals should not be grazed on treated vegetation two weeks before slaughter.

The environmentalists have said "What about here in the forests". They have meat animals too and forest spray operations for conifer release coincide with the deer hunting season. Therefore, they say hundreds are eating dioxin contaminated meat. This controversy is still raging today. In fact, those of you from California are familiar with the Behr bill introduced recently which will ban aerial applications of phenoxy herbicides on private forest lands. As a matter of fact, this bill is being deliberated in California State legislature this very day.

I will conclude this very brief introduction to the subject and say that forestry herbicide users believe that the further use of herbicides in vegetation management is a safe practice; and in fact there is no evidence to support the claim of some environmentalists that the substantial question of safety exists.

DISCUSSION:

Kempen: I wonder how Extension can educate 20,000,000 urban people who are not knowledgeable of vegetation management techniques or the economics of nonherbicidal techniques?

Passof: One approach is a good offense. The popular press is a good place to start. For example, reporter Paul Harvey carries favorable coverage on pesticides. Governor Brown has called for a greening up of California by reforestration. It's a good step, with one catch. They give bonus points if site preparation is mechanical but not when using environmentally harmful materials which I would guess would include herbicides. I think we have a long way to go because many landowners are involved. But all in all, mass media is our best bet.

Kempen: Is forestry a logical venture at this stage, with site preparation costs of $150 to $250 plus maintenance?

Passof: On the north coast on good sites, yes, but in the Sierras I have my doubts. Sixty percent is good site land and can produce 1000 board feet a year and is producing only 300 now. At $300/1000 board feet, it is a logical investment. There is some question whether they will ever be able to cut it. There is still interest in trees and interest in herbicide use.

Audience participant: Where does burning fit into this management?

Radosevich: It is an important tool and is widely used in the Northwest on clear-cut areas. Indians formerly used fire and recently there is a move to use burning to remove slash and downed timber at higher elevations. It may be used more at lower elevations in the future.

Comparing fire to mechanical methods, it too is expensive but bears further evaluation. All management programs must integrate shrub management in long-term tree growing programs. This requires removal of the top story and then going from there.

Passof: Relative to fire, burning of brush among conifers burns both. Therefore, it is not a logical conifer release program. One area of study involves brush utilization; if utilized it opens new management techniques.

THE CASE FOR PREVENTATIVE WEED MANAGEMENT: BUT HOW?

Robert Higgins[1]: What are weeds? You know several difinitions that have come along through time. However, if you want to compare weeds with other problems such as colds or cancer you might say, "Weeds are an unhealthful condition caused by seeds." On the same basis, we would say colds and cancer are an unhealthful condition caused by viruses. There is no viracide that you can give that will remove the virus and make the person well from colds or cancer. Nor is there a seedicide that we can apply that will remove the seeds. In each case if we can't prevent it, it only leaves us with some means of treating symptoms in order to correct the problem.

Let's make an analogy of symptoms and start off with colds; the symptoms are headache, sore throat, stuffy head, fever. When we get these things, we proceed to treat the symptoms with aspirin, bedrest, etc. With cancer the symptoms are not as easily recognized. But, the symptoms of cancer we will say are uncontrolled growth of cells causing the many discomforts, pains, etc., that occur. Once the symptoms are noted and the cancer delineated we proceed to treat with radiation, by cutting, and hopefully removal.

Similarly with weeds the symptoms are uncontrolled growth (much the same as with cancer) and numerous side effects. But we seldom delineate the growth. However, we proceed to spend millions of dollars treating the symptoms (such as spraying with herbicides). In each case, as an end result if we are fortunate, the patient feels better and we say we have cured what ails them. How much better would it be to prevent and eliminate the cause instead of just treating symptoms.

Let's continue the analogy this time on prevention. For colds you could say: avoid exposure to sources of infection, keep warm, have proper nutrition and get enough sleep. If we do these things, hopefully we can prevent colds. For cancer prevention you are advised each day to avoid known cancer elements which may include pesticides, radiation, cigarettes, or what have you. Part of the prevention is to run tests for early detection and then remove or treat before it spreads beyond control. Similarly with weeds, although we probably know more about prevention than we do of colds or cancer, we say avoid introduction of seeds to the environment; provide competitive crop growth; be sure that your competing plants have proper nutrition. And let's reverse the statement of getting enough sleep to "Don't go to sleep on the job." Then have a detection and delineation system followed with treatment to remove the initial symptom before it spreads into a major condition which requires more treatment and cost than we may be able to afford or accomplish.

In each case the symptom is often the result of: poor management, neglect and ignorance. Weeds are symptoms of faulty management of land, water, and human resources. I suggest we can and should do more on prevention, detection, and delineation of infection than we have been doing. However, we must continue working on the symptoms. Is this idealistic? Exceedingly so! Is it realistic? Mabye not, but maybe so. It depends on who you talk to: with society, with the grower, sometimes with the researcher, and the extension worker.

Weeds are a specter in which we are always looking for something that will take the symptom away. We often express our concern for weeds as

[1]Extension Agronomist, University of Idaho, Twin Falls, ID.

follows: "As I was going up the stair, I met a man who wasn't there. He wan't there, again today. I wish, I wish he'd go away."

Let me quote from a 1966 talk by Dr. L. C. Erickson. "The saddest words of mouth or pen are these four words, 'It Might Have Been.'" He quoted Churchill, "History is a record of man's errors." "Prevention is still the greatest singular practice." "A strong defense is the strongest offense." "It may do us little good today to know that it is now 200 years since General Burgoyne's army seed the infamous thistle trail from Montreal to Saratoga. Or than 80 years ago Professor Henderson of the Idaho Agricultural Experiment Station noted and warned that there were two infestations of Canada thistle in this state--one at Sandpoint and one at Boise (comprising less than 5 acres in total). But it is of vital concern to us that we now have 200,000 acres infested in Idaho and about 2 million acres in the Columbia Basin."

I said that we knew a lot about prevention of weeds. Let's review some techniques quickly. 1. Planting crop seed without weed seeds in it. 2. Maintain a beneficial competitive vegetative cover. 3. Avoid opening up land to weed invasion. 4. Reestablish grass cover when land is opened up. 5. Prevent existing weeds from going to seed. 6. Don't bring in new exotic plants until we know they won't become a problem. Examples of exotics are parrotfeather (somebody thought it was a good duck feed); lythrum (allowed to escape as an ornamental; it now infests miles of canals and lateral waterways): and dalmation toadflax (an attractive wild snapdragon as an ornamental now escaped to be a most serious range weed). 7. Use water and fertilizers for maximum crop growth. 8. Use herbicides or cultural practices on a timely thorough basis. 9. Help develop the human resource,that is: men, women, boys and girls to be proud of the land and its appearance. Remember, weeds are only weeds because man so designates them as such. Only the individual can prevent them, we can't wish them away.

Let's look at some of the things we really don't know as much about as we should: 1. How to influence people or persuade people to prevent these symptoms of poor management, or even to recognize that they have a problem. 2. Economic information that is strong enough and valid enough to convince people that they have a problem. 3. Proven methods of detection and delineation so that we can make a competent thorough successful effort of preventing spread and invasion of new weed species. 4. Ways and means means for the appropriate agencies to take action at a time when success can be more or less assured instead of waiting until a major problem exists and then trying to solve it. No one will put money into research or trial work when a problem is of a size it can be handled. After it becomes a major economic problem, then we clamor for action. By then it is often too late. 6. We have been squirting chemicals so long we can't see beyond the use of an herbicide for the control of the symptoms of poor management. 7. Management studies that show how we can prevent the symptoms from developing and have a relatively weed free situation because we are good managers and not just because we have an herbicide to squirt after we have the problem. 8. Research, perhaps by social scientists and economists, to help us show the social costs and increase the social awareness. Each dollar lost to weeds is more than a dollar lost to the economy and to the welfare of the community.

We have spend millions of dollars, millions of hours and a lot of high-powered research and extension effort to try to solve the weed problem. In some ways we have failed miserably to do so.

Eugene Heikes[1]: Weeds are a social problem not just a production problem. Weed control requires people support and action. As weed fighters we are concerned with what weeds are, why they should be eradicated or controlled, and how best to do it. Often we do not really realize why we don't get more support and action to do the job.

Groups or individuals, such as the farmer, the home owner, the Chamber of Commerce, or what have you, have certain needs and stimuli. If everything is stable in their eyes, then there is no problem and they don't do anything. They have expectations and they have perceived ability to meet these expectations. As long as the expectations and the perceived ability are parallel and close together, they have no problem. Therefore no strong action takes place. It is only when the expectation level is high and their perceived ability is low that they start to be aware that there is a problem to work on.

Applying this to weeds, when we can show the farmer, the business man or the agency that a weed or weeds is preventing them from meeting their expectations, then they will take interest in weed control or else lower expectations. We must get their real attention and concern.

Here are examples of cost of weeds when prevention failed. The first one is a real example and at this time one which possible could be handled in a different way but this is what happened.

Russian knapweed was introduced to Fort Hall Indian Reservation lands by the government in hay during a hard winter years ago. Nothing was done to prevent its thorough establishment. In the early 1950's the Michaud Flats Irrigation Project was started. There were 400 acres which were badly infested with Russian knapweed. It had to be cleaned up before the land could be developed for irrigation. Over a five year period the direct cost of trying to eradicate the infestation amounted to $14,620. Non-infested land did not have this cost. Users of the land are still affected by the infestation by at least $10 per acre per year.

The second illustration is a hypothetical one. At this time we have rush skeleton weed in Idaho. It is continuing to spread. If it is allowed to spread into Power County and infest their 116,000 acres of non-irrigated wheat lands, the following could be the economic impact per year:

Power County has 116,000 acres of non-irrigated wheat. On 2,434,000 bushels, at $1.50 per bushel, the value is $3,651,000. Loss of 1/3 to 2/3 due to skeleton weed (estimate one-half) is $1,204,830 multiplied by $1.87 equals an economic impact on the country of $2,253,032 per year. The loss to automobile and implement dealers alone would be $1,204,830 multiplied by .0559 equals $67,350. Other segments of the economy would be similarly affected.

A recent study on weed costs was conducted in the economics section of WSWS by Jesse Hodgson on Canada thistle. In general cost studies are few and hard to find. We need to encourage more economic evaluations in graduate studies; I've voted for it but have been turned down on the matter.

Farmers want cost information when evaluating herbicide usage. We lose a lot of educational punch by not having more economic data. Legislative people also want economic data, not just estimages. But we can't even get enough money to get the economic data to justify a weed program. I don't expect much hope to get a statewide program such as Harold Alley relates in Wyoming.

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[1]Extension Agronomist, Colorado State University, Fort Collins, CO.

ASCS formerly had cost-sharing programs on controlling weeds. Now they do not because they feel their programs should be incentive programs and weed control is a normal management function. SCS is more inclined to fund soil erosion practices than weed prevention. Yet I feel land lost to weeds is worse than due to erosion.

A serious problem is getting the message across to people that weeds can be cleaned up. Cost per farm is $2000 per year, but farmers do not seem to get excited about trying to save that money.

There is data than perennial weeds cost $100 to $200 per acre in row crops. Cost is obviously higher on small acreages. Also in distant unaccessable areas, cost to control weeds may be prohibitive.

Harold Kempen[1]: In the San Joaquin Valley some growers say, "I don't mind spending $100 per acre foot for water but I object to paying $100 per acre to control the weeds that come in with it." I agree.

Another way to look at this is to measure loss from weeds on a rental basis. If worth $150 per acre, but with a need for $60 per acre for weed control practices, then the land is only worth $90 per acre. Thus the weeds are a negative asset.

I recently had a chance to evaluate the cost of johnsongrass. We always advocate preventative programs on this agressive perennial. A management firm asked me to evaluate the loss due to a lessee allowing johnsongrass to grow during the final season of his lease.

In one field he had let it go so badly it was solid johnsongrass. So it was out of the question to grow cotton. The alternative was to dry fallow which would mean planting grain in the winter and following with repeated cultivations during the hot dry summers we have, to control the johnsongrass. I figured that would cost about $45 to $50. But because they couldn't grow cotton (and the price of cotton was good) it would cost them another chunk of money, so the total loss amounted to about $210 per acre, just because the lessee let the johnsongrass go.

On a moderate infestation in another field, I felt he could grow cotton. There he would spot treat with repeated applications of MSMA. But the cost would probably be about $80 to do that, plus he would lose at least $130 in crop yield; again a total loss of about $210.

That adds up to a lot of money. We therefore advocate that one never lets perennials get out of hand. That's the cheapest way to go.

Roguing weeds such as johnsongrass in cotton is easy where you can see the difference. In Holland, Dr. H. Nabor reported that they have a wild oat control district, and require farmers not to let the wild oats go to seed in cereals. They enforce it. They have as many regulatory people there as they have farmers. They claim they are successful.

What does this mean to us? Maybe we need to change our attitude on some of these matters. I intend to emphasize just what some of these weeds cost in my newsletter. It's going to be a guess, but it's a calculated guess. If for instance we just make the asumption that every one of the herbicides we use in the field gives us at least a 2-1 cost-benefit ratio; if we spread this word around in our newsletters and our reports, eventually this might become "a truth" and EPA could put it in their computer model and come out with a good cost/benefit assessment. Then we could get preventative programs.

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

I have wondered if weed control districts are not logical to prevent certain weeds from becoming established. I have checked with several and find that none have been legally formed. In Salinas, where many roadside weeds carry a virus that spreads to lettuce and causes drastic yield reductions in lettuce, they went to a weed abatement program in all the non-cropped areas. Rather than make this a legal arrangement, they did it on a voluntary basis. Workers like Harry Agamalian got everyone together and talked this out, pointing out the need in terms of social value to the community. It's been quite successful and I must say they have done a very nice job.

We have had other districts, or attempted districts up in the East Bay area, and again they went with the volunteer system. I recently suggested we should have prevention districts in our area; maybe an irrigation district could be also a preventative district. The reaction was that, "I don't want anyone who is controlling my water to control my weeds too. It's just too much power."

Basically the attitude of growers is against another regulatory program. They are willing to listen and I think people like Bob Meyer, who does weed consulting in our area, certainly can show us that you can do a better job of weed management on ranches. But to be a viable system, it must be a profitable system.

Participant: I think that through newsletters, through meetings, and every opportunity you have to talk about the extent of weed problems, we can get people to accept that there are community losses due to weeds. I think our commissioners now are more popular by taking a stand that they are going to do something rather than they would by not doing anything.

Kempen: Yes, I agree, especially when you get into low profit crops like rangeland. You really can't afford to go into annual control programs and there it is much more important to go to a preventative program. Weeds slowly and insiduously spread and take their costs out of our hides.

Participant: I'd just like to make a comment. There are now people in government agencies (Highway Department) who have put up signs that say: ROADSIDE VEGETATION MAINTAINED FOR WILDLIFE HABITAT.

Heikes: We had somewhat the same problem in Colorado. Actually the Highway Department said there should be no spraying or mowing done until the midle of June when the pheasants quit their nesting. Personally I don't know of any self-respecting pheasant who would nest along the highway with all that noise going by. Evidently they think they do. One thing is, we have a problem with our share of environmentalists, more so than many other states.

I remember over in Vale in the Aspen area where they have some pretty good weed districts, that they actually passed a law that the thistles with the pretty little blue flowers (Canada thistle), are native vegetation and could not be controlled because they were native. They don't believe that it isn't native. We haven't even been able to get a control program going there because of the "native flowers". I just think this is another one of our problems.

Kempen: I saw this in England, too. They had a vegetation management program along the roadsides until this past year. I was thinking, those farmers along the road are going to pay for it. There were a lot of plants going to seed and the ones that are airborne can cause some real problems.

Higgins: In Idaho the Highway Department is developing a different approach to the vegetation problems along the highway. One of them is very important to weed control; that is maintaining a desirable vegetative cover on the land, rather than trying to keep it bare or to construct through an area and then not do anything about it. They are seeding desirable grasses and maintaining a desirable vegetative cover within the highway right-of-way as much as possible. They also have a spraying program where they will be spraying the weeds designated as noxious in the state. I think this is the big step forward. There is progress being made.

PENETRATION OF TWO HERBICIDES INTO TANOAK LEAF DISCS

M. G. King and S. R. Radosevich[1]

Abstract. Penetration of triclopyr ([(3,5,6-trichloro-2-pyridinyl)oxy] acetic acid) and glyphosate [*N*-(phosphonomethyl)glycine], 1 x 10^{-5} M each, into leaf discs of tanoak was studied. Uptake as a function of leaf surface (adaxial or abaxial) and leaf age (young, not fully expanded and mature, fully expanded) was also investigated. Treatment time was six hours, during which light, humidity and temperature were kept constant.

Significantly more triclopyr penetrated into young leaf discs than into mature leaf discs. More triclopyr moved through the abaxial than the adaxial surface. Little of the glyphosate applied (4.0 percent) was absorbed. However, the results indicate that more glyphosate penetrates through the adaxial surfaces than the abaxial surfaces and that leaf age is not a significant factor.

Various leaf surface features were studied and correlated to herbicide penetration. Cuticle thickness, stomatal densities, wax quantities and relative amounts of pubescence were investigated for each of the age classes.

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THE COMPLETE RESEARCH REPORT

AN ESSENTIAL STEP TO EPA REGISTRATION

James D. Riggleman[1]

The objective of field research is usually to find better tools for more efficient crop production. One the field work is finished, the results are summarized for publication or presentation through various professional groups, in Experiment Station publications, or popular magazines. In many cases, these reports are used in support of EPA or State registrations which then permit growers to use these new discoveries. However, for

[1]Product Development Manager, E. I. Du Pont de Nemours & Co., Inc., Biochemicals Department, Wilmington, DE

registration officials to make sound judgement about the discovery, certain essential background information must be included with the report. Seemingly, this is a simple task; however, as much as 75 percent of the reports I review to support registrations are deficient in one way or another. Filling in the gaps requires hours of telephoning, if the researcher can still be located.

Before listing the essential parts of a complete research report, let's first examine a herbicide product label, which is the last line of communication between the manufacturer and the grower. The example is from a selective residual herbicide which can be applied pre or postemergence (linuron, metribuzin or atrazine). The following items are among the more prominent items on a label:

- List of weeds controlled or suppressed
- Crops which may be treated
- How treatment may be applied (pre or post)
- Size of crop and weeds
- Rate of application based on soil texture and organic matter
- Spray volume per acre
- Rainfall requirement for activation of consequences if too much
- Precautions

Thus, there are two main reasons why a research report needs to be complete:

1. To acquaint the reviewer with the conditions of your test and
2. For a specific background information to develop a useful label.

The Elements of the Complete Research Report

Without the following essential elements, it is difficult, if not impossible, for the regulatory agency reviewer to fully assess the data.

Crop and variety: While authors rarely forget to mention the crop, the variety is frequently ignored. Varietal information is almost as important as the crop itself because of varietal tolerance or susceptibility to certain herbicides.

Rate applied and formulation: Express the amount applied in terms of active ingredient (lb/A or kg/ha). Since considerable difference in performance may exist among formulations (e.g., emulsions, wettable powders, granules), one should specify the formulation with a simple code (e.g., 4 EC, 50 WP or 10G). The source may be footnoted if more than one exists. If additives such as surfactants, thickeners or safeners were employed, specify the concentration as well as the name of the additive.

Soil texture, organic matter and pH: The application rate of most residual herbicides varies with soil texture and organic matter content. Lower rates are normally used on coarse textured soils low in organic matter. For example, with one residual herbicide, as little as 1/2 lb/A is recommended on coarse soils low in organic matter; while up to 5 lbs/A are required to achieve similar results on fine textured soils of higher organic matter. It is obvious, therefore, that reporting soil texture and organic matter is as important as reporting the amount of herbicide used per acre.

Since soil pH can affect crop tolerance to certain herbicides, this measurement is also helpful.

Depth of planting: Crop safety is often partially due to the protective zone of soil between the herbicide on the soil surface and the seed buried 1-1/2 to 2 inches below. Thus, disclosure of planting depth can be very useful to reviewer in interpreting crop tolerance.

Control of individual weed species: Weeds are listed individually on product labels. Rarely are such broad categories as broadleaved weeds or grasses used. Similarly, growers and consultants often want to know about control (or lack of control) of one or more specific weeds that may be a problem. Unless data are recorded by individual species, it is impossible to develop a list of weeds for the product label.

While the percent control system of rating seems to be the most popular for recording data in computer systems, any scheme which works best for you is acceptable, but always identify what is good, bad and commercially acceptable control.

Though weed population is not required by EPA, it is very helpful to have counts per unit of area by individual species in the untreated check.

Crop tolerance: Very few herbicides can be applied at excessive rates without affecting the crop. To determine what the effects are and what margin of safety exists, the researcher should include small non-replicated plots of 1-1/2 and 2 times the rate required for adequate weed control. The symptoms of crop injury, if any, should be noted for all rates tested (X, 1-1/2X and 2X rates). The degree of injury should be recorded by a numerical rating system. As with weed control, a scoring system based on percentage seems the most popular and is easily computerized. The range of commercial acceptability should also be defined. If no injury was detected, this fact should be reported and not left up to the reviewer to assume that no mention of any injury is the same as "no injury".

As part of the crop tolerance evaluation, the inclusions of yield and quality data are helpful in determining, if any, direct or indirect effects occurred to the crop as a result of treatment.

Plot size and number of replications: Without this information, it is difficult for the reviewer to grasp the magnitude of the test. While a plot or two square feet may provide adequate data for heavy seed producing weeds such as crabgrass or pigweed, it could hardly suffice for cocklebur or jimsonweed which tend to have lower seed populations and are often not uniformly distributed throughout the plot area.

Application equipment: It is helpful to know if the herbicide treatment was subjected to the variable inherent in large field equipment or if it was applied with precision small plot equipment.

Spray volume: This information, although not essential, is helpful in developing the range of spray volume recommended on the product label.

Date planted, treated and evaluated: It is helpful to know whether this was an early, main or late season test and essential to know the interval between planting and treating and treating and rating. These items are best handled by providing the actual dates. The intervals can then be calculated by those summarizing the data.

Size of crop and weeds at time of treating: This is important for post-emergence treatments to an existing crop or to a field prior to planting the crop such as in no-till or stale seed bed situations.

Daily rainfall or irrigation for at least one month after application: Rainfall or irrigation is required to place many herbicides near germinating weed seeds. Without this information, it is impossible for the reviewer to determine why a herbicide threatment worked well or not as well as expected.

General comments on soil variability or abnormal test conditions: Conditions such as flooding, soil crusting, hard pans, wind storms, animal traffic or any other unusual conditions should be mentioned.

Author and location of test site: Last, but not least, the name of the research worker and the name of the town nearest to the location of the test plot should be noted.

Check List and Report Outline

A check list derived from the EPA requirements and "Instructions for Contributors to the Proceedings of the Northeastern Weed Science Society" (1) and "Research Methods in Weed Science" published by the Southern Weed Science Society (2) is presented below:

- Crop and variety
- Herbicide, formulation and rate applied (lbs/A or kg/ha)
- Soil texture, organic matter, pH and seed bed conditions
- Depth of planting
- Control of individual weed species (percent control for treated weed populations in untreated plots), designate level for commercially acceptable control
- Crop tolerance at X, 1-1/2X and 2X rates (designate commercially acceptable range)
- Yield and quality assessment
- Plot size and replications
- Application equipment
- Kind of spray and volume
- Date planted, treated and evaluated
- Size of crop and weeds at time of treating
- Daily rainfall or irrigation for at least one month
- General comments on soil variability, abnormal weather, or other conditions
- Author and location of town nearest test site

Literature Cited

1. Instructions for contributors to the Proceedings of the Northeastern Weed Science Society. Proc. Northeast. Weed Sci. Soc. 32, 1978.

2. Information requirements from field experiments. Research Methods in Weed Science. So. Weed Sci. Soc. 1977. p 221.

The same information in the check list above is presented as working field forms:

TEST BACKGROUND INFORMATION

Researcher________________________ Affiliation____________________________

Test Location_________________Crop _________________Variety_______________

Soil Texture_____Organic Matter_____%, pH_____Seed Bed Cond_____________

Plot Size____________Reps______________Depth of Planting___________________

Application Equipment__________Kind of Spray___________Spray Volume________

Date Planted_________________________ Date Treated_________________________

Size of Crop_________________________ Size of Weeds________________________

Daily Rainfall for 1 Month____

General Comments____

FIELD EVALUATION FORM

Date Evaluated____________________________

Herbicide	Form.	Rate lbs ai/a	% Weed Control* Species a	Species b	Species c	% Crop** Injury	Yield Etc

*Above_________% is commercially acceptable weed control

**Below_________% is commercially acceptable crop injury

CONCLUSION

No one is in a better position to provide all of the details required for a registration reviewer to make an intelligent decision than the researcher himself. Let's all work together and provide this information to speed up obtaining better crop protecting systems for more efficient agriculture.

THE PRECISION SPRAYER - HOW TO BUILD IT

Orrie Baysinger and Gary A. Lee[1]

Proper application of a pesticide is an important procedure in controlling pests. Equipment must be designed to uniformly and accurately distribute the chemical over the desired area for several reasons. Over-application of a pesticide will result in increased expenditures for chemicals, possible crop damage, increased hazard of excessive pesticide residue in the crop, and possible pesticide resideu carryover in the soil which may damage a susceptible crop in the subsequent rotation. Under-application of a pesticide results in ineffective control of the target pest and additional costs of re-application or excessive loss induced by the pest. Perhaps the most important aspect of uniformly applying a pesticide is to assure that the pesticide residues do not exceed the legal tolerance set by the Environmental Protection Agency (EPA).

There are many situations where a small sprayer can effectively apply herbicides, insecticides, or fungicides. Homeowners, fieldmen, extension agents, researchers, county weed supervisors, and growers can easily convert existing sprayers with minimal expense and effort so that a uniform application can be made without over- or under-application of the pesticide.

After the proper assemblies have been made, be sure to calibrate the unit and keep all parts in good working order. Nozzle tips should be replaced periodically so that excessive wear does not increase rate of application. Be sure to clean the spray unit after each use with water and small amounts of cleaning ammonia.

The purpose of this bulletin is to illustrate the procedures necessary to convert a conventional sprayer into a unit which will accurately apply pesticides to a small area.

Spray Tank Conversion. Applying agricultural chemicals requires special equipment that is dependable and accurate. Anything less can cost time, money, and cause personal injury. It is, therefore, recommended that you select a sturdy three-gallon, stainless steel tank with a self-sealing, quick release lid for convenience in cleaning and handling. Most tanks do not come equipped for percision spraying, so some modifications are necessary.

Adding an adequate source of propellent for the tank may be a problem. Several systems are available for your consideration.

1. Air bombs such as you get at a filling station do not have enough capacity and are inadequate.
2. Spark plug attachment pumps are slow, inconvenient, and undependable.
3. An engine driven air compressor run by gasoline or other fuels are nice, but do constitute a fir hazzard, they are moisy and they require constant repair.
4. Vehicle engine pumps are dependable, but restrict you to the area of that particular vehicle and also require maintenance.
5. A rechargeable CO_2 cylinder is highly dependable, low cost, portable, safe, and convenient. They do require that you take them to a dealer to have them refilled.

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[1]Extension Associate and Professor of Weed Science, Department of Plant and Soil Sciences, University of Idaho, Moscow, ID 83843.

6. Stay away from combustible gasses such as oxygen, propane, or acetylene as they are extremely dangerous.

Maintenance and Care

1. Most sprayer malfunctions are due to clogged nozzles, so clean water is absolutely essentail at all times.
2. Clean all screens and nozzles thoroughly and flush the tank before using the sprayer. Never use metal objects to clean the nozzles as they can completely change the spray pattern and capacity of the tips.
3. Keep all screens in place unless using wettable powders which will clog the screens.
4. Clean sprayer thoroughly inside and out after each use to prevent corrosion and accumulation of chemicals. Under no circumstances should chemicals be left in the tank for a long period of time, such as overnight.
5. When changing chemicals or at the completion of a spraying operation, clean the sprayer thoroughly both inside and out. A 10 percent solution of household cleaning ammonia will satisfactorily remove chemical residue. Recharge the sprayer and vent the ammonia solution through the boom system. Thoroughly rinse the entire can and boom with clean water to eliminate the ammonia solution. Some chemicals are particularly persistent in the sprayer, and must be removed completely to prevent possible injury in other spraying operations. For proper cleaning at the end of the season, the following procedure is recommended:
   (a) Remove and clean all screens and tips in an ammonia solution using a soft brush. This solution should also be circulated through the spray tank and flushed out through the boom.
   (b) Replace the screens and nozzle tips.
   (c) To one gallon of water add 3 teaspoons of household ammonia. Place this mixture in the spray tank, and circulate it through the system and out through the tip for a short period of time. Allow 3/4 of the solution to remain in the tank overnight and then run it out through the nozzles the following morning.
   (d) Flush the system with a tank full of clean water.
6. A small amount of kerosene placed in the tank and run through the system coating all parts will help protect the tank from possible rust development and damage during storage. The tank should then be stored upside down in a clean dry location with the lid removed to prevent accumulation of moisture.
7. Be sure that all chemicals and cleaning water are disposed of according to EPA specifications. Contact your local extension agent or EPA representative for information.

Safety.

1. Read and follow all label instructions.
2. Knowand follow all pesticide safety precautions.
3. Once a spray can has contained herbicides, there can be no quarantee that a cleaning operation has removed all of the chemical. It is, therefore, recommended that you do not use a herbicide sprayer for the control of insects.
4. Store your spray can as well as supplies and labeled chemicals in a safe place so that they will not be used for purposes for which they are not intended.

5. Exercise all reasonable care in the use and maintenance of this spraying equipment.
6. It is advisable to occasionally check the tank for airtight integrity by using a paint brush and brushing soapsuds over the connections while the sprayer is under normal working pressure.
7. Do not exceed the tank's maximum working pressure as stated by the manufacturer on the spray can label. Normal operation should not require exceeding 80 pounds per square inch (psi) pressure in the tank, with 40 psi working pressure at the spray nozzles.
8. This spray can modification complies with the rules for pressure vessels published by the Idaho Industrial Commission as per Section Five (5) Paragraph Five-A (5A) of the 1976 Boiler Safety Code.

Details for building and assembling a precision sprayer can be obtained by writing to: The Agriculture Information Department, College of Agriculture, University of Idaho, Moscow 83843 and requesting a copy of the Current Information Series No. 419, The Precision Sprayer: How To Built It.

ORGANIZATION AND PROGRAM DEVELOPMENT--THE KEY TO NOXIOUS WEED CONTROL

DeVere Tovey[1]

I have been County Agent in Franklin County since 1959 with one of my responsibilities being education, organization and encouragement in weed control. In 1976 at the encouragement of the State Weed Coordinator, State Department of Agriculture, and in an effort to meet their responsibility to the Idaho Weed Law, the County Commissioners appointed a County Weed Supervisor to expand the weed program and to represent them in a regulatory capacity if necessary.

Weeds are prolific, persistent plants that seriously compete with man for the use of our environment. Weeds, in my judgment, are our No. 1 resource problem and getting worse by the minute. Weeds are not specific or peculiar to any commodity or organization but are a primary problem of each. I would like to discuss a few serious noxious weeds of Idaho and Utah and our approach to control.

Dyer's woad (*Isatis tinctoria*), an annual, biennial or short-lived perennial, is quite generally spread through Northern Utah, Southern Idaho and Western Wyoming. A single plant starts from seed spread by a grain truck, livestock, equipment, wind or people. We have had a campaign in Franklin County to destroy every single plant we could find. A single plant is a parch next year. It jumps the fence, spreads across the fields, over the foothills to the top of the mountain range and down the other side. It matures with dark brown to black seeds. Unless sprayed early it develops viable seed. When pulled, cut, pastured or sprayed it sends out new shoots from the crown or leaf axles, recovers and matures seed. Franklin County

[1]Extension Agricultural Agent, Preston, ID 83263

through the efforts of the County Agent, Weed Supervisor, Weed Committee and an alert public has a near total effort but we still find a few scattered plants and new range infestation.

Rush skeleton weed (*Chondrilla juncea*), a range and crop weed from Australia, is a serious threat to Idaho. From a meager 10 acres at Banks, Idaho, in 1969 it is reported in 1977 to cover 3,000,000 acres in a 10,000 square mile area. It is starting to appear on crop land. The Idaho Wheat Commission is funding research for control and containment with chemicals and biological control.

Musk thistle (*Cardus nutans*) started in our area in Bannock County on the McCammon Freeway intersection. The State Highway Department is now making a good effort, but five years of delay let it spread to adjoining pastures, ditches, fence lines through several counties from this single source. Musk and many other weeds hold out the fishermen and make hunting miserable.

Scotch thistle (*Onopordum acanthium*) is competitive, dense and sometimes grows seven to eight feet tall. It is not penetrated by man or by livestock.

Puncture vine (*Tribulus terrestris*), spread by tires, wipes out the bicyclist.

Yellow star thistle (*Centaurea solstitialis*) is getting intensive treatment by the Bureau of Land Management in the Lewiston-Hell's Canyon area of Idaho. A meager start is getting eradication treatment through Cache and Box Elder Counties in Utah by the Bear River Resource, Conservation and Development (RC & D) Weed Committee.

Buffalo-bur (*Solanum rostratum*), introduced to Oneida County, is in the process of being eradicated by the County Weed Supervisor and County Weed Committee, with cost-share money through the State Weed Coordinator.

Halogeton (*Halogeton glomeratus*) becomes a real shocker when it kills 1200 head of sheep in one winter herd at one time. Intensive coordinated effort probably could ahve eradicated this weed in the early 1930's or late 1920's. Now we have to live with it.

False helebore (*Veratrum californicum*), eaten in gestation, causes monkey-faced lambs and other deformities in livestock and game. Might poison plants or seeds of poison plants in crops also cause deformed babies?

Goats rue (*Galega officinalis*), another useless, toxic plant, was introduced before the turn of the century. It escaped and spread quite rapidly in recent years. As a result of concern of Idaho's Region V Weed Committee and Idaho weed personnel, and through the influence of Bear River RC & D, Cache County and Utah State University have initiated a joint eradication program.

Fields may be lost to noxious weeds and not harvested for several years. At the request of neighbors Clair Hull, Weed Supervisor, and Robert Hull, County Commissioner, inspected the field and implemented the Idaho Weed Law. The owner and the manager recognized the problem, realized they were losing the farm to weeds, understood the concern of neighbors, appreciated the recommendations and help of the weed program and extended the County Agent and Weed Supervisor special hunting privileges on the ranch.

Excellent leafy spurge (*Euphorbia esula*) control can be obtained with picloram (4-amino-3,5,6-trichloropicolinic acid). Weeds can be controlled. It is not easy or cheap, but they must be controlled.

Weeds cause unbelievable loss and impact. Weeds are self-perpetuating and like a cancer engulf and destroy our resources.

Weed scientists three years ago estimated crop weeds cost Idaho $250,000,000 each year. A federal poison plant and range weed authority estimated that poison plants and noxious weeds on range lands would cost Idaho an equal amount. When you add roads, railroads, irrigation systems, industry, human health and other weed costs to this the impact is tremendous. Compare weed costs and losses to the Teton Flood, considered Idaho's greatest diaster with a damage replacement of $400,000,000 or the drought of 1977 which reportedly cost Idaho $65,000,000, we get the weed problem in proper perspective.

In 200 years as a nation it is obvious we have not succeeded in weed control.

Every weed survey I have seen shows more weeds than the previous one. I don't know of a single noxious weed that has been eradicated or become extinct. Dean Doyle Matthews of Utah State University stated in a Utah meeting, "We have done many miraculous things in this country. We have put man on the moon, but we have not yet come to grips with the weed problem."

Even 50% success is still 50% failure. In weed control anything less than 100% success may end up as failure.

Just as they need a pad to launch a missile, we need organization, program and support groups to turn the noxious weed problem around. I don't believe a county weed department can handle all of the varied and extensive weed problems on a county level without a committee or organized support group of some kind. I don't believe the Weed Society can succeed in securing the budget and program at State and National levels without support groups and political leadership.

Weed control has not been a glamorous function and weed control is negative in that with success you have nothing to show. Weed control does not have the leade-ship and support that it deserves and needs at county, state or congressional levels.

It is more satisfying, more productive and rewarding to be a part of a program that is succeeding. The Weed Society and each individual member should do what it can to promote general weed control, to point out the impact of weeds and to expound on the benefit of weed control to our resources and to society. We need to do everything we can to develop lay leadership and political leadership. Weed Society should do what it can to help organize, train and support committees and support groups at all levels of government.

We need to challenge EPA on registration and unreasonable regulations that inhibit weed control. We need to incorporate weed control in Senator Church's proposed Conservation Bill. We need to sell National ASCS on ACP cost-share for noxious weeds. We need employment programs directed to weed control and natural resources. We need full cooperation of all public and private land agencies.

We need effective weed laws and enough support and budget to give weed regulatory personnel the means and courage to implement weed laws where necessary. (An individual making an honest effort should not be the victim of a neighbor or a society not meeting responsibility.)

To do these things and others we need well planned and well coordinated programs over large enough areas to be effective. We need some sort of organization or group support to help county weed programs and weed societies bring these things into being.

I don't know of any formula or specific pattern that is best. I don't know the structure of Wyoming State Weed Committee but they are to be commended for going to Washington D.C; and implementing the Carlson Act for weed control on public lands.

In Southwestern Idaho we started with a tour by three county agents and the weed specialist evaluating a serious dyers woad problem and threat. An educational leaflet was prepared. A 7-County public tour was held. Region V Weed Committee was formed. A coordinated 7-County Program was developed. The Governor, Legislature & Commissioner of Agriculture were approached for budget, appointment of a weed coordinator for Region V and State registrations and for general support.

The weed coordinator committed to get weed supervisors in each county and get cooperation and program from all Federal, State and private agencies. In cooperation with Mr. Marion Olsen, Cache County Commissioner and R C & D Chairman, Bear River R C & D Weed Committee was organized. A 3-State meeting (Idaho, Utah and Wyoming) on Dyers Woad was held at Preston to solicit all out effort of each. Dyers Woad control research was being conducted by Utah State University and screening trials and demonstrations were established by Idaho weed personnel.

Franklin County reorganized its weed committee with appointment of a weed supervisor. The weed committee representing all communities works cooperatively with the County Agent & Weed Supervisor on educational and regulatory activities. Robert Hull, representing the County Commissioners is Chairman of the executive weed board.

Cost-share grants were received from the Pacific Northwest Commission. The Idaho Legislature is now providing cost-share money for invading weeds. Region V prepared a slide presentation soliciting weed control support for over twenty State conventions in Idaho and Utah. Fair exhibits have been developed.

Weed control campaigns and many other activities have been conducted by Region V and Bear River R C & D weed committees. Some counties are represented in both committees but this helps toward coordination of larger areas and provides multi-state cooperation.

It appears there is still little or no weed control leadership surfacing in State Legislatures, the National Congress or other key people in responsible positions. Weed control still needs a champion. The potential for increased program and support is unlimited.

SYMPOSIUM: TECHNIQUES TO MANIPULATE HERBICIDAL ACTIVITY

CONTROLLED RELEASE HERBICIDES---THEORY AND PRACTICE

R. W. Baker and H. K. Lonsdale[1]

Introduction

The concept of sustained release of beneficial agents has been in existence for many years. Only within the past decade, however, has the utility of the concept been widely appreciated. For example, a wide variety of controlled release medications are now entering the market place in the pharmaceutical industry. Progress has been slower in the agricultural chemical industry, largely because the principal criterion for introduction of new products in this industry is cost effectiveness, and the evolving controlled release products have not been clearly superior economically. The realization is growing, however, that while the first cost of a controlled release formulation is higher than that of the raw chemical, the added cost can be more than repaid through the need for lower dosages and fewer applications. In addition, controlled release formulations generally exhibit greatly reduced mammalian toxicity so that farm workers applying these chemicals are exposed to much lower risk. Finally, it is now recognized that labile pesticides that were once considered of limited utility because of their rapid degradation can be quite suitable in controlled release formulations.

Several methods can be used to achieve controlled release of herbicides or other pesticides. These include chemical derivatization, the use of slowly eroding matrices, or the use of encapsulation within an inert polymer from which the agent escapes by diffusion. It is this last method that we will address principally in this paper because of the relatively advanced state of the technology. Other methods are the subject of current research programs in several laboratories, but there appear to be no commercial products embodying these advanced concepts.

The Controlled Release Rationale: Some of the benefits of controlled delivery can be appreciated by examining Figure 1. It illustrates the concentration of an active agent in a local environment as a function of time after delivery in a conventional manner. Typically, shortly after the agent is applied, the concentration rises rapidly to a maximum and then falls as the agent is metabolized or otherwise degraded. On Figure 1 are shown two important concentration levels: the effective concentration, which is the minimum concentration necessary to produce the desired effect, and the toxic concentration above which undesirable "side effects" occur. For example, below some threshold concentration, an herbicide will not properly control weeds. Above some "toxic" concentration, non-target crops and even the human applicator or other mammals can be endangered. It is important, therefore, to maintain the concentration of the active agent between the effective and toxic levels. This is inherently difficult with

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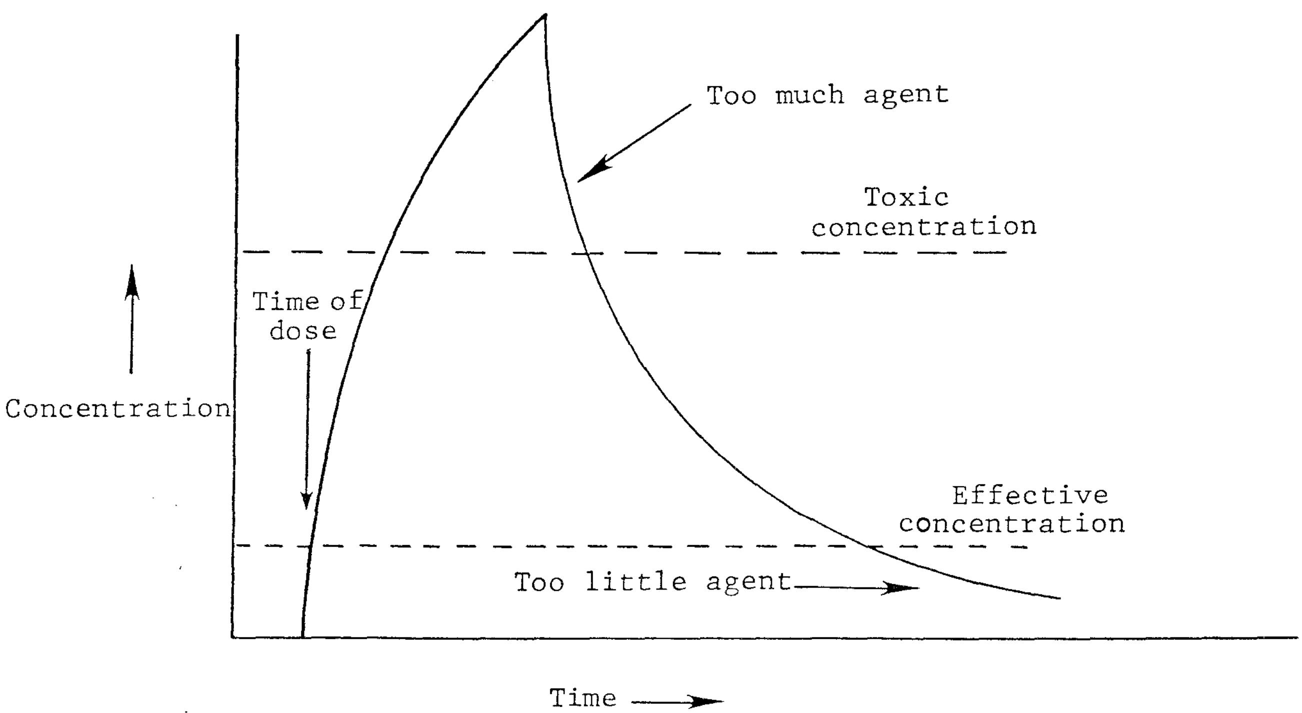


Figure 1. Typical time course of local concentration of agent achieved with a conventional formulation, showing potential for over- and underdosing.

conventional formulations and delivery systems that tend first to overdose and then underdose the local environment. In addition, in weed control, it is generally desired to maintain an effective level of the herbicide for a prolonged period. The farmer not only wants to kill the weeds presently in his field but he wants to protect his crop from reinfestation throughout the growing season. To do so with conventional delivery systems, it is necessary to repeatedly reapply the herbicide as the effects of earlier applications diminish. However, frequent re-application leads to buildup of the herbicide to the point that the toxic level may be exceeded. If the applications are spaced too widely, there will be periods when insufficient herbicide is present and the infestation can reoccur. As shown in Figure 2, effective concentrations can be maintained for prolonged periods with controlled release formulations that meter out the herbicide at the same rate it is consumed.

Controlled Release Mechanisms:

A. Diffusion: Diffusion-controlled devices can be divided into two main categories: depot (or reservoir) systems, in which the agent is totally encapsulated within a rate-controlling membrane; and monolithic systems in which the agent is homogeneously dispersed or dissolved throughout a rate-controlling matrix. The two systems are shown schematically in Figures 3 and 4.

With depot systems, the release rate can be maintained constant as long as a source at constant thermodynamic activity is maintained within the device. Normally, therefore, depot systems are the more efficient. In addition, unless the device is very small, the herbicide can represent as much as 90% of the volume of the device, thus reducing transportation and application costs. On the debit side, encapsulation in a depot system is usually more expensive than making monolithic systems. This is a result of the release rate being critically dependent on the thickness, area, and permeability of the membrane barrier, so that these parameters must be carefully controlled. With monolithic systems, the release pattern depends on the geometry of the system, the polymer or other matrix material, and the loading of the herbicide. In general, it is easier to manipulate release rates from this type of device than from depot systems. Finally, thin spots or pinholes that can lead to catastrophic failure of a depot system do not substantially alter the release rate from a monolithic device. This reduced requirement for quality control together with the ease with which dispersions can be made (by milling or extruding, for example) make for much lower fabrication costs. This cost advantage can outweigh the frequently less desirable declining release rates from monolithic systems.

In designing depot devices that deliver at a constant rate over a prolonged period of time, it is essential to maintain the thermodynamic activity or driving force of the herbicide within the device at some fixed value. The most convenient fixed point is unit activity, achievable by means of either a saturated solution with excess solid phase present, or a pure liquid or solid phase. Unit activity, and therefore constant release, can then be maintained. The length of time a device can maintain constant release rate is thus limited only by the size of the reservoir.

Devices in which the herbicide is dispersed or dissolved in a matrix are simple to prepare but do not have the constant release (or "zero order") kinetics of depot systems. The herbicide is removed from the surface layers first and the distance the herbicide must diffuse to the surface increases with time. The kinetics of release can follow one of two patterns.

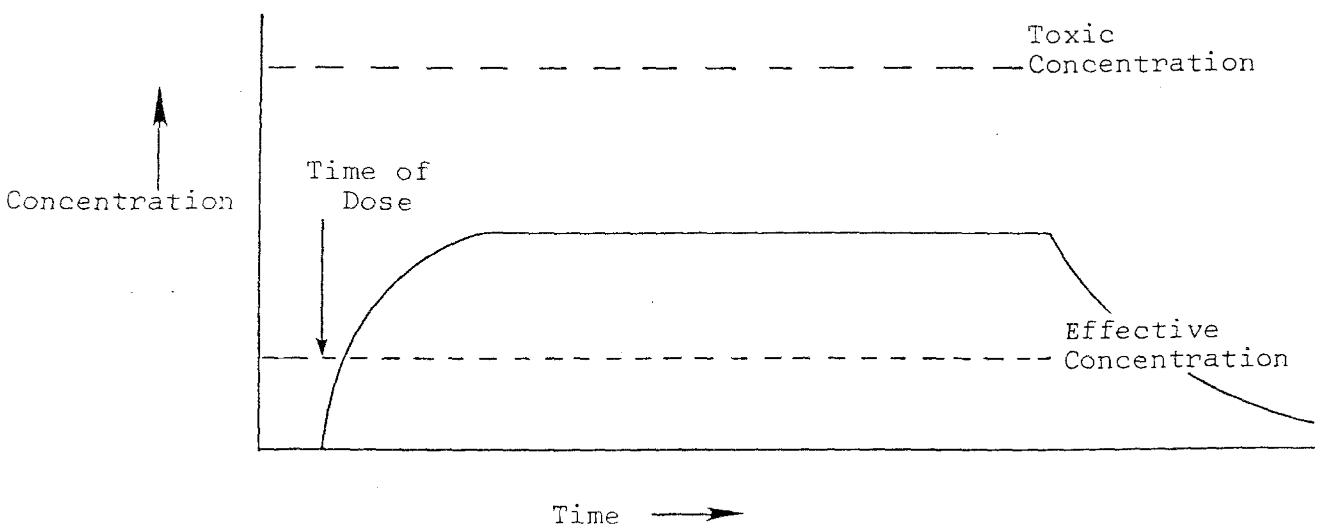


Figure 2. Typical time course of local concentration of agent achieved with a controlled release formulation showing essentially constant concentration levels.

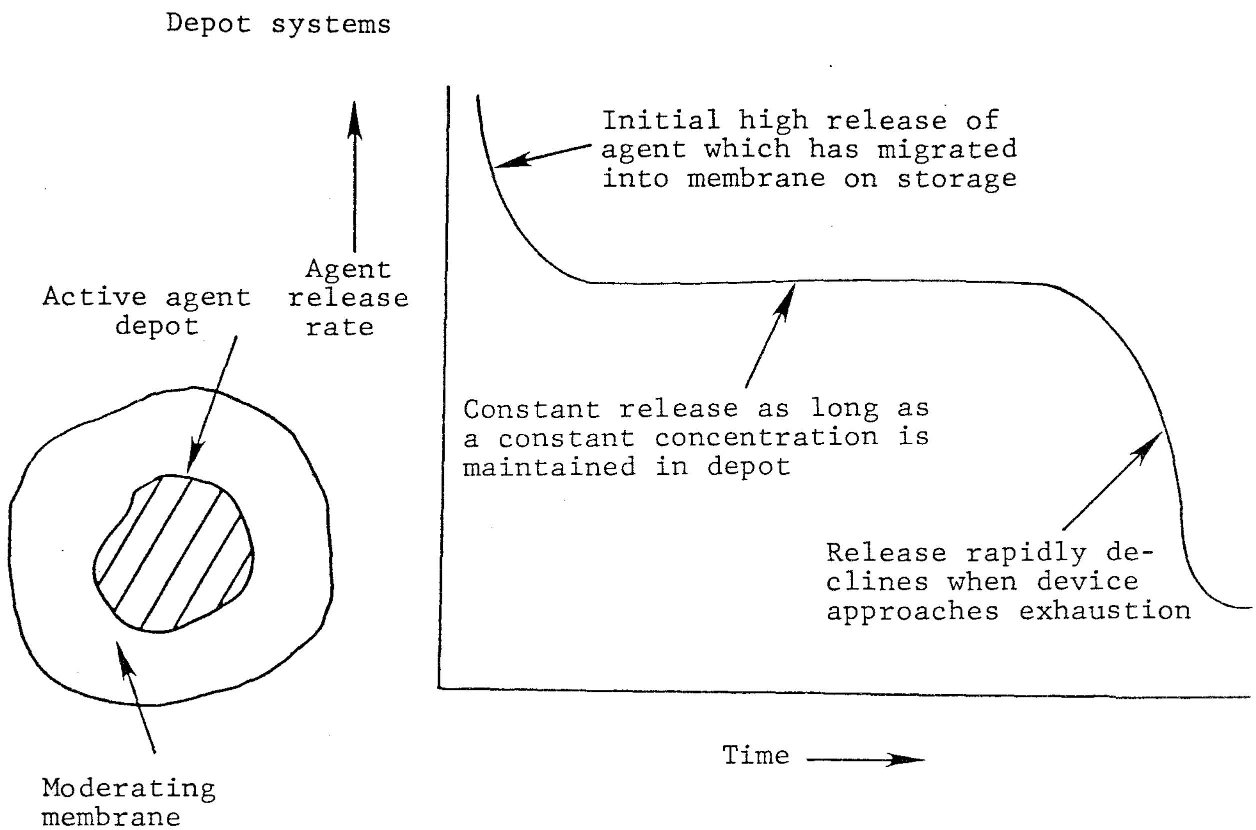


Figure 3. Design of depot system, showing typical release patterns.

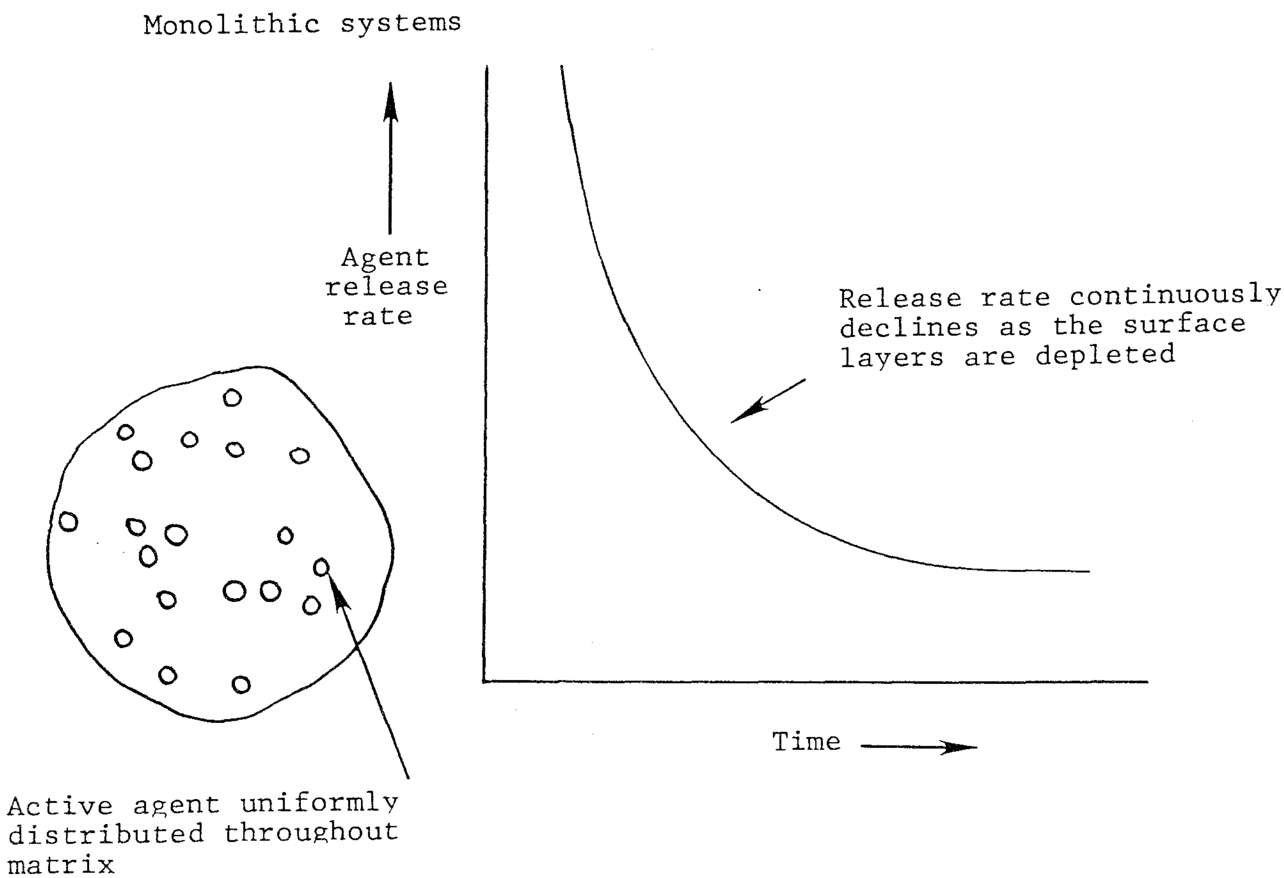


Figure 4. Design of monolithic system, showing typical release patterns.

One is obtained when the herbicide is molecularly dissolved in the matrix. Different behavior obtains if the solubility of the herbicide in the matrix has been exceeded and excess herbicide is dispersed as discrete particles. In both cases for most of the device's life, release rate essentially falls off proportional to $1/\sqrt{time}$.

B. Erosion: The delivery devices outlined above are permanent, in the sense that the membrane or shell of the device remains in the field after its delivery role is completed. Systems that degrade, either by biodegradation or other mechanisms, are also possible and offer certain obvious advantages.

Three principal classes of polymers can be used for erodible devices: (1) water-soluble polymers insolubilized via hydrolytically unstable cross-links; (2) water-insoluble polymers that become soluble via hydrolysis reactions but retain their backbone integrity; (3) and water-insoluble polymers that become soluble via back-bone cleavage reactions (Figure 5). With these polymers it is, in principle, possible to program the release of an herbicide by dispersing it through the polymer matrix, causing the herbicide to be released as the matrix erodes. With a cylindrical or spherical device, the area of the device decreases as it erodes. However, constant release rate could be achieved by using a higher concentration of herbicide in the interior of the device than in the surface layers. Alternatively, controlled release systems could be devised in which the herbicide is released from the intact device via diffusion, as just discussed, following which the device erodes. Such a system has the advantage that the delivery mechanism is separated from the erosion mechanism.

In practice, controlled erosion of either kind has proved difficult to achieve, but progress is being made with several erodible polymeric delivery systems. These include systems based on polylactic and polyglycolic acids which erode by backbone cleavage, and related systems that erode by hydrolysis of pendant groups. However, no erodible controlled release herbicide system, to our knowledge, is now approaching the market place.

C. Poly-Herbicides: A third approach that may be particularly attractive is to prepare a polymeric form of the herbicide. The concept is illustrated in Figure 6. Several methods can be used. For example, herbicide A can be reacted with polymer -S-S-S- to form the pendant herbicide -S-S-S- (each S bearing a pendant A). Specifically, an herbicide such as 2,4-D containing an acid moeity could be reacted with a poly alcohol. In the combined state, the poly-herbicide would have minimal biological effect. However, as the ester linkages degrade, the free herbicide is released. Several other approaches to preparing polymerized herbicides are illustrated in Figure 6.

Potential Problem Areas: Two potential problems should be cited, in closing. The first concerns the cost of controlled release herbicides. The customer for these products, i.e. the farmer, is understandably cost sensitive. For him,the increased cost of controlled release herbicides must be more than offset by savings in application costs and improvement in efficacy. These factors should be carefully considered before an expensive development program is undertaken.

A second problem area that is frequently overlooked concerns toxicity. With conventional formulations, typically only acute toxicity is of concern, i.e. the effect of relatively high doses over a short time span. With controlled release herbicides, we are concerned instead with chronic toxicity, i.e. the effect of relatively low dosages over a prolonged time span. These effects are essentially unexplored.

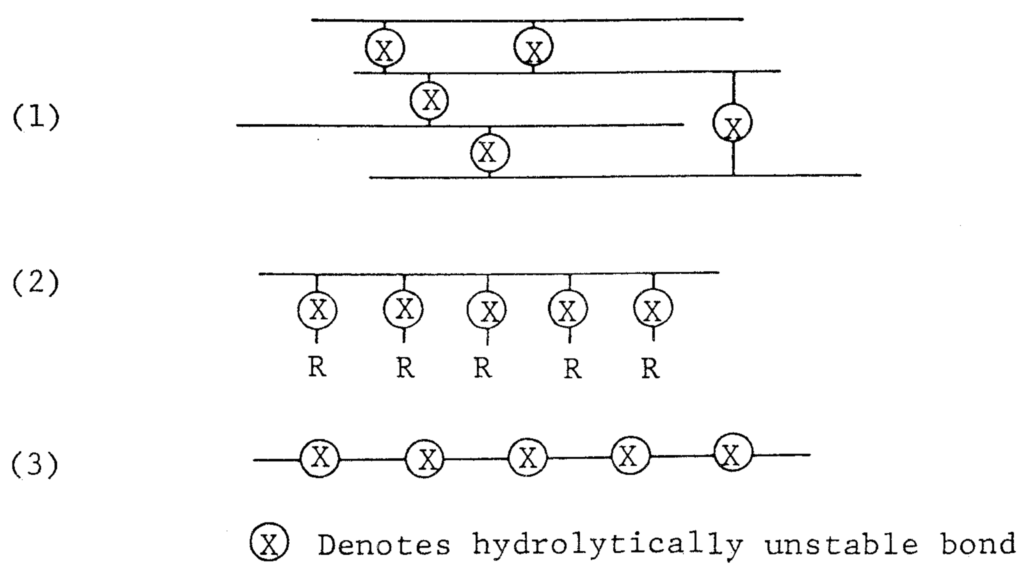


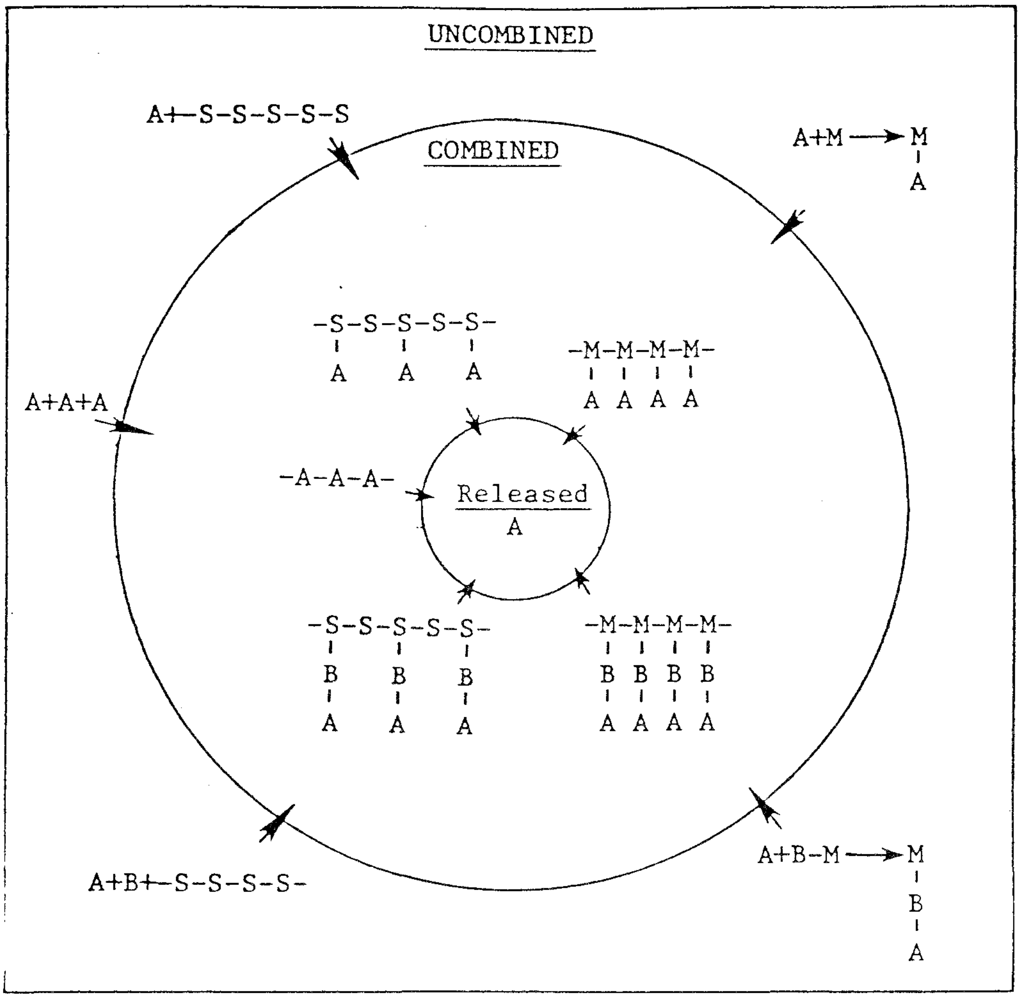
Figure 5. Types of erodible polymer matrices.

A denotes the herbicide

M denotes vinyl-containing monomer

B denotes linking group

-S-S-S-S- denotes substrate polymer



After A.N. Neogi and G.G. Allan in Controlled Release of Biologically Active Agents, A.C. Tanquary and R.E. Lacey (Eds) Plenum Press (1974).

Figure 6. Routes to synthesis of controlled release poly-herbicides.

MICROBIAL INHIBITORS

Joseph Deli[1]

Most of us are familiar with the ways that a herbicide dissipates from the soil. Dissipation mechanism could be through volatility, chemical degradation, leaching, photodegradation, or perhaps through microbial degradation. Any one of these factors can influence the soil life of a herbicide. I want to concentrate my discussion on the microbial degradation of the soil applied herbicide. Although degradation is a desirable process, it is not desirable when degradation occurs prematurely, before the desired herbicidal action has been completed. Therefore, certain herbicides, which are highly affected by soil microorganisms, lose their efficacy very quickly; their commercial use is limited. On the other hand, some herbicides which are highly persistent could benefit from enhanced degradation.

Newman and Downing (2) mentioned several herbicides, which lost herbicidal activities soon after applied to the soil, and they have studied the factors causing loss of herbicidal activities. They concluded that in many instances microbial degradation was involved. For several years attempts were made to limit the microbial degradation of herbicides, general poisons like pentachlorophenol or various kinds of azides were applied concurrently with the soil applied herbicide. In this way the herbicidal activity could be extended.

We have come a long way from the earlier attempts of extending the soil life of herbicides; we learned a lot. Let me discuss the kind of requirements we have to have for a microbial inhibitor that we could use to extend soil life of a herbicide. First of all, we have to have an efficacious compound. The compound has to inhibit soil microbial degradation of the herbicide. Also, if we want a good inhibitor, it must not be phytotoxic. We do not want to alter the selectivity of the herbicide which we intend to protect. Furthermore, the inhibitor should affect the target organism only; that is, hopefully only affect those organisms which are involved in the degradation of the herbicide. A general biocide is not acceptable for several reasons. One reason is that it's ecologically not desirable. The other reason is, if a sterilant eliminates the soil microflora, we can cause problems. For example, from the lack of benefits of nitrification bacteria, crop plants perhaps could suffer. We could open the door for some diseases to establish themselves in the cropland. The inhibitor should have limited persistence in the soil. We would like to have it there while we want the herbicide to be protected and dissipate afterwards as soon as we don't need it any more. Also, the inhibitor has to remain active once it is applied to the soil. Many compounds could be active in a test tube but not in soils. They may leach differently than the herbicide and the herbicide and inhibitor separate, thus the inhibitor loses its efficacy. Also, the inhibitor has to be an economical compound that can be added to the herbicide without a considerable cost. Moreover, the inhibitor and the herbicide you want to protect have to be compatible. Formulation or compatibility problems can cause difficulties.

Let's assume there is a herbicide which has an alkyl group, and this alkyl group is related to herbicidal activity. Of course, once the alkyl group is removed, the activity is decreased or lost. This is one of the major routes by which soil microbials deactivate herbicides. Now what we

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intend to do is to prevent this dealkylation. We do not want to block it completely but we want to delay the dealkylation process. Basically, we want to have the herbicide around but only for a limited time. Let's have an example. Let us look at a phenyl carbamilate. These compounds are deactivated in soil through dealkylation. Products which tend to slow down this dealkylation are the N-alkyl carbamates.

Kearney and Kaufman (1) have been working with these phenyl carbamates and N-alkyl carbamates for several years and they have found that the N-alkyl carbamates slow down the rate of microbial breakdown of the N-phenyl carbamates. Many N-alkyl carbamates are usually insecticides and have limited herbicidal activities. The N-phenyl ones tend to be herbicides. They isolate from soil microbes the enzymes which were responsible for the breakdown of these N-phenyl carbamates. Also, they have done some work with the inhibitors and looked at the effect of N-alkyl carbamates on the microbials and the enzymes. Consequently, they looked at combinations of the two types of carbamates.

They added herbicide (substrate) to a microbial culture, and observed induction of an enzyme. The induction of enzymes appear after a two-day delay period after the first application. The second application of herbicide to the same culture did not show delay time until the enzyme induction. This induced enzyme decreased herbicidal activity. Now when they took the inhibitor, N-alkyl carbamate added to a similar culture it also acted as a substrate and induced the enzyme of production and this enzyme slowly degraded the substrate, the inhibitor. When the inhibitor and the herbicidal substrate mixture was added to the culture, there was an induction of enzymes and a slow degradation of both substrates.

Enzyme showed great affinity for the N-alkyl substrate. As you see we are getting to fulfill some of the requirements which were described earlier. It is apparent that N-alkyl carbamates were efficacious in protecting N-phenyl carbamate herbicide. The N-alkyl carbamates were not phytotoxic. They did not kill the target organisms, just so to say curb the microbes appetite for the herbicide since the target organisms could eventually degrade both inhibitor and herbicide. Thus, their presence and persistence were limited in soil. Fortuitously, some of these N-alkyl carbamates leach in soil approximately the same as the N-phenyl carbamates. They are not very expensive and often very compatible in mixtures of N-phenyl carbamates.

As you see one could utilize these inhibitors economically. When as N-phenyl carbamate is mixed with an N-alkyl carbamate, the N-phenyl carbamate herbicide will persist longer and the herbicidal activity will be prolonged but it will not be increased. When you add an X amount of herbicide, and if that X amount is necessary to control the weeds, by using inhibitors you can't cut the X rate and expect control; you cannot by the addition of inhibitor increase that inate herbicidal activity. With or without inhibitors, 3 lbs of herbicides will only do what 3 lbs should be doing. Although if you apply 3 lbs and there is a weed that will be controlled at 1 lb., that 1 lb rate or dose will be around for a much longer time when an inhibitor is present than when the herbicide is alone. This is the tremendous benefit especially when you intend to control a weed which germinates over a long period of time and is sensitive to the given herbicide.

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CHEMICAL SAFENERS FOR HERBICIDES TO INCREASE CROP TOLERANCE

C. L.Prochnow[1]

The idea of safening herbicides so there is greater crop tolerance to a material is not new. For years, manufacturers of pesticides have tried various approaches to improve crop selectivity without reducing the ability of the pesticide to control the target pest or pests.

One of the major break-throughs in this area was made by Stauffer Chemical Company with the compound R-25788 (*N*,*N*-diallyl-2,2-dichloroacetamide). This material, when combined with bulylate (*s*-ethyl diisobutylthiocarbamate), EPTC (*s*-ethyl dipropylthiocarbamate) or vernolate (*s*-propyl dipropylthiocarbamate), gave acceptable corn tolerance to rates of these three thiocarbamate herbicides, that when used alone under certain conditions, gave unacceptable corn injury.

A very unique feature of this material is the protection to one group of monocotyledonous plants, and not to another. Little effect has been noted in the degree of grass and broadleaf control by any of the thiocarbamates with the addition of R-25788.

The protectant is included in the formulation of Sutan^{R}+, Eradicane^{R}, and Vernam^{R}+ to give the proper ratio of protectant to herbicides under normal use patterns. Eradicane can be used for <u>any</u> annual grass control which is labeled at a 4 lb ai/Acre rate, or used to control perennial grass such as quackgrass at 6 lb ai/Acre and still afford maximum protection to the corn without changing the amount of safener needed.

The safener, if used as a tank mix or a pre-package combination mix, should have several features in common with the herbicide:

1) It should not be considerably more water soluble than the herbicide, so as to be leached from the zone of protection by heavy rainfall or heavy irrigation.
2) It should persist long enough to remain in the protection zone, as long as the crop is sensitive to the herbicide.
3) It should not interfere or reduce the effectiveness of the herbicide, thereby forcing higher than economic rates to control the target weeds.

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[1]Supervisor, Domestic Research & Development, Stauffer Chamical Company, Vancouver, WA.

4) It should be compatible with other herbicides or insecticides that may be added to the spray tank, or applied in the soil control zone at the time the herbicide is present.

Chemical additives to pesticides that increase their crop safety provide greater utility and markets for companies and researchers in searching for economic pest control.

The use and search for current and new chemical protectants can add to greater utilization of some of the currently registered herbicides into new crop areas. A specific hard-to-control weed problem could be answered. The selection of a herbicide that is effective on the problem weed, plus a chemical protectant for the crop, could shorten the time for a new coded herbicide to answer the problem.

The development of materials such as Sutan[R]+, Eradicane[R], and Vernam[R]+, is only a start in this direction. The future undoubtedly will see the development of other safener-herbicide combinations to answer a growing need.

CARBON PROTECTANTS

W. Orvid Lee[1]

In experiments begun in Oregon in 1967, we investigated the use of activated carbon to protect new plantings of perennial ryegrass (*Lolium perenne* L.), tall fescue (*Festuca rubra* L.), orchardgrass (*Dactylis glomerata* L), Kentucky bluegrass (*Poa pratensis* L.), and Colonial bentgrass (*Agrostis tenuis* Sibth.) from herbicides applied preemergence. In these experiments, we mixed finely-ground activated carbon with water at 1/2 lb/gal. We applied the resultant slurry to the soil surface during planting in a one-inch band positioned over the seeded row. Activated carbon rates of 75, 150, and 300 lb/A were compared. (Where the crops were planted on 12-inch row spacings and a 1-inch band applied, only 1/12 of the field surface is treated. Thus, the above rates are equivalent to 6.3, 12.6, and 25 lb carbon/seeded acre.)

After planting, several different herbicides were applied as blanket applications at rates necessary for a high level of weed control. When carbon was applied at 75 lb/A, stands were usually too erratic to be considered satisfactory. When carbon was applied at 150 lb/A, excellent stands of all grass developed on plots treated with diuron [3-(3,4-dichlorophenyl)-1,-dimethylurea] at rates to 3.36 lb/A but stands were erratic on plots treated with other herbicides. When carbon was applied at 300 lb/A, the grasses were protected from all herbicides which in addition to diuron included atrazine [2-chloro-4-(ethylamino)-6-(isopropylamino)-*s*-triazine],simazine [chloro-4,6-bis(ethylamino)-*s*-triazine], bromacil (5-bromo-3-*sec*-butyl-6-methyluracil),terbacil (3-*tert*-butyl-5-chloro-6-methyluracil), and pronamide (3,5-dichloro(*N*-1,1-dimethyl-2-propynyl)benzamide].

Weed control between the rows was frequently complete. Some weeds often survived beneath the carbon bands but populations were usually reduced sufficiently so that it was feasible to remove the survivors with hand labor.

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The use of activated carbon bands to protect grass plantings from diuron applied preemergence was registered in Oregon in 1970. The registration specifies that the activated carbon should be applied at 300 lb/A (25 lb/seeded acre) in a 1-inch band and followed by diuron at 2.5 to 3.0 lb/A. The commercial use of carbon banding has increased each year and in 1977 it is estimated that 15,000 acres of grass were seeded using this technique.

Carbon banding has been most widely used to control weeds while establishing turf-type perennial ryegrass varieties for seed. This technique makes it possible to produce a full crop of high quality seed the first summer after a fall planting without the loss of year's crop production as occurs with other practices. Total cost of the practice is about $26/A (carbon $14, planter and carbon equipment rental $3, and herbicide and application $9). However, for this small investment, the grower can produce a crop with a potential value of $400 to $650/A. In addition, where weeds are controlled during establishment, weed control is much easier in later years. While the practice works equally well in other grass species, the financial incentive is not as great as in turf-type perennial ryegrass and thus the practice is not as widely used in other grass species.

This practice has also been evaluated on many different crop species with many different herbicides. It looks especially promising for use in situations where a crop shows some tolerance to a given herbicide but where the tolerance is not great enough on sandy or low organic matter soils to permit its safe use. Examples of this include Dr. Ogg's work in the Yakima Valley where he used carbon banding to protect direct seedings of asparagus from linuron, and Don Rydrych's work in the Columbia Basin where he has found carbon banding to be an effective way to protect wheat from metribuzin on low organic matter soils.

In this day and age, when it is extremely difficult and expensive to register new herbicides for use in minor crops, it may be much easier and less expensive to modify the activity of presently recommended herbicides by use of carbon banding, than to attempt to solve weed problems by finding new herbicides.

PLUG PLANTING: A TECHNIQUE TO IMPROVE HERBICIDE SELECTIVITY USING MARGINAL HERBICIDES

A. Lange, R. Goertzen, H. Carlson, H. Kempen, B. Mullen, J. Orr, W. Bendixen, H. Agamalian, F. Ashton, C. Elmore and K. Glenn[1]

The increased use of selective herbicides in row crops has resulted in the selection of herbicide tolerant weed species, often closely related to the crop. Several striking examples occur in California. The nightshades and ground cherries have become particularly troublesome in tomatoes. Composite weeds such as prickly lettuce, groundsel and sowthistle are becoming predominant in lettuce. The weedy crucifers, London rocket, shepherds purse, black mustard and wild radish, are prevalent in cole crops.

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[1]University of California, Parlier, Davis, Bakersfield, Stockton, Sacramento, Santa Maria, and Salinas Counties.

Chenopodium species are frequent in sugar beets; but because of the size and foresight of this industry, considerable research effort has resulted in effective cultural practices and herbicides. Such is not the case with the smaller acreage or 'minor' crops and the newly expanded industries such as processing tomatoes. The hope of finding new selective herbicides today is less because of increasing research costs and the lack of regulatory decisions. For these and other reasons, we have been studying less selective, broad spectrum herbicides that rapidly dissipate and those short residual herbicides which are marginally safe in direct seeded crops. With plug planting, we can protect the seed as it germinates and the seedling as it emerges by providing an envelope of protection, keeping as much herbicide away from the germinating seed as possible and allowing the young plant to establish itself before it contacts significant amounts of herbicide. The germinating weed seed, not having this protection, are killed.

The concept of establishing plants using plug planting is not new, as it was successfully used in Hawaiian papaya as early as 1956. For several years, plug planting has been used in Florida in order to assure a good stand of tomatoes under adverse conditions. Currently, plug planting is being used on a small scale for anti-crusting in California soils and to reduce thinning costs for processing tomatoes and several other vegetable crops.

The plug mix consists of vegetable seed mixed in a 1:1 peat and vermiculite mixture, such as have long been used commercially by the bedding plant and greenhouse industries. In our work, the plug mix appeared to provide the micro-environment necessary to protect germinating tomato seed from several herbicides. Addition of carbon at 5-10% by weight of plug has significantly increased the seedling vigor in greenhouse and field trials.

One field test in a Delhi loamy sand showed nightshade effective herbicides could be safened for germinating tomato seeds in plugs (Table 1). Also, the protection with carbon was greater for the germinating tomatoes in the plug than it was for a tomato transplant grown in a 1:1 peat-vermiculite mix with carbon rooting media. Because of the low organic matter and sandy nature of the soil, rates of pebulate, normally safe for tomatoes in other soils, were toxic in this light sandy soil. Other work has shown that chloramben moves readily downward under sprinkler irrigation in sandy soils. The results of this trial suggest that the carbon in the plug deactivated the herbicide as it moved into the plug with the water or the carbon in some other way improved the environment for the germinating tomato seed.

In Santa Barbara County, California, several herbicide combinations were screened for hairy nightshade control and herbicide safety in a direct vs. hand planted plug planting. Plug size was 150 ml. volume with no carbon added. High rates of chemicals were used to effectively control the severe weed population and determined the amount of safety afforded by the plug mix (Table 2). The tomato vigor in the plug planting was generally higher than the direct seeded tomatoes. Poor plug vigor in the check plot was a result of weed competition.

In some later trials in the San Joaquin Delta and in Monterey County, the plug mix simulated an air wick. Without continuous rewetting by sprinklers, the plug dried out faster than the soil around it. In order to meet this problem, this winter several hydrogels were examined for their water holding and retaining capacities under droughty conditions (Table 3).

Table 1. The effect of activated carbon on the response of direct seeded plug and transplanted tomatoes.

		Average Percent of Untreated[1]			
		Transplant	Plug		
Herbicide	lb/A	Carbon 20%	With Carbon	No Carbon	Direct Seeded
Pebulate	4	54.6	105.5	80.2	54.7
Pebulate	8	84.3	95.1	64.8	61.3
Pebulate	16	10.4	69.2	31.9	8.3
Chloramben	2	61.0	124.8	55.4	103.7
Chloramben	4	25.6	104.8	66.9	118.4
Chloramben	8	16.5	48.7	8.1	33.2
Alachlor	2	59.9	130.4	75.6	123.0
Alachlor	4	75.0	107.2	51.4	58.5
Alachlor	8	31.0	37.6	29.4	14.7
Check	-	100.0	100.0	100.0	100.0

[1]Average fresh weight of transplant cut just above 1st secondary leaf, weight of direct seed plug plants and weight of 2 ft. of row for non-plug planted, divided by the weight of the untreated.

Table 2. The effect of planting method on the activity of herbicide combinations for hairy nightshade control in tomatoes.

Herbicide	lb/A	Incorp. Method	Tomato Vigor Direct (Average[1])	Tomato Vigor Plug (Average[1])	No. of Plugs (Average[1])	Hairy N.S. W/C (Average[1])
Pebulate+Diphenamid	6+4	PPI	7.3	7.8	4.8	8.8
Pebulate+Diphenamid	12+4	PPI	4.0	8.0	5.3	9.3
Chloramben+Diphenamid	2+4	PRE	6.0	8.3	5.3	3.7
Chloramben+Diphenamid	4+4	PRE	4.3	5.3	2.8	8.8
Metribuzin+Pebulate+Diphenamid	1/2+3+4	PPI	3.8	6.8	4.0	9.5
Metribuzin+Pebulate+Diphenamid	1+3+4	PPI	2.7	8.0	4.8	8.3
Metribuzin+Chloramben	1/2+2	PPI	8.7	8.7	5.0	5.7
Pebulate+Diphenamid	6+4	PRE	8.3	8.0	5.0	8.7
Pebulate+Diphenamid	12+4	PRE	5.3	8.3	5.3	9.0
Check	-	-	0.0	0.8	1.5	0.0

[1]Average of 4 replications where 0 = no effect, 10 = complete weed control or most vigorous tomato. Evaluated 8/24/77.

Table 3. Effect of adding water retaining polymers to a plug mix on germinating tomato seedling numbers and fresh weight.

Hydrophilic Polymer	gms per plug	gms per ft^3 plug mix	Average[1] Number Seedlings per plug	Average[1] Wt. of plants per plug (gms)
General Mills	1	200	5.8	0.8
General Mills	2	400	4.8	1.2
General Mills	4	800	3.4	0.6
Union Carbide	1	200	5.4	1.6
Union Carbide	2	400	5.4	2.6
Union Carbide	4	800	0.6	0.3
Check	-	-	2.0	0.1

[1] Average of 5 replications. Planted September 14; harvested October 17, 1977. Ten Ace Royal seeds per plug.

[3] 5 oz. volume plug, average 16.9 grams.

When added to the plug mixes, hydrogels resulted in improved stand and vigor. Hydrogels are being field evaluated this spring. Under cool winter greenhouse conditions, some root rot or damping off occurred with the hydrogels, which may require the addition of fungicides to the plug mix. The addition of a starter fertilizer to the plug mix has added to the seedling vigor and needs further study. Also to be evaluated is the addition of sterilized field soil to the plug mix to reduce the cost of the artificial mix and possibly improve the plug media.

The results of plug planting have been encouraging and has lead into another approach for providing a safe environment called "fluid drilling". This technique was developed in England and Michigan. In our work, we have used the same hydrogels, previously mentioned for their water holding capacity, as the planting medium. Pregerminated or "chitted" tomato seed were uniformly mixed into the gel and then placed in a drill seeder for field trials which uses a squeeze pump apparatus (as is used with acid fertilizers) to extrude a small quantity of seed in the gelatinous fluid.

This winter, greenhouse studies have shown that the addition of activated carbon to the fluid has given excellent protection for germinating tomatoes in soil treated with some marginally safe herbicides such as chloramben, but less safety with others effective with the plug, such as alachlor (Table 4).

We plan to study these two techniques, using short residual, fairly immobile herbicides which show some selectivity to tomatoes, and of course, emphasizing those herbicides with favorable label registrations.

Table 4. Effect of Herbicides on Tomato Germination Using Fluid Drilling With and Without Carbon

Herbicide	Rate (lbs, a.i.)	Seeding Method[1]	Tomato Seedlings (number)	Tomato Vigor	Black Nightshade (control)
ethalflurafin PPI	1	fluid + carbon	2.5	8.0	3.3
ethalflurafin PPI	1	fluid - carbon	1.5	7.0	3.0
ethalflurafin PPI	1	direct seed	0.3	1.5	4.5
ethalflurafin PPI	2	fluid + carbon	3.5	5.3	4.8
ethalflurafin PPI	2	fluid - carbon	0.8	3.8	4.8
ethalflurafin PPI	2	direct seed	0.0	0.0	6.0
pebulate PPI	4	fluid + carbon	1.8	4.8	0.0
pebulate PPI	4	fluid - carbon	0.0	0.0	0.0
pebulate PPI	4	direct seed	4.0	6.5	1.0
pebulate PPI	8	fluid + carbon	1.8	6.8	1.3
pebulate PPI	8	fluid - carbon	1.5	6.5	4.3
pebulate PPI	8	direct seed	2.5	5.3	0.0
alachlor PPI	2	fluid + carbon	3.8	7.5	6.5
alachlor PPI	2	fluid - carbon	1.5	6.0	7.0
alachlor PPI	2	direct seed	3.5	6.0	4.3
alachlor PPI	4	fluid + carbon	0.8	2.8	8.8
alachlor PPI	4	fluid - carbon	0.5	1.5	9.0
alachlor PPI	4	direct seed	3.0	4.3	9.8
chloramben m.e.PRE	3	fluid + carbon	3.3	9.8	8.8
chloramben m.e.PRE	3	fluid - carbon	1.3	1.5	10.0
chloramben m.e.PRE	3	direct seed	1.5	2.3	10.0
chloramben m.e.PRE	6	fluid + carbon	3.8	8.5	9.5
chloramben m.e.PRE	6	fluid - carbon	0.0	0.0	10.0
chloramben m.e.PRE	6	direct seed	0.0	0.0	10.0
untreated	-	fluid + carbon	4.3	9.3	1.5
untreated	-	fluid - carbon	2.3	6.3	2.0
untreated	-	direct seed	4.3	8.0	0.0

[1]Fluid-Viterra 2 10 gm/300 ml; 10 ml/pot; seed: VF145-B7879; 5 seeds/ replication.

Average of 4 replications where 0 = no vigor or weed control; 10 = most vigorous or complete weed control. Planted and treated 1/31/78; evaluated 2/8/78.

Soil: sterilized Hanford fine sandy loam.

NEW METHODS OF APPLYING EPTC FOR WEED CONTROL IN ALFALFA[1]

J. H. Dawson[2]

ABSTRACT: New methods of application can sometimes open up new uses for old herbicides. EPTC (*s*-ethyl dipropylthiocarbamate) has been used for selective weed control in new seedings of alfalfa for nearly 20 years. It is usually sprayed on the soil surface and incorporated with the soil with a power-driven rotary tiller or by disking twice shortly before alfalfa is seeded. Recent research has demonstrated that alternate methods of application are effective and may offer certain advantages.

When EPTC at 2 or 3 kg/ha is applied in two subsurface lines 5 cm deep and 6 cm apart, the herbicide spreads to control weeds in a band about 12 cm wide. Alfalfa seeded midway between the two lines tolerates the herbicide. When injectors are coupled with planters, the herbicide is applied into the soil and the seed is sown in one convenient operation.

Research at Prosser, WA has shown that liquid or granular formulations of EPTC at 2 to 4 kg/ha applied in the rows in direct contact with the alfalfa seed controls several species of annual grass in a band 5 to 8 cm wide. Although the rate of herbicide in the immediate vicinity of the seed is increased about 17-fold by this method, the alfalfa is sufficiently tolerant that there is satisfactory selectivity.

When the EPTC is formulated as granules of the same size and density as alfalfa seed, the herbicide and seed can be blended and applied together via conventional seeders. The herbicide is thus applied without any separate operations and without any special equipment.

The most recent development involves application of the EPTC directly to the alfalfa seed before sowing, so the seed is the herbicide carrier. Using a microsyringe, we applied appropriate volumes of an acetone solution of EPTC to individual alfalfa seeds which had been coated with a lime-based material.[3] The coating absorbed the solution, the acetone evaporated, and seeds with an EPTC-impregnated coating remained.

We have applied EPTC at 2, 4 and 8 kg/ha. The amount of EPTC applied to the seeds was based on a spacing of the seeds 1 cm apart in the row and the assumption that the treated area was a band 5 cm wide. Thus each seed carried the EPTC for 5 square cm.

Annual grass control of 90 to 100% in bands 5 to 8 cm wide resulted from these treatments. The EPTC treatment delayed emergence of alfalfa by about 1-1/2 days, but the stand was not reduced. Typical EPTC symptoms were present in the alfalfa, but the tolerance of alfalfa was acceptable.

These methods were evaluated in sandy loam and loam soils containing 1-1/2% or less organic matter.

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[1]Contribution of the Agric. Res. Serv., U.S. Dept. of Agric., in cooperation with the Washington State Univ. Coll. of Agric. Res. Center.

[2]Res. Agron., Agric. Res. Serv., U.S. Dept. of Agric., Irrigated Agric. Res. and Ext. Center, Prosser, WA 99350.

[3]Commercial product of Celpril Corp.

ECOLOGY OF BARBWIRE RUSSIAN THISTLE

Kent McAdoo, Bruce Roundy, James A. Young and Raymond A. Evans[1]

ABSTRACT: Barbwire Russian thistle (*Salsola paulsinii* Litv.) has become, during the past decade, the dominant herbaceous species in degraded plant communities of the salt desert zone of the northern Great Basin. This species of *Salsola* was introduced to the western United States from Central Asia early in the 20th centruy. It generally has not been recognized as a distinct taxon from Russian thistle (*S. iberica* Sennen and Pau.) with which it freely hydridizes.

Many shrub communities in the salt deserts were degraded by excessive grazing by sheep in the late 19th and early 20th century. Russian thistle and later halogeton [*Halogeton glomeratus* (Bieb.) C.A. Mey] invaded these degraded communities. Gradually barbwire Russian thistle has replaced the common Russian thistle on most of these ranges. Rodents play an important part in the seedbed ecology of barbwire Russian thistle through the caching of seeds. Previous to degradation of these communities the rodents cached the seeds of native shrubs, grasses, and herbaceous species. The introduction of a weed with tremendous potential for seed production interacts with the population dynamics of the rodents and the seedbed ecology of native plant species.

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PHENOLOGY OF SALT RABBITBRUSH

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

ABSTRACT: Salt rabbitbrush [*Chrysothamnus nauseosus* subsp. *consimilus* (Greene) Hall and Clem.][2] is one of the most distinct and widespread subspecies of the gray rabbitbrush group. This rabbitbrush characteristically grows on alkaline/saline soils in the intermountain region. The subspecies often is associated with black greasewood [*Sarcobatus vermiculatus* (Hook.) and Torr.] and Great Basin wildrye (*Elymus cinereus* Scribn. and Merr.) communities adjacent to native hay meadows. Forage production on these areas can be increased by reducing the brush density. In order to control species of rabbitbrush with phenoxy herbicides careful timing of date of application in relation to current annual growth and soil moisture is necessary. The phenology of salt rabbitbrush is quite different from other species of rabbitbrush that grow on upland range sites. Growth is initiated later and continues longer than for green rabbitbrush [*Chrysothamnus viscidiflorus* (Hook.) Nutt.]. Fortunately the topo-edaphic situations where salt rabbitbrush occurs generally have soil moisture available later in the growing season than upland range sites. Studies of phenology, moisture depletion,

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[2]Salt rabbitbrush has been accepted by the terminology WSSA for this subspecies of *C. nauseosus*.

and susceptibility to herbicides are being conducted in unison to develop guidelines for predicting the optimum date of spray for control of salt rabbitbrush. Salt rabbitbrush appears to have a fairly long accelerated growth phase when susceptibility to herbicides is most likely. This phase began in 1977 about the third week of May when soil moisture was readily available and average temperatures had increased 10 C over those during bud burst in March. Accelerated growth continued about 10 weeks until the first of August when soil moisture generally became unavailable.

GERMINATION OF SEEDS OF MUSK THISTLE

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

ABSTRACT: Musk thistle [*Cardus nutans* var. *leiophyllus* (Petrovic) Arenes] has become one of the most important weeds of meadows in the intermountain region of the western United States. The germination characteristics of musk thistle seeds (achenes) has been reported for plants naturalized in the central and northern Great Plains. We have conducted similar experiments to evaluate the germination of musk thistle seeds from populations growing in the Great Basin under contrasting environmental conditions. Musk thistle seeds are fairly germinable with maximum germination at 60 to 75% at optimum temperatures. Optimum temperatures for germination occurred with night (16 hour) temperatures of 5 to 10 C alternating with day (8 hour) temperatures of 15 to 25 C. Alternating temperature regimes that included 30 C or higher warm temperature produced little germination. Constant temperatures of 35 C inhibited germination. When seeds were exposed to light during the warm period germination tended to increase, but not significantly (p=0.05).

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AN INTEGRATED APPROACH TO MUSK THISTLE CONTROL

T. J. Miller and L. O. Baker[1]

ABSTRACT: *Rhinocyllus conicus* as a parasite of musk thistle (*Carduus nutans* L.) has been successfully established in the Gallatin Valley of Montana. A study has been conducted using spraying and mowing treatments to further reduce the economic impact of the thistle without endangering the success of the weevil.

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Four flowering heads on each of 10 randomly selected plants were individually bagged after oviposition to study the effect of the insect on seed production and insect survival in each treatment. There were three replications with 10 treatments in each replication.

Spraying with 2 lb/A 2,4-D (2,4-dichlorophenoxyacetic acid) on May 15 and October 15 controlled most musk thistle plants with no adverse effect on weevil production. Treatments made June 15 and July 1, after bud formation, reduced growth but seed was still produced. Weevil survival was decreased only slightly.

Mowing reduced competition which permitted more seedlings to survive. More than one mowing is necessary to completely prevent seed production and mowing which reduces seed production is detrimental to weevil production.

A large seed load in the soil is necessary for musk thistle to produce flowering plants. Plant counts made in June 1976 and 1977 reveal that only 5% of first year plants produced flowering plants the following year.

CONTROL OF CREOSOTEBUSH WITH TEBUTHIURON AND KARBUTILATE

Howard L. Morton[1], Herbert M. Hull[1], Richard D. Martin[1], and Thomas H. Wright[2]

ABSTRACT: Creosotebush (*Larrea divaricata* (D.C.) Colville) infests from 35 to 46 million acres in southwestern United States and northern Mexico. Some of the infested land was once grassland and would benefit from control of creosotebush.

Pelleted formulations of karbutilate [*tert*-butylcarbamic acid ester with 3(*m*-hydroxyphenyl)-1,1-dimethylurea] and tebuthiuron (*N*-[5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl]-*N,N*-dimethylurea) were applied to dense stands of creosotebush on the Santa Rita Experimental Range, Arizona at rates of 0.5, 1.0 and 2.0 lb a.i./A on May 7, 1974. Tebuthiuron treatments killed 77, 97 and 99% of the creosotebush plants at the 0.5, 1.0 and 2.0 lb/A rates, respectively. Karbutilate was less effective in that at the same respective rates it killed 25, 37 and 77% of the creosotebush plants.

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HERBICIDAL CONTROL OF ALFOMBRILLA

Alfonso Sanchez-Munoz[1], Howard L. Morton[2] and Herbert M. Hull[2]

ABSTRACT: We elavuated the toxicity of herbicides to alfombrilla (*Drymaria arenarioides* H.B.K.), a native, toxic, range plant from northern Mexico under greenhouse and field conditions. Plants were grown at the ARS-USDA facilities in Tucson, Arizona from seed collected in Chihuahua, Mexico. Foliage sprays of the potassium salt of picloram (4-amino-3,5,6-trichloropicolinic acid), the wettable powder of buthidazole (3-[5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl]-4-hydroxy-1-methyl-2-imidazolidinone), the ethylene glycol butyl ether ester and monoethanolamine salts of triclopyr ([(3,5,6-trichloro-2-pyridinyl)oxy]acetic acid) at 0.5 kg/ha all killed more than 90% of the alfombrilla plants under greenhouse conditions. The wettable powder of tebuthiuron (*N*-[5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl]-*N,N'*-dimethylurea), dimethylamine salt of dicamba (3,6-dichloro-*o*-anisic acid), propylene glycol butyl ether esters of silvex (2-[2,4,5-trichlorophenoxy]propionic acid) and isopropylamine salt of glyphosate (*N*-[phosphonomethyl]glycine) killed 70, 57, 45 and 10% of the alfombrilla plants, respectively, and generally eliminated flower production. Herbicidal applications were also evaluated for their toxicity to alfombrilla and injury to grasses at the La Campana Experimental Station, INIP-SARH, and San Francisco Ranch, Chihuahua, Mexico. In these field studies, both granular and liquid formulations of the potassium salt of picloram at 1 and 3 kg/ha killed 86 and 98% of the alfombrilla plants, respectively, when applied before the rainy season. The ester and amine formulations of triclopyr, granular formulation of dicamba, and pelleted and wettable powder formulations of tebuthiuron and wettable powder formulation of diphenamid (*N,N*-dimethyl-2,2-diphenylacetamide) were less effective than picloram. They did not markedly reduce flower production on the surviving plants as was observed in the greenhouse. Picloram at 1 and 3 kg/ha caused injury to 20 and 60% of the grass plants, respectively.

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THE POST-FIRE REGROWTH AND PHYSIOLOGICAL RESPONSES OF CHAMISE

S. G. Conrad and S. R. Radosevich[1]

ABSTRACT: Chamise (*Adenostoma fasaculatum* H. & A.) is the most abundant shrub of California chaparral. In many areas this species must be controlled to maintain open fuel breaks for fire control. Management tools for this species have included herbicides, fire, mechanical removal, and livestock grazing. The difficulty of control is increased by the shrub's ability to resprout following any form of top removal. The present study was initiated in November 1975 at the University of California field

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station in Hopland, California to determine the effect of the time of top removal on the resprouting capacity of mature chamise.

Chamise-dominated chaparral was burned at five phenological stages (fall quiescence, shoot growth initiation, full flower, seed set, summer quiescence). Each burn covered approximately one acre. Growth rates, photosynthetic rates, and xylem sap tensions were measured on resprouts from all treatments and on mature plants. Plants burned during fall quiescence or at the time of spring shoot growth initiation grew rapidly throughout the summer, became quiescent in November 1976, and resumed growth in March 1977. Plants burned at later phenological stages continued to grow throughout the winter of 1976-77. By the end of the second growing season, cover and stem lengths on the three later burns were still less than those on the two earlier burns. Growth was extremely slow on unburned plants. These plants remained quiescent from June through February.

June 1977 photosynthetic rates of resprouts on the three later burns (3.4-3.9 mg CO_2/gdw hr) were significantly higher (1.5-2 times as great) than those for the earlier burns (2.1-2.8 mg CO_2/gdw hr). Rates of mature shrubs (1.7 mg CO_2/gdw hr) were lower than those for the resprouts. The lower photosynthetic rates correlate well with higher water stress in the mature plants and older resprouts as measured by pre-dawn xylem sap tensions. As the foliar biomass resprouts increase, increased transpiration will accelerate water loss. The increased water stress will result in lower photosynthetic rates, less assimilate translocation, and decreased growth rates in more mature plants.

THE USE OF CATHODOLUMINESCENCE IN EVALUATING EFFECTS OF LEAF MATURITY AND SPRAY PRESSURE ON DISPERSAL PATTERNS OF FOLIAR APPLIED DICAMBA

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

ABSTRACT: The scanning electron microscope in conjunction with cathodoluminescence (CL) was used to study mesquite leaf topography, epicuticular wax ultrastructure and herbicide deposition patterns. An aqueous solution of the dimethylamine salt of dicamba (3,6-dichloro-*o*-anisic acid) containing 0.5% (v/v) of a nonionic surfactant was applied by means of a hand sprayer to greenhouse seedlings and outdoor trees of velvet mesquite. Dicamba was used because of its ability to produce a particularly intense CL image.

At a pressure of 70 psi (4 kg ae/ha, 40 L/ha) the spray drops averaged about 160 μm in diameter after impingement on the leaflet surfaces of young seedlings, whereas they spread to a mean diameter of 320 μm on the foliage of outdoor trees. The greater spreading in the latter case (and resultant decrease in contact angles) apparently resulted from a more complex and weathered configuration of the surface wax, as determined by the secondary electron image. It may have also been affected by the presence of extraneous material which was on the surface of many outdoor leaves. When spray pressure was increased to 130 psi, droplets were smaller, spreading to a mean diameter of only 55 μm on the greenhouse seedlings and about 160 μm on

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the outdoor foliage. The greater wettability of the mature outdoor leaves corroborates earlier work, and may be a partial explanation for certain differences in herbicidal response sometimes observed between greenhouse and outdoor plants.

The secondary electron image of outdoor leaflets showed a somewhat greater concentration of discrete deposits at the base of trichomes than would be expected at random. However, the CL image indicated that in not every case did these deposits contain dicamba. When drops impacted the leaflet surface, minute droplets were thrown outward from the impact area which were sometimes visible as faint streaks. The CL image of these streaks faded rapidly however, apparently due to volitilization of the herbicide under the high operating vacuum of the microscope column.

INFLUENCE OF SURFACTANTS ON THE PHYTOTOXICITY OF DICLOFOP ON WILD OAT, UNDER GREENHOUSE AND FIELD CONDITIONS

M. E. Coleman-Harrell and G. A. Lee[1]

Diclofop (methyl 2-[4-(2,4-dichlorophenoxy)phenoxy]-propanoate) has been shown to be an excellent herbicide for the control of wild oat (*Avena fatua* L.) in cereal grains (1,3). Surfactants have been reported to reduce the chemical dosage necessary to satisfactorily control wild oat with dichlfop (5). Lee and Englert (4) reported enhancement by surfactants of induced phytotoxicity symptoms and herbicidal activity of diclofop on wild oat plants. They (4) also observed that the time interval from application until visual phytotoxicity symptoms occurred was reduced with treatments which contained surfactants, and that as the rate of diclofop increased, the differential response due to surfactants decreased.

Materials and Methods

Greenhouse investigations were conducted in 1977 to determine the influence of several surfactants on the phytotoxicity of diclofop on wild oat. Diclofop at .56, .74, and 1.12 kg/ha was applied in 20 gpa of water carrier alone and in combination with surfactants. Surfactants were added to the herbicide spray mixture at a rate of 0.5% v/v. The herbicide treatments were applied when the wild oat plants were in the 1- to 3-leaf stage of development. The wild oat plants were visually evaluated at 6, 12, 18, and 28 days after treatment. Phytotoxicity values ranged from 1 to 10, and an increase in rating reflected an increase in herbicide phytotoxicity symptoms.

Further investigations were initiated to determine if the addition of surfactants to diclofop spray mixtures would enhance herbicidal activity under field conditions. Diclofop at .70, .84, and 1.12 kg/ha was applied in 40 gpa of water carrier alone and in combination with surfactants, which were added to the herbicide spray mixture at a rate of 0.5% v/v. The herbicide treatments were applied when the wild oat plants were in the 1- to 3-leaf stage.

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Field studies were conducted in both winter wheat (*Triticum aestivum* L. 'Hyslop') and spring barley (*Hordeum vulgare* L. 'Vanguard'). Percentage wild oat control was determined by count and by biomass[2], 60 days after treatments were applied. Grain yeilds were harvested with a Hege small-plot combine, approximately 4 months after planting.

Both greenhouse and field experiments were arranged in randomized complete block designs. The greenhouse and field studies included 6 and 4 replications of each treatment, respectively. Phytotoxicity data and percentage wild oat control data from the studies were statistically analyzed. Means were analyzed for significance at the 0.05 level of probability by an analysis of variance. A Duncan's Multiple Range Test was utilized to evaluate differences among means.

Results and Discussion

Under greenhouse conditions, treatments of diclofop at all rates, alone or in combination with Renex 36 or a non-phytotoxic crop oil, ultimately resulted in complete kill of wild oat plants (Table 1). The rates of induced phytotoxicity, however, were observed to differ among treatments.

At 6 days after treatment, the phytotoxicity ratings for plants treated with diclofop at .56 kg/ha with Renex 36 or with the crop oil, were significantly greater than the rating which resulted from diclofop at .56 kg/ha alone. The phytotoxicity ratings of wild oat plants treated with diclofop at .74 kg/ha alone or in combination with surfactants did not differ significantly and were not significantly greater than the ratings for diclofop at .56 kg/ha plus surfactants. Treatments of diclofop alone at 1.12 kg/ha did not result in significantly greater phytotoxicity ratings at 6 days than treatments of diclofop at .56 kg/ha with surfactants. The addition of surfactants enhanced the herbicidal activity of the low rate of diclofop in the greenhouse. The rate of induced phytotoxicity as a result of treatments of diclofop at 1.12 kg/ha plus the crop oil was the same as diclofop at 1.12 kg/ha plus Renex 36, and significantly greater than the rates of induced phytotoxicity due to all other treatments.

At 12 days after treatment of greenhouse grown wild oat plants, phytotoxicity symptoms continued to show differences among treatments. Treatments of diclofop at .56 kg/ha plus Renex 36 resulted in a significantly greater phytotoxicity rating than treatments of diclofop at .56 kg/ha alone. The same pattern of significance resulted from treatments of diclofop at .74 kg/ha with Renex 36. All treatments of diclofop at 1.12 kg/ha resulted in phytotoxicity ratings which were statistically the same. These treatments were also the same as diclofop at .56 and .74 kg/ha plus surfactants.

Under greenhouse conditions, the addition of surfactants to lower rates of diclofop enhanced the rate of induced phytotoxicity symptoms, as well as herbicidal activity. These results prompted further field investigations.

Percentages of wild oat control resulting from field applications of diclofop were similar in both spring barley and winter wheat. In winter wheat (Table 2), percentages of wild oat control and total grain yields did not reflect any notably significant variations. The addition of surfactants to diclofop spray mixtures did not enhance herbicidal activity.

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[2]Weed control evaluation techniques as reported by Mundt and Lee, in "Comparitive methods of evaluating wild oat control in small grains", Proceedings of the Western Society of Weed Science, 1978.

Table 1. Influence of Surfactants on the Phytotoxicity of Diclofop on Wild Oat in the Greenhouse.

Treatment	Rate kg/ha	Phytotoxicity Rating, Days after Treatment 6	12	18	28
Diclofop	.56	3.2 d[1]	5.7 b	9.0 a	9.8 a
Diclofop + Renex 36[2]	.56	5.3 bc	8.0 a	10.0 a	10.0 a
Diclofop + Non-Phyto Crop Oil	.56	5.3 bc	7.3 ab	9.2 a	10.0 a
Diclofop	.74	4.3 cd	6.3 b	9.3 a	9.8 a
Diclofop + Renex 36	.74	5.3 bc	8.0 a	9.8 a	10.0 a
Diclofop + Non-Phyto Crop Oil	.74	4.5 cd	7.8 ab	9.8 a	9.8 a
Diclofop	1.12	4.7 c	8.3 a	9.8 a	10.0 a
Diclofop + Renex 36	1.12	6.3 ab	8.7 a	9.8 a	10.0 a
Diclofop + Non-Phyto Crop Oil	1.12	7.0 a	8.3 a	10.0 a	10.0 a

[1]Ratings in the same column followed by the same letter are not significantly different at the .05 level.

[2]All surfactants were added to the herbicide spray mixtures at a rate of 0.5% v/v.

Table 2. Influence of surfactants on the phytotoxicity of diclofop on wild oat plants, under field conditions in winter wheat.

Treatment	Rate (kg/ha)	Percentage Wild Oat Control Count	Percentage Wild Oat Control Biomass	Grain Yield (kg/ha)
Diclofop	.70	98 a[1]	98 a	4691 a
Diclofop + Renex 36[2]	.70	88 ab	93 a	3777 b
Diclofop + non-phyto crop oil	.70	58 c	76 ab	4166 ab
Diclofop + Genapol 060	.70	98 a	99 a	4146 ab
Diclofop	.84	87 ab	85 ab	4415 ab
Diclofop + Renex 36	.84	95 a	97 a	3756 b
Diclofop + non-phyto crop oil	.84	64 bc	67 b	4308 ab
Diclofop + Genapol 060	.84	79 abc	95 a	4321 ab
Diclofop	1.12	98 a	99 a	4657 a
Diclofop + Renex 36	1.12	99^{+}a	99^{+}a	4247 ab
Diclofop + non-phyto crop oil	1.12	99 a	99^{+}a	4234 ab
Diclofop + Genapol 060	1.12	95 a	98 a	4388 ab

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

[2]All surfactants were added to the herbicide spray mixture at a rate of 0.5% v/v.

An important trend to be noted was that treatments of diclofop at .70 and .84 kg/ha plus crop oil resulted in substantially lower wild oat control than all other treatments. Grain yields from those areas treated with diclofop at .70 and .84 kg/ha plus crop oil were slightly less than yields from wheat which was treated with diclofop alone. Coleman-Harrell (2) reported that the longer wild oat plants remained in association with cereal grain crops during the growing season, the lower the resulting grain yields. These data indicate that the addition of crop oil to lower rates of diclofop may have inhibited herbicidal activity or reduced the rate of induced phytotoxicity.

A second striking observation was that grain yields from wheat which was treated with diclofop at .70 and .84 kg/ha plus Renex 36 were substantially lower than yields from all other treatment areas. Low grain yields indicate that wild oat plants were not rapidly killed by the herbicide treatments, even though ultimate percentages of control were significantly high.

Neither percentages of wild oat control nor wheat grain yeilds were enhanced by treatments of diclofop plus surfactants. Field data indicate that surfactants do not enhance the herbicidal activity of lower rates of diclofop.

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THE RELATIONSHIP BETWEEN SOIL MOISTURE AND DICLOFOP ACTIVITY ON WEEDY GRASSES

Wendy A. Dortenzio and Robert F. Norris[1]

ABSTRACT: Diclofop (methyl 2-[4-(2,4-dichlorophenoxy)phenoxy]-propanoate) offers potential for use in postemergence control of grasses, particularly wild oats and barnyardgrass. Because of variable activity in the field, a program of greenhouse and field trials was established to investigate the relationship between diclofop activity and soil moisture.

Yellow foxtail, wild oats, canary grass and barnyardgrass were sown in pots under various soil moisture regimes. Dry weight data indicated a loss in 25 to 50% of the activity of diclofop (1.0 and 2.0 lb/A) at soil moistures of 2 to 3% above wilting point as compared to near field capacity. When cycled, soil moisture must be high (18 to 20% dry weight of soil) between one and two days following treatment.

Two field trials were conducted to ascertain if these greenhouse results could be extended to field applications. Diclofop was applied to barnyardgrass (4 to 5 leaf growth stage) under daily irrigation, with single irrigations at increasingly longer intervals following application, or with combinations of two or more irrigations.

Maximum control was observed in plots irrigated daily or every other day. A single irrigation the day of spraying resulted in 10 to 30% less control. Activity was regained with irrigation on the second day; a progressive increasing loss in activity with single irrigations was observed from the third to the tenth day. Recovery of 15 to 20% of the control was noted with irrigations at 0 and 3 days or at 0, 2 and 4 days. The decreased activity of diclofop with low soil moisture was negated at high rates of the herbicide. Preliminary results indicate that HOE-29152 shows similar changes in activity in relation to soil moisture.

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THE SITES OF UPTAKE AND EFFECT OF SIMULATED OVERHEAD IRRIGATION ON UPTAKE OF DICLOFOP BY BARNYARDGRASS

L. D. West[1], J. H. Dawson[2] and Arnold P. Appleby[1]

Barnyardgrass (*Echinocloa crusgalli* (L.) Beauv.) is a serious pest in sugarbeets grown in central Washington. Diclofop (methyl 2-[4-(2,4-dichlorophenoxy)phenoxy]propanoate) has shown considerable promise for selective control of barnyardgrass in sugarbeets.

The determination of site of uptake has value when considerations of application timing, soil placement, etc., are made. Discovery of the site of soil uptake of diclofop was the primary objective of this study.

Site of uptake studies were done both in the greenhouse and the field.

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[2]ARS, USDA, Irrigated Agr. Res. and Ext. Center, Prosser, WA 99350.

Greenhouse studies were initiated in glass-faced root boxes. The first internode and root system were separated from each other by a 3 mm activated carbon barrier. Site of uptake was evaluated by root and shoot growth. In the field studies, foliar, soil, and foliar plus soil treatments were combined with three levels of simulated overhead irrigation (0, 2.5, and 10 mm). Mortality and injury evaluations were made in the field.

Our studies confirmed previous observations that diclorfop has both foliar and soil activity on barnyardgrass (1,2). Under favorable environmental conditions (warm temperature, high moisture), foliar treatment provided excellent control. When these conditions were not met, control was reduced.

Greenhouse studies indicated that the primary site of soil uptake is the barnyardgrass root. This was supported by field results that indicated an increase in barnyardgrass control with increasing amounts of simulated overhead irrigation after postemergence treatment (soil only), although increasing soil moisture may have effects other than that of moving the chemical deeper in the soil (such as influencing plant water status).

This dual site of uptake (both root and foliar) has obvious advantages. Two of the more obvious are: 1. more surface area for chemical absorption than by either route alone, and 2. when conditions for absorption by one route are not optimum, it may be compensated for by the other site.

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COMPARATIVE METHODS OF EVALUATING WILD OAT CONTROL IN SMALL GRAIN

G. A. Mundt and G. A. Lee[1]

Weed scientists utilize several methods of assessing herbicide activity and resulting weed control. One of the objectives of these assessment methods is to provide reliable and reproducible information concerning the impact of the herbicide on the target weed species and subsequently on the crop. The method of assessment may not provide a satisfactory measure of herbicide performance relative to crop response. There is a definite need to compare evaluation techniques so that the most reliable methods can be utilized to report research data.

Wild oat is an economically important weed species in the northern latitudes of the United States. The wild oat plant is a strong competitor in cereal grain crops. Sparse populations can significantly reduce crop vigor and yields. Reliability of evaluation methods must be compared to determine which assessment technique most accurately reflects the relationship of percentage weed control to crop response.

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The purpose of this study was to compare methods of evaluating herbicidal control of wild oat in spring wheat and to identify the evaluation method most indicative of resulting crop yield.

The methods utilized for assessing wild oat control were biomass (foliage dry weight), actual counts and visual ratings.

The experiment was designed as a randomized complete block with three replications. Evaluations of all three methods were made June 15, 1977, before the spring wheat was in the flag stage of growth. Weed counts were accomplished by taking two 2.5 square foot sub-samples per treatment and counting the wild oat plants present. These wild oat plants were then clipped at the soil surface, dried and weighed for total biomass. Visual ratings consisted of estimating the density and size of the wild oat plants present in the treated area and comparing them to the check. All visual evaluations were made by one researcher to eliminate variability. Yield data were obtained on August 3, 1977, by harvesting 384.25 square feet from each treatment with a Hege small plot combine.

The three weed control assessment methods for evaluating each herbicide treatment were correlated to spring wheat yields to determine the relationship between percentage weed control and crop yield response.

Wild oat counts and biomass weights resulted in quantitative data that can be easily duplicated by other researchers. Wild oat counts are a good measure of plant density, but give no indication of weed height, tillering and overall weed vigor. Wild oat biomass reflects the utilization of available resources such as moisture, light and nutrients, but does not indicate plant height nor vigor. Both methods involve subsampling which often does not reflect plant response within the entire plot.

Visual evaluations are subjective, and permit the introduction of variability relative to the researcher's skill and experience. Reproduction of results is difficult because of the subjective nature of the assessment method. Similar morphological characteristics of the wild oat and cereal grain plants can hinder visual rating systems because of the difficulty in distinguishing the two species at an early developmental stage. An advantage of evaluator subjectivity is other parameters such as crop vigor and response can be included in the evaluation results. Visual ratings are less time consuming than weed counts or weed biomass analysis, and allow for several evaluations to be made throughout the growing season with little or no disturbance of the treated area.

Of the three evaluation methods, visual ratings of wild oat control were most highly correlated ($R = .78$) to resulting spring wheat yields (Figure 1). Weed counts were poorly correlated with crop yields. Wild oat biomass was also a poor indicator of crop yields ($R = .61$, Figure 2). A strong relationship existed between visual ratings of wild oat control and wild oat control as determined by biomass. This strong relationship is demonstrated by the close fit of both a linear regression model ($R = .90$) and a curvalinear regression model ($R = .96$, Figure 3).

Biomass ratings consistently resulted in higher percentages of wild oat control than visual ratings, for the same herbicide treatment (Figure 4). The low visual ratings for percent weed control may be a result of crop vigor influencing the evaluator. Applications of post emergent wild oat herbicides do not result in immediate elimination of the wild oat plants from the crops. Complete kill of wild oat plants occurs over a period of several days to weeks.

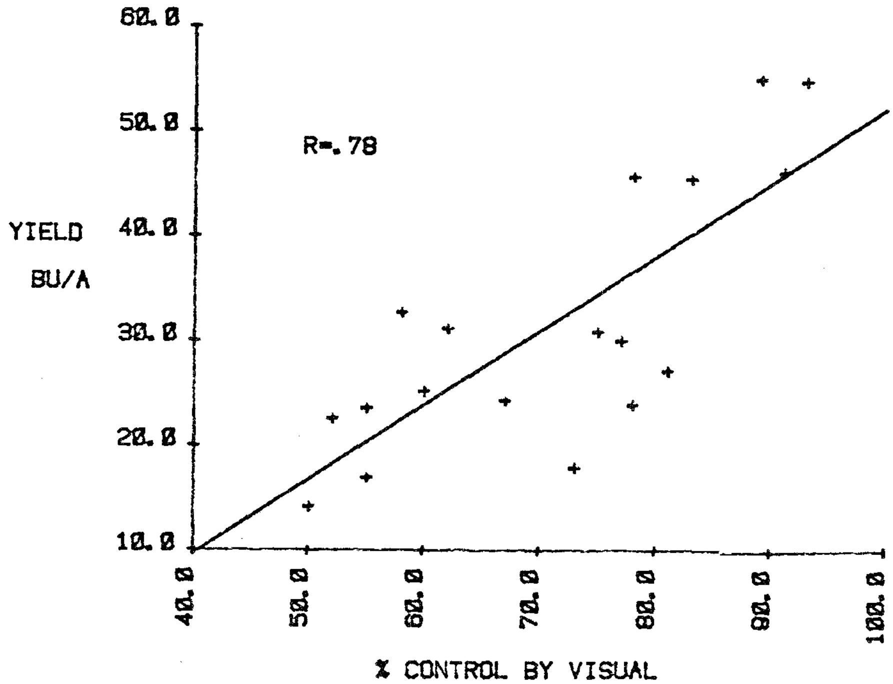

Figure 1. Linear regression relationship between percent wild oat control by visual evaluation to yield of spring wheat.

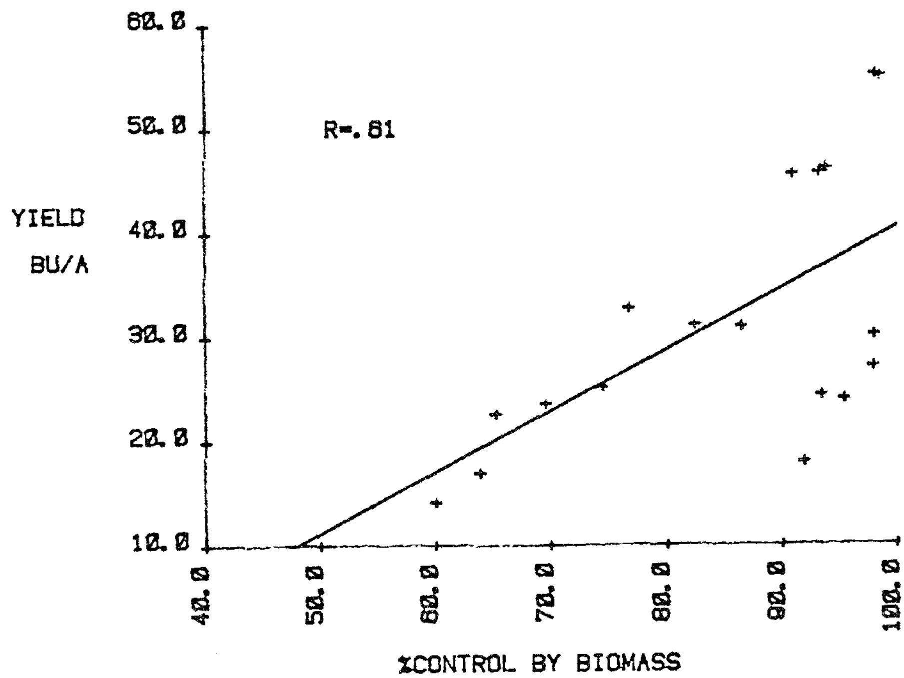

Figure 2. Linear regression relationship between percent control of wild oat (biomass evaluation) and spring wheat yield.

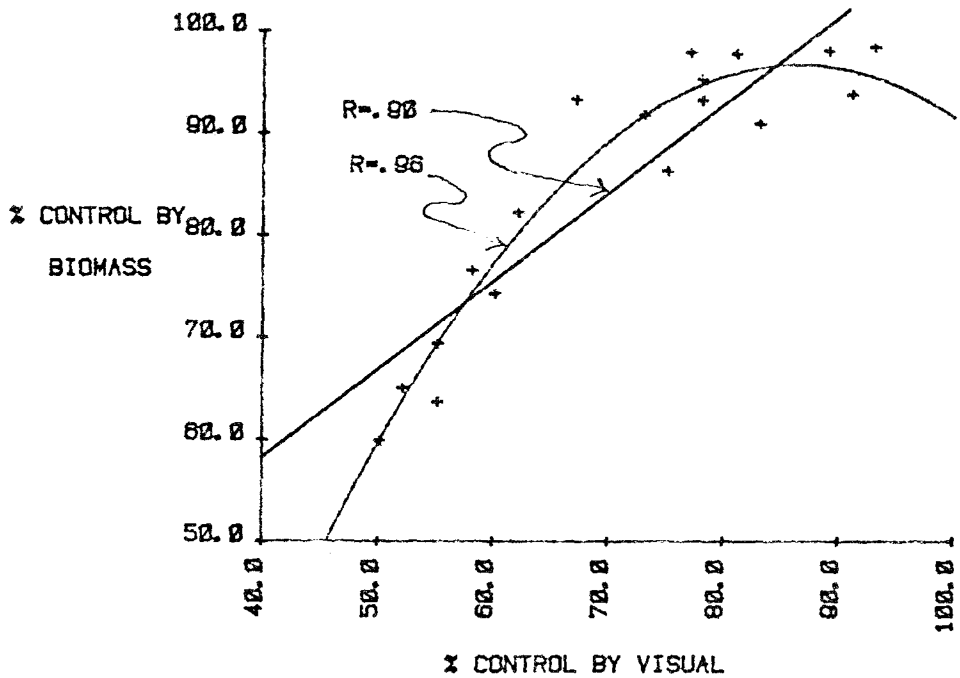

Figure 3. Comparison of linear and curvalinear regression relationship between wild oat control utilizing visual and biomass assessment methods.

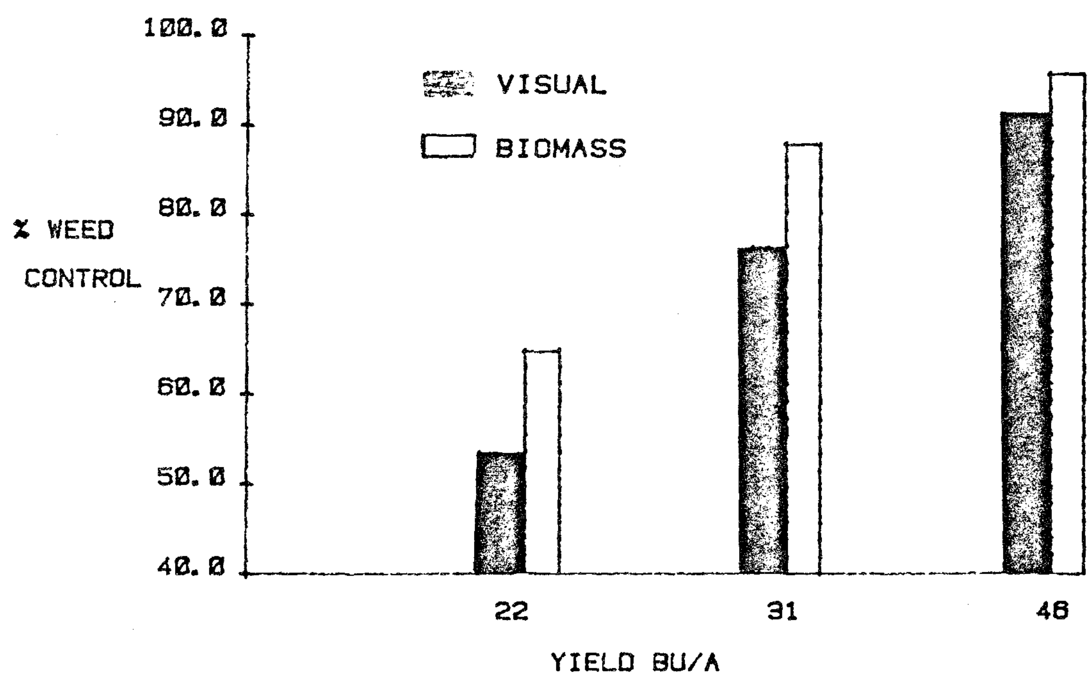

Figure 4. Comparison of visual observations and biomass assessment methods to corresponding spring wheat yields.

Crop yields were significantly reduced by the continued presence of wild oat populations. Studies at the University of Idaho show that one wild oat plant per square foot left in the field until the 3-4 leaf stage reduces yields in spring wheat by 17% (Table 1).

Table 1. Grain Yields and Percentage Yield Reductions as a Result of Spring Wheat Exposure to Four Periods of Wild Oat Durations in 1977.

Stage of wild oat[1] when removed	Spring wheat yield[2] (bu/A)	Percent yield reduction
1 to 2 leaf	21.1 a	0.0 a
3 to 4 leaf	16.9 b	17.0 b
5 to 6 leaf	11.9 c	49.5 c
not removed	7.8 c	54.9 c

[1]Wild oat population density was 25 plants per square foot

[2]Means in the same column followed by the same letter are not significantly different at the .05 level as determined by Duncan's mean separation.

Herbicidal phytotoxic action on the wild oat plant does vary resulting in rapid reduction or prolonged competitive interference with the wheat crop.

Herbicides that only suppress wild oat growth and require prolonged periods for complete weed species kill permit the wild oat population to compete for extended periods of time. If the wild oat population removal is accomplished prior to field evaluations, the resulting data could indicate excellent wild oat control without a corresponding yield increase.

Data points labeled "A" indicate excellent wild oat control with a corresponding increase in yield (Figure 5). The phytotoxic action resulting from herbicide treatments that enhanced the rapid elimination of the wild oat population minimized the duration of competition. Herbicides that suppress and remove some of the wild oat population result in a corresponding lower yield (Figure 5, C). There are situations, however, where excellent wild oat control is ultimately achieved, but prolonged duration of the weed population significantly reduces the crop yield (Figure 5, B). It is these data that lower the correlation coefficient of yield to wild oat control.

Methods must be developed to include evaluation of wild oat control and the duration factor. Visual ratings taken several times during the growing season or a combination of evaluation techniques may be necessary to assess the effect of duration of weed populations. If these methods are found to be unsatisfactory, then development of a duration-population index for assessing weed control and yield response may be necessary. Poor statistical correlations of percent weed control and resulting crop response by the three methods discussed in this paper indicate the need for better assessment methods.

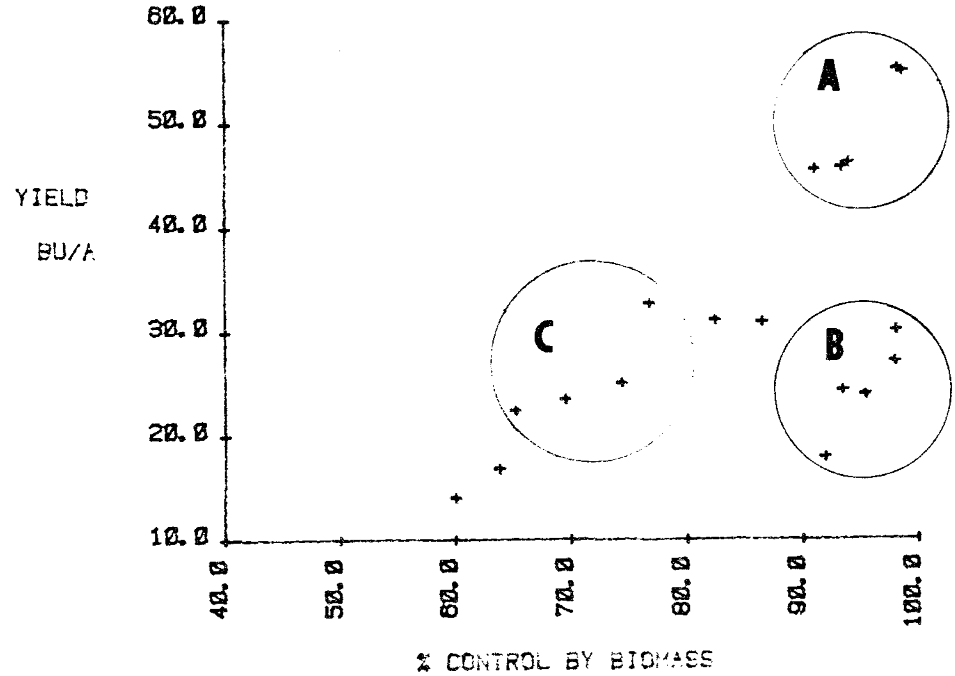

Figure 5. Comparison of yield response utilizing biomass assessment where (A) excellent wild oat control was obtained with rapid elimination (B) excellent wild oat control was obtained with slow elimination, and (C) intermediate wild oat control was obtained.

OSMOTIC STABILITY OF MANNITOL AND POLYETHYLENE GLYCOL SOLUTIONS USED AS SEED GERMINATION MEDIA

D. C. Thill and A. P. Appleby[1]

ABSTRACT: Little quantitative information is available on the affect of water stress on weed seed germination. To simulate water stress, mannitol and high molecular weight polyethylene glycols (PEG) are often used to produce solutions of different osmotic water potential in seed germination studies. However, little is known about the osmotic stability of these solutions as well as differences in effects on seed germination of osmotic potentials versus the matric potential characteristics of soils. The purpose of this study was to determine the osmotic stability of mannitol and PEG (m.w. 20,000) solutions and to compare osmotic versus matric water potential effects on germination of winter wheat (*Triticum aestivum* L. var. 'Nugaines'). Lacking a weed seed source of known genetic uniformity and

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high percent germination, winter wheat, which has both of these traits, was used as the test plant. Four solutions of mannitol, PEG, and KCl (standard), ranging in water potential from -3.5 to -18.0 bars, were incubated at 10, 20, and 30C and analyzed periodically, four measurements per solution, for water potential using thermocouple psychrometry. In addition, percent and rate of germination of winter wheat seeds placed in 27-day-old or freshly prepared solutions of mannitol and PEG were compared to each other and to percent emergence and rate of emergence from watered soil media. The osmotic potential of the different mannitol solutions did not change with time. However, the osmotic potential of the -4.0, -6.4, and -9.1 bar PEG solutions decreased about -1.0 bar, while the -17.4 bar solutions did not change with time. Percent and rate of germination of winter wheat was the same in the 27-day-old and freshly prepared mannitol and PEG solutions; but at comparable osmotic potentials, the germination rate was more rapid in the mannitol solutions. Wheat emergence rate in soil was linearly related to germination rate in PEG solutions, but not mannitol solutions. Hence, the slight instability of PEG solutions appears to be of no biological consequence, and wheat seed emergence rate at different soil matric potentials can be approximated from germination rate in PEG osmotic solutions.

EFFECTS OF SEEDING RATE AND SEEDING DEPTH ON YIELD AND COMPETITION WITH WEEDS OF TWO WHEAT VARIETIES

D. L. Shaner, W. H. Isom and J. L. Lyon[1]

The effects of seeding rate and seeding depth on yield and the competitive ability of two wheat varieties (Anza and INIA 66R) were tested during the 1977 growing season. The tests were conducted on small plots (1.5 m x 5.5 m) and each treatment was replicated four times. The seeding rates used were 56, 112, 168 and 224 kg/ha, and the seeding depths were 0, 2, 4 and 7 cm below the soil surface. Half of the plots were treated with 0.56 kg/ha bromoxynil (3,5-dibromo-4-hydroxybenzonitrile) at the 4-5 leaf stage of the wheat.

The surface planting of both wheat varieties resulted in very poor stand establishment, but there was good stand establishment at the other three depths. Since the seeding depths of 2, 4 and 7 cm had no significant effect on yield at any seeding rate, whether or not plots were treated with bromoxynil, the rest of the comparisons will be made on the 0 and 4 cm seeding depths.

At the 0 cm seeding depth there was an increase in yield as the seeding rate increased (Figures 1 & 2). Controlling the broadleaf weeds with bromoxynil resulted in a 30 to 50% increase in yield in both varieties. At the 4 cm depth, yields were much higher than at the 0 cm seeding depth (Figures 1 & 2). Without weed control there was a significant increase in yield of Anza wheat as the seeding rate increased from 56 to 112 kg/ha, but there was no further increase in yield with increased seeding rate.

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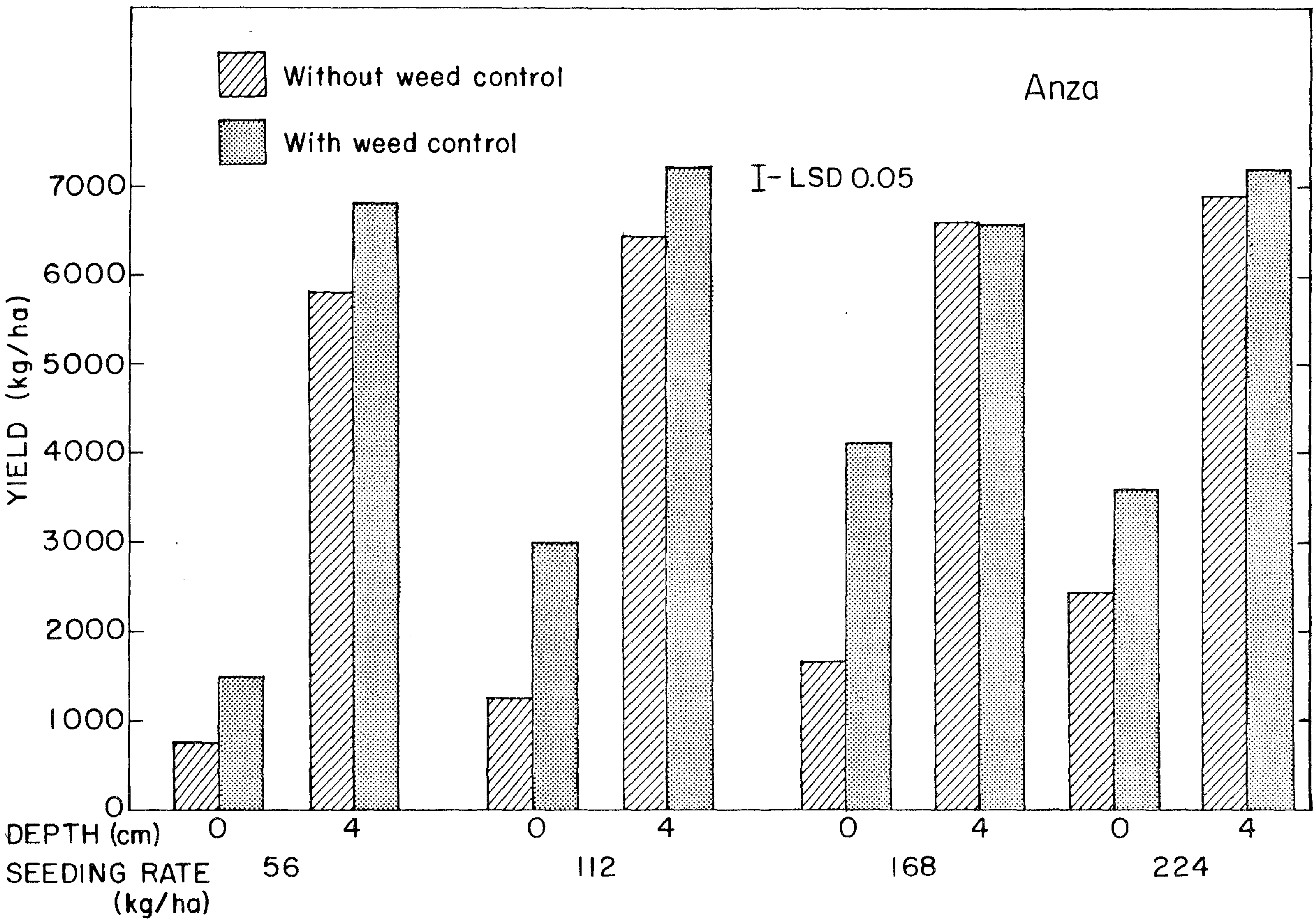
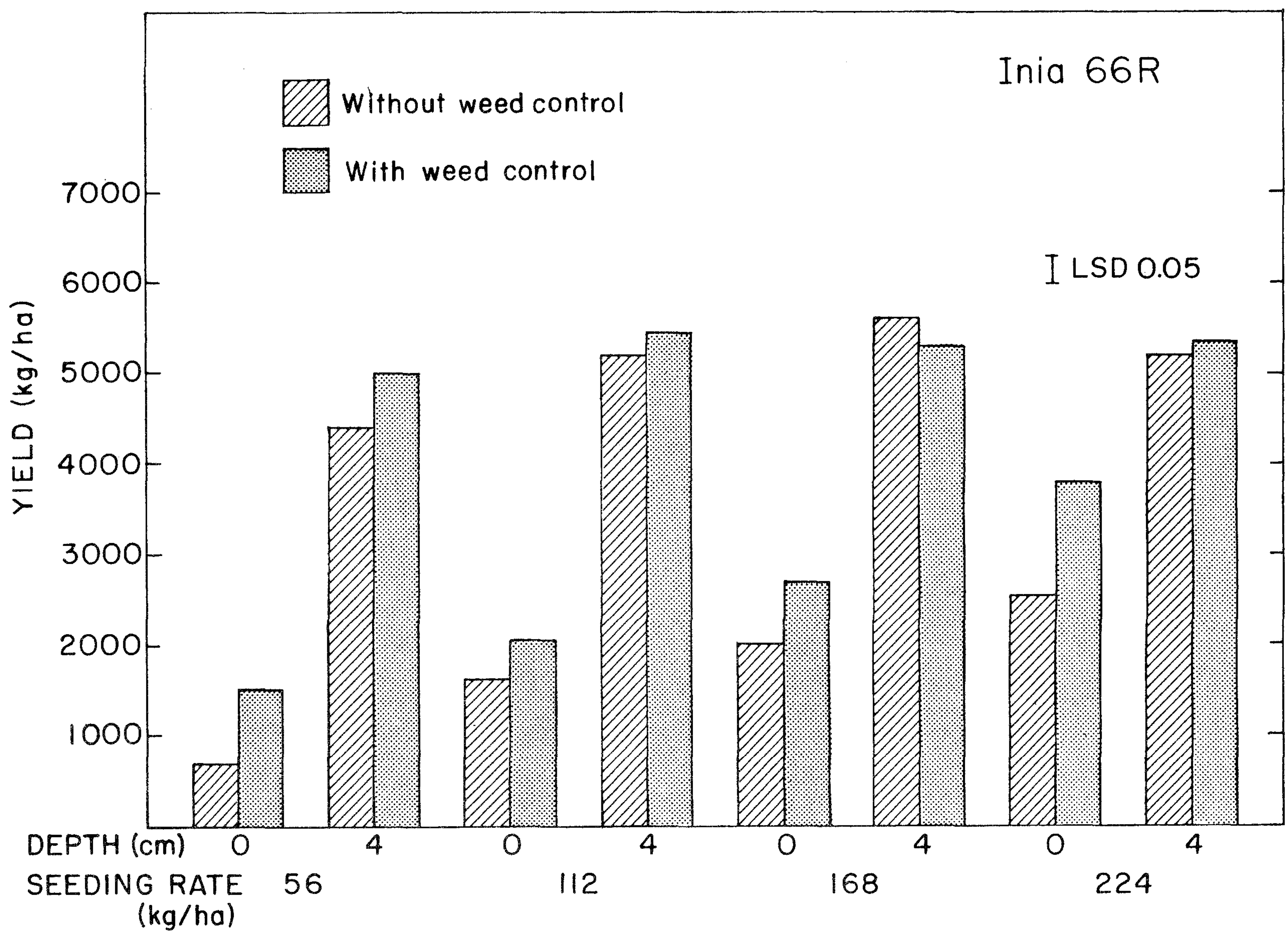
FIGURE 1



Without weed control
With weed control
Anza
I- LSD 0.05
YIELD (kg/ha)
7000
6000
5000
4000
3000
2000
1000
0
DEPTH (cm)
0
4
0
4
0
4
0
4
SEEDING RATE (kg/ha)
56
112
168
224

FIGURE 2



Inia 66R
Without weed control
With weed control
LSD 0.05
YIELD (kg/ha)
7000
6000
5000
4000
3000
2000
1000
DEPTH (cm) 0 4 0 4 0 4 0 4
SEEDING RATE (kg/ha) 56 112 168 224

With INIA 66R wheat there was not only an increase in yield as the seeding rate increased from 56 to 112 kg/ha, but also as the seeding rate increased from 112 to 168 kg/ha (Figures 1 & 2). Weed control with bromoxynil resulted in a substantial increase in yield at the 56 kg/ha seeding rate. Bromoxynil had a smaller effect on yield at the other three seeding rates in both varieties. In fact, weed control appeared to decrease yield at the 168 kg/ha seeding rate.

There was a negative correlation between weed count per plot and yield in both varieties at the three deeper seeding depths, indicating the differences in yield in plots not treated with bromoxynil was due primarily to weed competition (Table 1). Anza wheat appeared to be a better competitor than INIA 66R as evidenced by fewer weeds at the 112 kg/ha seeding rate.

Table 1. Relationship Between Weed Count and Yield at Different Seeding Rates[1]

Seeding Rate (kg/ha)	Variety			
	Anza		INIA 66R	
	Weed Count (weeds/plot)	Yield (kg/ha)	Weed Count (weeds/plot)	Yield (kg/ha)
56	84 a	4894 a	80 a	3700 a
112	24 b	5581 b	45 b	4366 b
168	13 b	5741 bc	14 c	4620 c
224	12 b	5842 c	17 c	4790 c

[1] Means within a column followed by the same letter are not significantly different at the 1% level by Duncan's multiple range test.

Part of the competitive ability of the two varieties of wheat at the different seeding rates could be related to the differences in early season plant height at the different seeding rates. Early in the growing season, the height of the plants increased as the seeding rate increased in both varieties, although at the end of the growing season these differences had disappeared (Figures 3 & 4). This effect of planting density on plant height could result in an earlier shading of weed seedlings and thus increase the competitive ability of the wheat. However, this height difference cannot totally explain the competitive differences of the two varieties of wheat at different planting densities.

An analysis of the comparative returns and costs of different treatments calculated from current prices on Anza wheat revealed several interesting facts. As the seeding rate increased, there was a decreasing net return per hectare for the money spent on weed control (Table 2). It appeared that part of the weed control expense could be offset by increasing the seeding rate. In fact, at 168 kg/ha seeding rate, there was a substantial loss per hectare with weed control. The maximum return per hectare appeared to result from planting at 112 kg/ha and spraying with bromoxynil, because when 112 kg/ha plus weed control was compared to either 56 kg/ha plus weed control or 224 kg/ha plus weed control, the first treatment resulted in a larger net return per hectare.

FIGURE 3

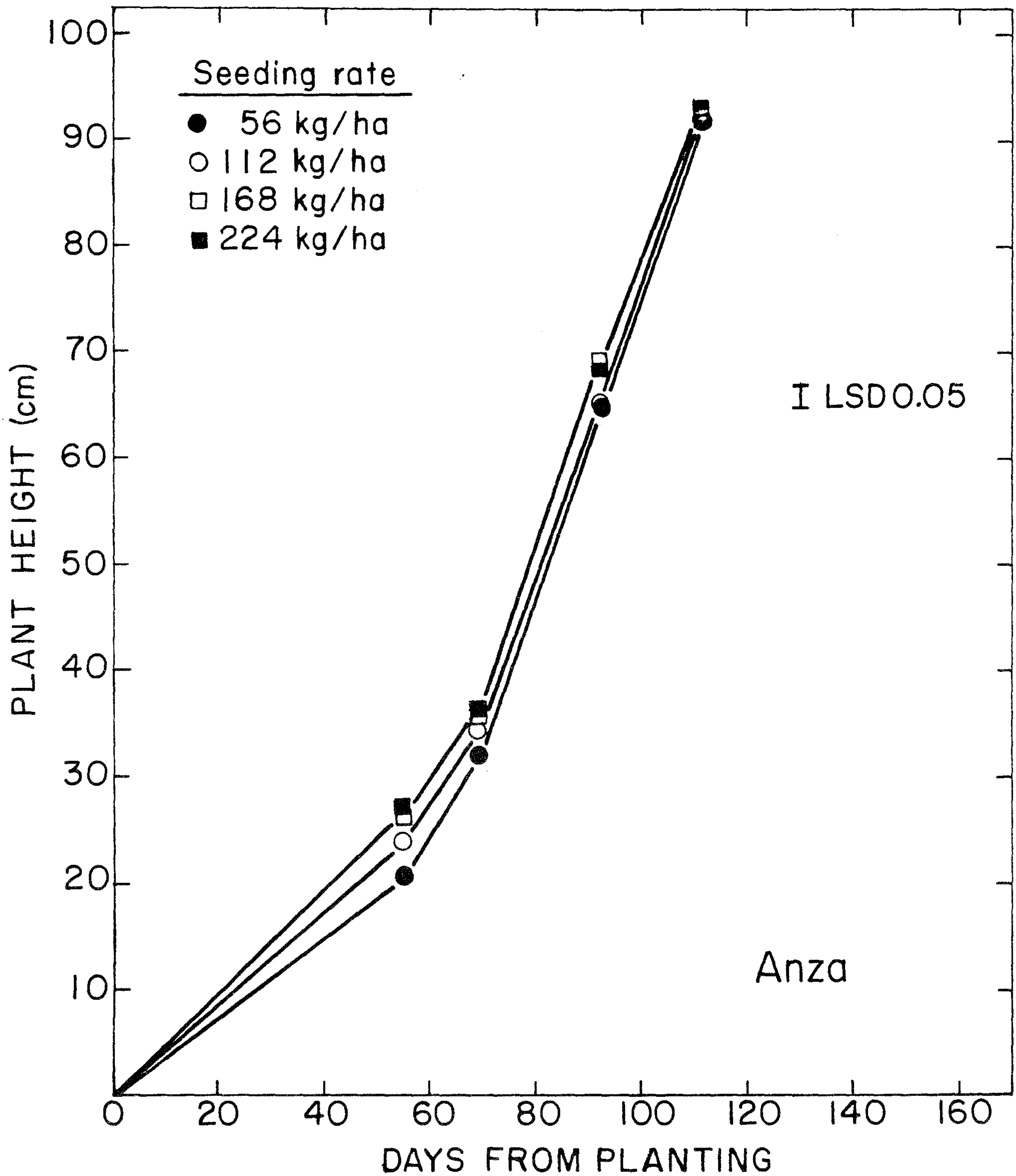

Seeding rate
56 kg/ha
112 kg/ha
168 kg/ha
224 kg/ha
I LSD 0.05
Anza
PLANT HEIGHT (cm)
100
90
80
70
60
50
40
30
20
10
0
20
40
60
80
100
120
140
160
DAYS FROM PLANTING

FIGURE 4

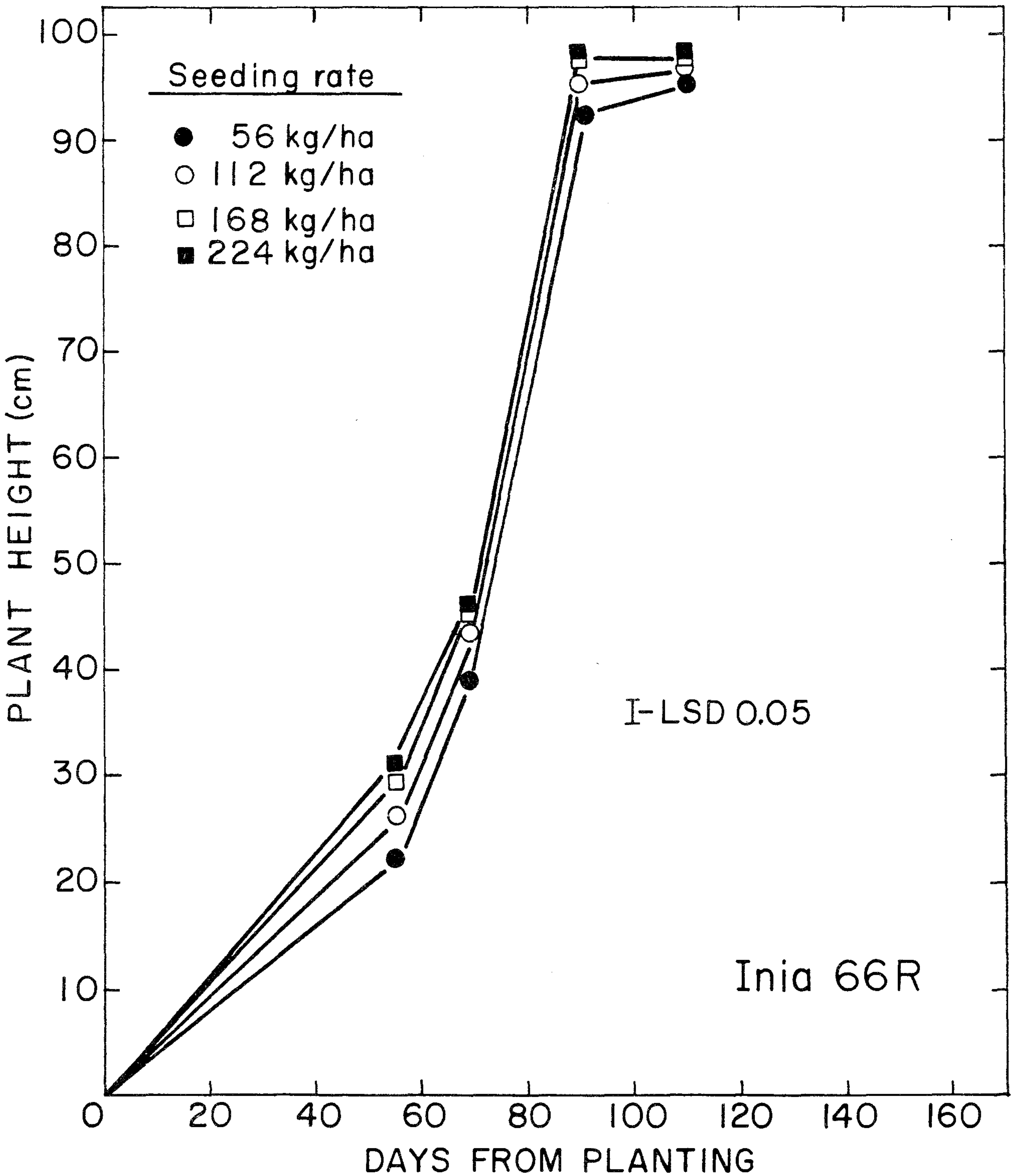

Seeding rate
56 kg/ha
112 kg/ha
168 kg/ha
224 kg/ha
PLANT HEIGHT (cm)
100
90
80
70
60
50
40
30
20
10
I-LSD 0.05
Inia 66R
0
20
40
60
80
100
120
140
160
DAYS FROM PLANTING

TABLE 2

A COMPARISON OF THE MONETARY COST AND NET RETURNS OF

DIFFERENT SEEDING RATES AND WEED CONTROL METHODS IN ANZA

TREATMENT[1]		A	B	C	D	E	F	
1	2	RETURN[2] ON TREATMENT 1 ($/ha)	RETURN ON TREATMENT 2 ($/ha)	A − B ($/ha)	COST[3] OF TREATMENT 1 ($/ha)	COST OF TREATMENT 2 ($/ha)	D − E ($/ha)	NET RETURN C − F ($/ha)
56^{+}	56^{-}	745	641	103	39	11	28	+75
56^{+}	112^{-}	745	708	37	39	22	17	+20
56^{+}	168^{-}	745	731	14	39	32	7	+ 7
56^{+}	224^{-}	745	749	−4	39	43	−4	0
112^{+}	112^{-}	789	708	81	49	22	27	+54
112^{+}	168^{-}	789	731	58	49	32	17	+41
112^{+}	224^{-}	789	749	40	49	43	6	+33
168^{+}	168^{-}	724	731	−7	60	32	28	−35
168^{+}	224^{-}	724	749	−25	60	43	17	−42
224^{+}	224^{-}	791	749	43	71	43	28	+15
112^{+}	56^{+}	789	745	44	49	39	10	+34
224^{+}	112^{+}	791	789	2	71	49	22	−20

1 Under the different treatments the number indicates the seeding rate of Anza in kg/ha. The "+" means with weed control and the "−" means without weed control.

2 Return based on the yield/ha and a market price for the wheat at $110/metric ton ($4.90/cwt).

3 Cost based on a combination of seed cost @ $0.193/kg ($8.75/cwt), and, where applicable, herbicide cost @ $20.71/ha (Bromoxynil @ 0.5#/A; price @ $33.82/gal) and application cost @ $6.80/ha ($2.75/A).

2,4-D, 2,4-D/DICAMBA AND DICAMBA ON WEED FREE WHEAT

P. E. Heikes[1]

Studies have shown that precise timing is necessary for applications of 2,4-D [(2,4-dichlorophenoxy)acetic acid] on wheat, but there is less information of the use of dicamba (3,6-dichloro-*o*-anisic acid) or 2,4-D/dicamba combinations on wheat. Most farmers know that after the jointing stage, 2,4-D or dicamba should not be used, but often they do not heed this information; or they may not be able to spray at the right time, or there might not be weeds early when the wheat is right to spray.

The purpose of this experiment was to study the effect of 2,4-D LV ester alone; 2,4-D/dicamba combination and dicamba alone on fall seeded, weed free wheat, and to show farmers what yield loss can be expected from herbicide applications made at the wrong growth stage. A second reason for the study was that recently there has been greater emphasis on the use of dicamba on wheat.

Herbicides were applied at five different growth stages. The first application was made at the 5-leaf, fully tillered stage, with subsequent applications at about two week intervals thereafter, for a total of 5 treatment dates. 2,4-D LV ester was applied at 3/4 lb ai/A; 2,4-D amine/dicamba at 1/4 + 1/8 lb ai/A and dicamba at 1/8 lb ai/A. Plots were 10 ft x 50 ft with 4 replications. Herbicides were applied with a 10 ft boom with 6-8001 T-jet nozzles in 20 gallons of water per acre.

For each of the 5 treatment dates, the crop was mostly in the following stages of growth:

1.	April 22	5 leaf-fully tillered	70 F
2.	May 6	Early boot	70 F
3.	May 22	Bloom	60 F
4.	May 30	Past bloom	80 F
5.	June 4	Hard dough	80 F

Observations: See Table 1 for yield comparisons. Wheat was harvested with a Hege 4 ft plot combine, June 28.

It was apparent from this experiment that there is a period of about four weeks after early boot, through bloom period, that neither 2,4-D, dicamba nor combinations whould be applied on fall seeded wheat, and there is less than 10 days when wheat can be treated with minimum effect on yield. The most critical time was between boot and bloom stages. There was no significant yield loss when herbicides were applied at the fully tillered stage of growth or after blossom when the kernels were fully formed.

It was also apparent that the timing for use of dicamba is more critical than for 2,4-D. When 2,4-D was applied at bloom stage, there were some blank heads and some yield loss, but only parts of the head were blank, mostly the top part, with the lower part producing normal grain. Where dicamba was applied at the same growth stage, there were completely blank heads or kernels much reduced in size and yield loss was greater. Much of the grain was so light it was lost with the threshing.

There was no significant difference between the effects of dicamba alone and dicamba/2,4-D with the same rates of dicamba.

[1]Cooperative Extension Service, Colorado State University, Fort Collins, CO 80523.

Table 1. Yield Comparisons of Winter Wheat Following 2,4-D and Dicamba Applied at Five Growth Stages and Harvested June 29, 1977 at Burlington, CO

Treatment	Stage of Growth	Average of 4 Reps: Bu. Wt.	Average of 4 Reps: Yield (bu/acre)
1. 2,4-D 3/4 lb/A	Fully tillered	63	47.5
2. 2,4-D 3/4	Early boot	63	47.6
3. 2,4-D 3/4	Bloom	63	43.3
4. 2,4-D 3/4	Past bloom	64	49.5
5. 2,4-D 3/4	Hard dough	63	48.4
6. 2,4-D 1/4 + dicamba 1/8	Fully tillered	64	53.4
7. 2,4-D 1/4 + dicamba 1/8	Early boot	63	47.5
8. 2,4-D 1/4 + dicamba 1/8	Bloom	62	25.2
9. 2,4-D 1/4 + dicamba 1/8	Past bloom	64	49.4
10. 2,4-D 1/4 + dicamba 1/8	Hard dough	64	52.1
11. Dicamba 1/8	Fully tillered	63	54.4
12. Dicamba 1/8	Early boot	63	50.7
13. Dicamba 1/8	Bloom	54	31.6
14. Dicamba 1/8	Past bloom	62	50.5
15. Dicamba 1/8	Hard dough	63	50.6
Untreated control		64	52.5

THE EFFECTS OF METRIBUZIN IN DRY LAND AND SPRINKLER IRRIGATED WHEAT

J. L. Moore[1]

ABSTRACT: Metribuzin (4-amino-6-*tert*-butyl-3-[methylthio]-*as*-triazin-5[4-*H*]-one) has been shown to be an effective broadleaf and grass herbicide in numerous tests throughout the Northwest. Applications post-emergence of 4 to 8 oz ai/A to dry land wheat have shown excellent crop tolerance. Timing of application must be related to stage of development of weed species with winter annuals requiring the earliest application. Variety trials have shown slight differences in tolerance, with the majority of varieties tested tolerant enough to allow commercial application. Trials conducted during 1977 indicate crop tolerance as well as winter annual control is drought related.

[1]Mobay Chemical Corporation, Boise, ID

Sprinkler irrigated wheat is highly susceptible to metribuzin applications. Trials conducted at rates of 4 to 8 oz ai/A have unanimously shown crop damage at or near 100%. Because of these results, sprinkler irrigated wheat has been removed from the proposed labeling.

THE RESULTS OF TWO YEARS' TESTING WITH ETHOFUMESATE UNDER AN EXPERIMENTAL USE PERMIT IN GRASS SEED CROPS

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

Ethofumesate (2-ethoxy-2,3-dihydro-3,3-dimethyl-5-benzofuranol methanesulfonate) was first tested in grass seed crops in Oregon and Washington in 1971. These tests and subsequent ones showed ethofumesate to be selective in annual and perennial ryegrass when applied preemergence or postemergence. Furthermore, crop selectivity was demonstrated in established stands of Kentucky bluegrass, fescues and bentgrass. The major weed species controlled included annual bluegrass (*Poa annua*), rattail fescue (*Festuca myuros*), common chickweed (*Stellaria media*), wild oats (*Avena fatua*) and volunteer small grain.

Dosage rates of 0.75 to 1.5 kg/ha have proven satisfactory for controlling the above weeds.

In 1975 an Experimental Use Permit was received from the Environmental Protection Agency to test ethofumesate in grass seed crops under grower conditions. An extension of this permit was obtained in 1976. In the two year program, a total of 144 grower trials were established, ranging in size from one acre to over 100 acres. The results showed ethofumesate to be highly effective in controlling the aforementioned weeds. Control was consistently in the 90% to 100% range. Furthermore, crop selectivity was satisfactory, except under cold, wet condition, where slight stand reduction and stunting was observed in new seedings of ryegrass.

In the fall of 1977, the Oregon Department of Agriculture received an Emergency Exemption under Section 18 of Amended FIFRA from the Environmental Protection Agency permitting the use of ethofumesate in ryegrass during the fall of 1977.

Registration for use in grass seed crops is expected in 1978.

[1]Fisons Corporation, Bedford, MA

ETHALFLURALIN, A NEW HERBICIDE FOR PODDED CROPS

W. T. Cobb[1]

Ethalfluralin [*N*-ethyl-*N*-(2-methyl-2-propenyl)-2,6-dinitro-4-(trifluoromethyl)benzenamine] is the analog of the dinitroaniline herbicide, trifluralin (α,α,α-trifluoro-2,6,-dinitro-*N*,*N*-dipropyl-*p*-toluidine). When compared

[1]Plant Science Representative, Lilly Research Laboratories, Kennewick, WA

under field conditions, ethalfluralin has demonstrated a broader spectrum of weed control and slightly less soil residual activity than trifluralin. Trials conducted by Eli Lilly field personnel, university investigators, and technical representatives from several food processing and seed companies during the period of 1974 to 1977 have demonstrated that the major podded crops grown in the Pacific Northwest show good tolerance to ethalfluralin at rates required for effective weed control

Methods and Materials

Research trials were conducted on a number of podded crops in Washington and Idaho with ethalfluralin applied preplant soil incorporated. Soil incorporation was performed either by double discing to a depth of 3 to 5 inches or by a single discing followed by one pass with the grower-cooperator's incorporation equipment (springtooth harrow, springtooth plus spiketooth, etc.).

Ethalfluralin was evaluated on drybeans in 5 trials at rates from 0.38 to 3 lb/A (a.i.). Trifluralin plus EPTC (*S*-ethyl dipropylthiocarbamate) was used as a reference treatment. The soil texture among the trial locations varied from a loamy sand to loam with a range in organic matter percentage of 0.8 to 1.5. Bean types included red, pink, pinto and white.

Three trials each were conducted with ethalfluralin on lentils and peas at rates from 0.38 to 1 lb/A. Trifluralin was used as a reference treatment. The lentil trial sites ranged from coarse to medium in soil texture with an average organic matter content of 3.4 percent. Of the pea trials, one was conducted on irrigated green peas on a sandy loam soil containing 1.5 percent organic matter, while the remaining 2 trials were on dryland peas on silt loam soil containing 3 to 4 percent organic matter.

A 'Mendoza Bush' lima bean trial was conducted on a coarse texture soil with rates of ethalfluralin ranging from 0.75 to 1.25 lb/A. Several of the treatments received an overlay postemergence application of bentazon [3-isopropyl-1*H*-2,1,3-benzothiadiazin-(4)3*H*-one 2,2-dioxide]. A preplant application of triflualin at 0.5 lb/A was used as the reference treatment.

Results

Dry beans. As indicated in Table 1, dry beans exhibit excellent tolerance to ethalfluralin. Barnyardgrass and nightshade (black and hairy) evaluations at mid- to late-season are also presented. Although specific data for redroot pigweed, tumble pigweed, lambsquarters and Russian thistle are not shown, control of these species was excellent with ethalfluralin at 0.75 lb/A. Yield enhancement was observed in all treatments.

Peas. Both irrigated and dryland peas exhibited acceptable tolerance to ethalfluralin (Table 2). Slightly more early-season crop injury was observed on the earlier-planted irrigated peas. Also, the coarse textured soil of the irrigated peas in contrast to the medium soil of the dryland trials may have contributed to the increased early injury.

Yields were greatly enhanced on dryland peas from all herbicide treatments due to the degree of control of the heavy populations of wild oats.

Lentils. When compared on a rate-for-rate basis with trifluralin, ethalfluralin exhibited an increase in safety on lentils (Table 3).

Table 1. Response of Dry Beans and Herbicidal Efficacy from Preplant Soil Incorporated Applications of Ethalfluralin. (Ave. data from 5 trials)

Compound	Rate LB/A	Crop Injury[1]	Weed Control[2] Barnyard-grass	Night-shade	Yield % of Control
Ethalfluralin	0.5	0.5	8.8	8.8	156
	0.75	0.5	9.0	8.7	159
	1	1	9.7	9.1	161
	1.5	1.4	9.8	9.3	149
	2[3]	1.9	9.8	9.5	154
Trifluralin	0.5	0.9	8.6	5.5	160
Trifluralin + EPTC	0.5+3	0.8	8.9	9.1	149

[1]Early-season evaluations. 0 = No injury; 10 = Death of plant.

[2]0 = No control; 10 = 100 percent control.

[3]In two trials, 2 lb/A was not evaluated so the next higher rate, 3 lb/A, was used.

TABLE 2. Response of peas and herbicidal efficacy from soil incorporated applications of ethalfluralin under irrigated and dryland culture.

Compound	Rate Lb/A	Crop Injury[1] Irrigated	Crop Injury[1] Dryland	Yield[2] Irrigated	Yield[2] Dryland
Ethalfluralin	0.38	0.0	0.0	118	198
	0.5	0.2	0.7	95	200
	0.75	1.2	1.6	108	199
	1	3.4	1.8	87	218
Trifluralin	0.5	0.5	0.9	97	160

[1]Early-season evaluations. 0 = No injury; 10 = Death of plant.

[2]Expressed as a percent of the control.

The control of wild oats, lambsquarters, and tarweed was excellent with ethalfluralin at rates of 0.5 lb/A or higher. As was observed in the peas, the control of heavy populations of these weed species resulted in yield enhancement.

Lima beans. Mendoza bush lima beans exhibited acceptable tolerance to ethalfluralin at 0.75 lb/A, the lowest rate evaluated (Table 4). At this rate, 95 percent or greater season-long control of lambsquarters and barnyardgrass was provided.

Table 3. Response of lentils and percent weed control from preplant soil incorporated applications of ethalfluralin. (Data average of 3 trials)

Compound	Rate Lb/A	Crop Injury[1]	Weed Control[2]	Yield % of Control
Ethalfluralin	0.38	0.5	8.3	187
	0.5	1.2	9.1	186
	0.75	1.8	9.5	200
	1	3.1	9.7	185
Trifluralin	0.5	1.6	9.0	161
	1	3.7	9.3	142

[1]Early-season evaluations. 0 = No injury; 10 = Death of plant

[2]Average control of wild oat, lambsquarters, and tarweed. 0 = No control; 10 = 100 percent control

TABLE 4. Response of lima beans to preplant soil incorporated applications of ethalfluralin.

Compound	Rate Lb/A	Crop Injury[1]		Weed Control[2]	
		Early	Mid	Lambs-quarters	Barnyard-grass
Ethalfluralin	0.75	1.6	0.0	9.6	9.6
	1	2.0	1.0	9.5	9.6
	1.25	2.6	1.9	10.0	9.5
Ethalfluralin + bentazon	0.5+0.75	1.0	1.5	9.5	8.8
Trifluralin	0.5	1.5	0	9.5	8.3

[1]0 = No crop injury; 10 = Death of plant

[2]0 = No control; 10 = 100 percent control
Evaluations 6 weeks after planting.

Summary

Results from numerous research trials conducted over a four-year period indicate that a greater margin of safety to both dry beans and lentils can be realized from applications of ethalfluralin versus trifluralin. On the other hand, peas show essentially equal tolerance to ethalfluralin and trifluralin in rate-for-rate comparisons.

Ethalfluralin demonstrated efficacy comparable to trifluralin for control of wild oats, lambsquarters, and pigweed spp. However, control of nightshade spp. was superior to trifluralin.

Eli Lilly and Company plans to request an EPA Experimental Use Permit to make possible large-scale evaluation of ethalfluralin on podded crops in the Pacific Northwest in 1979.

HERBICIDE SCREENING--SOME OBSERVATIONS

R. L. Zimdahl[1]

It has been the custom among companies that manufacture and market herbicides to use an empirical screening technique to find and evaluate candidate chemicals. This involves application of a chemical, whose biological activity is unknown, to a series of plants to assess its activity and selectivity. One or a combination of three different ways of selecting candidate herbicides for inclusion in the screen is usually employed (1). The empirical method involves synthesis or acquisition of completely novel compounds and the hoped for discovery of activity. The imitative method may also be adopted whereby a company synthesizes molecules within a group with known herbicidal activity. The empirical method is attractive because it offers great likelihood of exclusive patentability but unfortunately a very low success rate. The imitative method usually has a higher success rate but low probability of exclusive patent rights. A third method offers great promise but has not achieved much success in herbicide development. It is the rational method whereby a compound is synthesized to specifically interfere with precisely defined metabolic processes. Most, if not all, of the initial discoveries of activity in a particular group of herbicides have been made by the empirical or serendipitous route. One might conclude that sound methodology is required but does not necessarily lead to success without serendipity or a little bit of luck.

I became interested in this process because I wanted to do a better job of helping undergraduate and graduate students understand where herbicides come from and the intricacies of the development process. During a sabbatic leave I took the opportunity to visit seven important herbicide companies and have since visited one other and surveyed six more by mail. It is understandable that some companies did not wish to reveal their screening process or specific information about it. Others were willing to release the information to me but requested that I not connect specific facts to them. Therefore, whereas the comments that follow accurately reflect the practices of the 14 companies contacted, they do not reveal specific information about any one.

We are all aware of the fact that herbicide development costs are increasing rapidly. It is not my intent to explore the reasons for this or to elaborate the fact. However, given that costs are going up I assumed that screening techniques would be well defined and that most companies would be carrying out a very similar process. I found that there was validity to this assumption if only general methodology was considered but that few generalizations could be made about specific screening procedures.

Among the companies surveyed, the number of compounds screened per year rnaged from 2500 to 10,000. The number of species employed in the primary screen ranged from 3 to 14 and from 15 to 36 in the secondary screen. Even greater diversity was noted in the rate of herbicide application. Primary screens ranged from a low of 1.25 and 5 up to 40 kg/ha. Secondary screens covered an even wider range from one company that used rates of 0.15, 0.635 and 2.5 to another that used 5, 10, 20 and 40 kg/ha. Most employed spraying but some used flooding to apply herbicides and others used flooding in the primary and spraying in the secondary screen. Total

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solution applied varied from 65 to 850 L/ha. A light soil was the most common growth medium but some used a greenhouse potting mix or soil amended with sand. There was disagreement about whether herbicides should be applied directly to seed. Generally they were not but in two cases they were and in a third seeds were placed directly on the sprayed soil surface.

In spite of differences in methodology there was surprising agreement on the main objective, which was to find herbicides with activity and selectivity in one or more of the world's major crops. Given the agreement on this principal objective and the universal spplication of the empirical screening method the wide diversity in specific methodology is all the more surprising.

The primary screen was universally described as a search for activity. This is why high rates are used and death or severe deformation is the criterion of success. The success rate from the primary to the secondary screen is about 10 percent. This is good because it indicates the screen is working and reduces work and expense. All companies, with a few specific exceptions, indicated that they could find any known herbicide with their present screening system.

To do this 46 species from 15 different families were used in primary and 85 from 22 different families in secondary screening (Table 1). The complete species lists are shown in Tables 6 (primary) and 7 (secondary).

Table 1. Annual and Perennial Species and Plant Families Used by 14 Companies

	Primary	Secondary
Annuals	34 14 families	69 20 families
Perennials	11 5 families	16 9 families
Total	45	85

Sagger (1) stated that crops are preferred for primary screening because of unifrom germination and predictable growth. These data do not support this assumption because more weeds were used in both stages (Table 2).

Table 2. Weed and Crop Species Used for Screening by 14 Companies

Screening Stage	Number of Weeds	Number of Crops
Primary	32	13
Secondary	60	25

The most commonly used family was the Poaceae (Table 3). Brassicaceae and Solanaceae were next most common in primary and Amaranthaceae, Malvaceae and Fabaceae in secondary screening. Another way to look at the data in Tables 6 and 7 is to examine the number of species from each family rather than the number of companies using particular family. These data again reveal the dominance of the Poaceae and the fact that many more annual species are used in primary screening (Table 4). The same data for secondary screening (Table 5) also show the predominance of the Poaceae and annual species. Based on this observation and other knowledge one logically concludes that grasses represent major unsolved problems in weed control and most screening programs are designed to find herbicides with grass activity.

However, I remain puzzled by the fact that 11 different grass species are employed in primary and 22 in secondary screening among the companies surveyed. The diversity of broadleaf species is also puzzling. I am convinced the species list would lengthen if additional companies were surveyed.

Several plausible reasons for species diversity between companies can be offered. Perhaps the most important is tradition. Many companies have been screening herbicides for some time and the same plant has been used throughout the life of the program or for several years. Its response to a wide variety of compounds has been well defined and it now serves as a reliable indicator. This leads directly to a second plausible reason for diversity which is known responses of certain species to proprietary compounds. Specific plants are used because of their known response to compounds being developed which are related to those the company has developed. Often a particular plant will be included because it has been designated as a target species. That is it is either an obvious problem that demands a solution or scientists think their herbicidal chemistry available to them has an excellent chance of success against a particular weed species or group of plants. A good example of the problem demanding solution would be inclusion of *Alopecuris myosuroides* in many programs and an example of the second kind could be the inclusion of *Equisetum arvense* in two programs.

More pragmatic reasons for diversity include total lack of seed availability, lack of a reliable seed source, or inability to grow some weed species at the location, or under the conditions, where screening is conducted.

A final important reason for diversity is our ignorance of specific physiological and biochemical processes. If we really understood how respiration is mediated, how the Hill reaction works or how cellulose is synthesized we would be better able to select target species. Such understanding would allow companies to better employ the rational screening method. It is, of course, understood that differences in plant morphology, cuticle and other surface characteristics, rooting habit, etc., preclude the total elimination of empirical screening of herbicides. However, we may see the day when such screening is confined to later development stages after initial activity and some aspects of selectivity have been determined.

It is not the intention of this paper to judge the quality or correctness of the several techniques presently employed. Rather, I have presented the techniques and elaborated their differences, while offering some reasons for them. The acquisition of this information has reinforced my belief that the process of herbicide development is lengthy, expensive and complex and highly empirical.

Table 3. Plant Families Used in Herbicide Screening by 14 Companies

Family	Number of Companies Using	
	Primary	Secondary
Amaranthaceae	4	11
Asteraceae	3	8
Brassicaceae	8	8
Caryophyllaceae	1	4
Chenopodiaceace	4	9
Convolvulacaeae	4	8
Cyperaceae	5	6
Cucurbitaceae	1	1
Equisetaceae	0	1
Fabaceae	4	10
Labiatae	0	2
Leguminosae	2	7
Liliaceae	0	1
Malvaceae	5	11
Poaceae	14	13
Polygonaceae	3	6
Portulacaceae	0	1
Rubiaceae	1	5
Solanaceae	7	7
Umbelliferae	0	2
Urticaceae	0	2

Table 4. Species Used in Primary Screening by 14 Companies

Family	Number of Annuals	Number of Perennials
Amaranthaceae	1	
Asteraceae	2	1
Brassicaceae	5	
Caryophyllaceae	1	
Chenopodiaceae	2	
Convolvulaceae	1	1
Cucurbitaceae	1	
Cyperaceae		3
Fabaceae	2	
Leguminosae	1	
Malvaceae	2	
Poaceae	11	5
Polygonaceae	2	1
Rubiaceae	1	
Solanaceae	2	
TOTAL	34	11

Table 5. Annual Species Used in Secondary Screening by 14 Companies

Family	Number of Annuals	Number of Perennials
Amaranthaceae	1	
Asteraceae	9	2
Brassicaceae	6	
Caryophyllaceae	1	
Chenopodiaceae	2	
Convolvulaceae	2	1
Cucurbitaceae	1	
Cyperaceae	1	2
Equisetaceae		1
Fabaceae	3	
Labiatae	1	1
Leguminosae	3	1
Liliaceae		1
Linaceae	1	
Malvaceae	3	
Poaceae	22	5
Polygonaceae	3	2
Portulacaceae	1	
Rubiaceae	1	
Solanaceae	5	
Umbelliferae	2	
Urticaceae	1	
TOTAL	70	16

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Table 6. Species Employed in Primary Screening at Fourteen Herbicide Companies

Scientific Name	Common Name
Amaranthaceae	
Amaranthus retroflexus	Redroot pigweed
Asteraceae	
Cirsium arvense	Canada thistle
Lactuca sativa	Lettuce
Xanthium italicum	Cocklebur
Brassicaceae	
Brassica juncea	Indian mustard
Brassica nigra	Wild mustard
Lepidium campestre	Field pepperweed
Sinapis alba	White mustard
Sinapis arvensis	Common mustard
Caryophyllaceae	
Stellaria media	Chickweed
Chenopodiaceae	
Beta vulgaris	Sugarbeet
Chenopodium album	Lambsquarters
Convolvulaceae	
Convolvulus arvensis	Field Bindweed
Ipomea purpurea	Tall morning glory
Cucurbitaceae	
Cucumis sativa	Cucumber
Cyperaceae	
Cyperus esculentus	Yellow nutsedge
Cyperus euphorbia	
Cyperus rotundus	Purple nutsedge
Fabaceae	
Phaseolus lunatus	Civet bean
Phaseolus vulgaris	Bean
Leguminoseae	
Glycine max	Soybean
Malvaceae	
Abutilon theophrasti	Velvetleaf
Gossypium hirsutum	Cotton
Poaceae	
Agropyron repens	Quackgrass
Agrostis alba	Redtop
Avena fatua	Wild oat
Avena sativa	Oat
Bromus tectorum	Downybrome grass
Digitaria sanguinalis	Large crabgrass
Echinochloa crus-galli	Barnyardgrass
Lolium multiflorum	Ryegrass
Lolium perenne	Perennial ryegrass
Panicum miliaceum	Proso millet
Setaria glauca	Yellow foxtail

Table 6. Continued

Scientific Name	Common Name
Poaceae	
Setaria italica	Foxtail millet
Setaria viridis	Green foxtail
Sorghum halepense	Johnsongrass
Triticum aestivum	Wheat
Zea mays	Corn
Polygonaceae	
Polygonum convolvulus	Wild buckwheat
Polygonum pennsylvanicum	Pennsylvania smartweed
Rumex crispus	Curly dock
Rubiaceae	
Galium aparine	Bedstraw
Solanaceae	
Datura stramonium	Jimsonweed
Lycopersicon esculentum	Tomato

Table 7. Species Employed in Secondary Screening at Thirteen Herbicide Companies

Scientific Name	Common Name
Amaranthaceae	
Amaranthus retroflexus	Redroot pigweed
Asteraceae	
Ambrosia elatior	Ragweed
Centaurea cyanus	Cornflower
Chrysanthemum segetum	Oxeye daisy
Cirsium arvense	Canada thistle
Helianthus annuus	Sunflower
Matricaria chamomile	Chamomile
Senecio vulgaris	Common groundsel
Taraxacum officinale	Dandelion
Tussilago farfara	Coltsfoot
Xanthium italicum	Cocklebur
Zinnia elegans	Zinnia
Brassicaceae	
Brassica juncea	Indian mustard
Brassica rapus	Summer rape
Brassica nigra	Wild mustard
Brassica oleraceae var. botrytis	Cauliflower
Capsella bursa pastoris	Shepherd's purse
Sinapis alba	White mustard

Table 7. Continued

Scientific Name	Common Name
Caryophyllaceae	
Stellaria media	Chickweed
Chenopodiaceae	
Beta vulgaris	Sugarbeet
Chenopodium album	Lambsquarters
Convolvulaceae	
Convolvulus arvensis	Field bindweed
Ipomea batata	Morning glory
Ipomea purpurea	Tall morning glory
Cyperaceae	
Cyperus esculentus	Yellow nutsedge
Cyperus iria	Rice flatsedge
Cyperus rotundus	Purple nutsedge
Cucurbitaceae	
Cucumis sativa	Cucumber
Equisetaceae	
Equisetum arvense	Field horsetail
Fabaceae	
Arachis hypogaea	Peanut
Glycine max	Soybean
Phaseolus vulgaris	Bean
Labiatae	
Glechoma hederaceae	Ground ivy
Lamium amplexicaule	Henbit
Leguminosae	
Cassia obtusifolia	Sicklepod
Medicago sativa	Alfalfa
Pisum sativa	Pea
Sesbania exaltata	Hemp sesbania
Liliaceae	
Allium spp.	Wild onion or garlic
Linaceae	
Linum usitatissimum	Flax
Malvaceae	
Abutilon theophrasti	Velvetleaf
Gossypium hirsutum	Cotton
Sida spinosa	Prickly sida
Poaceae	
Agropyron repens	Quackgrass
Agrostis alba	Redtop
Alopecuris mysuroides	Blackgrass
Apera spica-venti	Windgrass
Avena fatua	Wild oat
Avena sativa	Oat
Bromus tectorum	Downy bromegrass
Cynodon dactylon	Bermudagrass
Digitaria sanguinalis	Large crabgrass
Digitaria scalaria	Crabgrass

Table 7. Continued

Scientific Name	Common Name
Poaceae (continued)	
Echinochloa crus-galli	Barnyardgrass
Hordeum vulgare	Barley
Leptochloa filiformis	Red sprangletop
Lolium perenne	Perennial ryegrass
Oryza sativa	Upland rice
Panicum miliaceum	Proso millet
Poa annua	Annual bluegrass
Rottboellia exaltata	Itchgrass
Setaria faberi	Giant foxtail
Setaria italica	Foxtail millet
Setaria leutescens	Yellow foxtail
Setaria viridis	Green foxtail
Sorghum bicolor	Shattercane
Sorghum halepense	Johnsongrass
Sorghum vulgare	Sorghum
Triticum aestivum	Wheat
Zea mays	Corn
Polygonaceae	
Polygonum convolvulus	Wild buckwheat
Polygonum lapathifolium	Pale smartweed
Polygonum pennsylvanicum	Pennsylvania smartweed
Rumex crispus	Curly dock
Rumex obtusifolia	Broadleaf dock
Portulaca oleracea	Purslane
Galium aparine	Bedstraw
Solanaceae	
Datura stramonium	Jimsonweed
Lycopersicon esculentum	Tomato
Nicotiana tobaccum	Tobacco
Solanum nigrum	Nightshade
Solanum tuberosum	Potato
Umbelliferae	
Daucus carota sativa	Carrot
Pastinaca sativa	Wild parsnip
Urticaceae	
Urtica urens	Burning nettle

EVALUATION OF VELPAR, BUTHIDAZOLE, AND FLURIDONE FOR THE CONTORL OF AQUATIC WEEDS

N. Dechoretz and P. A. Frank[1]

Herbicide evaluation is an integral part of our research program to develop and improve chemical control of aquatic weeds. The primary objectives of the evaluation studies are: 1. to obtain preliminary data of the efficacy of registered and experimental herbicides when applied to aquatic weeds, 2. to determine the specific responses of various aquatic weeds when exposed to new compounds or new application methods, and 3. to develop new evaluation techniques or refine the techniques presently used.

Over the last 2 years, 150 compouds were evaluated for herbicidal activity. Of those tested, Velpar[2] [3-cyclohexyl-6-(dimethylamino)-1-methyl-*s*-triazine-2,4(1*H*,3*H*)-dione], buthidazole [3,5-(1,1-dimethylethyl) -1,3,4-thiadiazol-2-yl-4-hydroxy-1-methyl-2-imidazolidinone] and fluridone [1-methyl-3-phenyl-5-(3-trifluromethylphenyl)-4(1*H*)-pyridinone] exhibited the greatest phytotoxicity. The studies reported here deal with the phytotoxicity of the above three herbicides applied pre and postemergence on selected aquatic weeds in greenhouse tests, and with field tests made with Velpar and buthidazole.

Evaluations

Three techniques were used in this study to evaluate the activity of the test compounds. These procedures are described briefly as:

1. Application of the test compound to water after weeds have become established (Technique no. 1),
2. Application of the test compound to water before the emergence of the weeds from the soil (Technique no. 2), and
3. Application and incorporation of the test compound into the soil prior to plant emergence (Technique no. 3).

Silty clay loam soil, tap water, and 20-liter glass containers were used in all three treatment procedures. Sago pondweed (*Potamogeton pectinatus* L.) and American pondweed (*Potamogeton nodosus* Poir.) were used as test plants in all treatments. Elodea (*Elodea canadensis* Michx.) was included in evaluation Technique no. 1 only. These plants were selected because : 1. they infest a wide variety of water impounments and distribution systems; 2. they differ in form and structure; 3. vegetative material for planting is readily available and the plants are easily cultured; and 4. the susceptibility of these weeds to different herbicides is often varied.

Procedures for evaluation Techniques 1 and 3 have been published (2, 3). All of the compounds were evaluated in Technique no. 1 at concentrations ranging from 0.1 to 5 ppmw. In addition, fluridone was evaluated at 10 ppmw. The degree of phytotoxicity was based on visual observations of the plant responses made at weekly intervals for 4 weeks. A rating scale of 0 to 10 was used, in which 0 = no injury and 10 = plants dead.

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Application rates for the preemergence soil treatments ranged from 1.12 kg/ha to 22.4 kg/ha of active ingredient. Observations of plant responses and the extent of weed control were made at weekly intervals for four weeks and based on the 0 to 10 rating system.

Containers used in evaluation Technique no. 2 were prepared by placing 7.5 cm of soil in each 20-liter container. Each container was planted by inserting four sage pondweed tubers and four American pondweed winterbuds into the soil and then filling the container with approximately 18 L of water. The final step was addition of the herbicide. Water was added at weekly intervals to compensate for evaporation. The concentrations of herbicides used in these tests franged from 0.25 to 1 ppmw. Weekly observations were made for four weeks and the herbicidal activity was determined as in evaluation Technique no. 3.

Field Trials

Based on the results obtained in the laboratory, three small farm ponds containing dense infestations of aquatic weeds were selected for treatment with either buthidazole or Velpar. Fluridone was not field tested because of an inadequate supply of the herbicide.

Herbicide formulations, treatment rates and pond dimensions are summarized in Table 1. All herbicide treatments were made after the weeds were well developed and more than 90% of the pond surface was covered with vegetation. Pond 1 was infested with Eurasian watermilfoil (*Myriophyllum spicatum* L.), Pond 2 with watermilfoil and elodea, and Pond 3 with sago pondweed and *Chara* sp. Pond 1 contained a modest population of large-mouth bass (*Micropterus salmoides* Tepepedes), blue gill (*Lepomis macrochirus* Raf.) and mosquito fish (*Gambusia offinis* Baird and Girard); Pond 2 contained bluegill and mosquito fish; and Pond 3 contained mosquito fish.

Table 1. Herbicides and Formulations Used, Rates of Herbicide Application, and Dimensions of the Treat Ponds.

Treatment	Formulation	Treatment rate ppmw	Surface area ha	Mean depth m
Pond 1 - Velpar	Granules - 90%	1.0	0.24	1.8
Pond 2 - Buthidazole	WP - 75%	1.0	0.15	1.5
Pond 3 - Buthidazole	Granules - 5%	0.25	0.15	0.76

Pond 1 was treated with a water-soluble formulation of Velpar, and Pond 2 was treated with a wettable powder suspension of buthidazole. Both herbicides were injected 30 cm beneath the water surface behind a motor-driven boat. Granules containing 5% buthidazole were applied to Pond 3 using a granule spreader and a boat.

Results of Greenhouse Evaluations

Postemergence tests. Results of the greenhouse evaluations of the three herbicides when applied to water containing established growths of aquatic weeds are shown in Table 2. Of the three herbicides tested, buthidazole demonstrated the highest degree of activity. If an activity rating of 9

Table 2. Activity of Velpar, buthidazole, and fluridone when applied to water as a post-emergence treatment, 4-week exposure.

Treatment	Conc. ppm	Herbicidal activity measured by symptoms of injury [1/]					
		E. canadensis		*P. nodosus*		*P. pectinatus*	
Fluridone	.10	0[2/]	(0)[3/]	0	(0)	0	(0)
	.25	0	(0)	0	(0)	0	(0)
	.50	0	(0)	0	(0)	0	(0)
	1.0	0	(0)	4.5	(2.9)	6.5	(3.8)
	5.0	0	(0)	5.0	(3.0)	5.0	(3.5)
	10.0	0	(0)	5.5	(3.5)	7.0	(4.3)
Velpar	.10	0	(0)	0	(0)	0	(0)
	.25	6	(3.5)	5.5	(3.0)	6.5	(3.3)
	.50	6	(3.7)	10	(5.8)	9	(5.0)
	1.0	8	(5.1)	10	(5.8)	10	(5.5)
	5.0	10	(5.6)	10	(8.0)	10	(7.6)
Buthidazole	.10	0	(0)	10	(6.8)	9	(7.4)
	.25	0	(0)	10	(7.5)	10	(7.4)
	.50	8	(6.4)	10	(8.4)	10	(8.4)
	1.0	9	(7.3)	10	(8.6)	10	(8.6)
	5.0	9	(7.5)	10	(9.0)	10	(9.3)

[1/] Response of weeds based on 0 to 10 scale; 0 = no response, 10 = dead

[2/] Values in this column are averages of 4 weekly ratings.

[3/] Values within parentheses are averages of 4 weekly ratings.

represented the minimum level for acceptable control, then all test species were controlled at concentrations of 1 ppmw or greater. Concentrations as low as 0.1 and 0.25 ppmw killed American pondweed and sago pondweed, respectively. Elodea was only moderately susceptible to buthidazole at 0.5 ppmw, and was tolerant of concentrations lower than 0.5 ppmw.

Although the activity of Velpar was considered very good on sago pondweed and American pondweed at concentrations above 0.5 ppmw, symptoms of injury and kill of the test plants did not progress as rapidly with Velpar as with buthidazole. The test plants were more tolerant of Velpar than of buthidazole, with no injury evident in the 0.1 ppmw test, and only slightly more than moderate injury when treated at 0.25 ppmw. Elodea was again more tolerant than the pondweeds, but less so than observed in the buthidazole treatments.

Fluridone at 10 ppmw produced some phytotoxic effects, but the herbicide was generally ineffective on mature or well established plants. This is in comtrast with results from experiments conducted in Florida where fluridone was reported to be very effective on established infestations of hydrilla [*Hydrilla verticillata* (L. F.) Royle]. Although plants were generally resistant to fluridone, new plants produced from rhizomes were very susceptible. Approximately 3 to 5 days after treatment, new plants emerging from the soil became chlorotic. In addition to the chlorosis, plant growth was severely retarded. On the basis of evaluation data presented in Table 2, fluridone does not appear to be promising as a postemergence herbicide for control of aquatic weeds.

Preemergence tests. Neither Velpar nor buthidazole demonstrated significant herbicidal activity on the test plants when applied to the soil before emergence of the plants (Techniques 2 and 3). There are few data describing the effects of behavior of imidazole compounds in aquatic situations. We are unable to relate our results to the work of others and can draw no conclusions at this time.

In contrast to the imidazole compounds, the effects and fate of triazines in aquatic situations have received some attention (1, 4, 5, 6, 9). Triazines such as simazine [2-chloro-4,6-bis(ethylamino)-*s*-triazine] and terbutryne [2-(*tert*-butylamino)-4-(ethylamino)-6-(methylthio)-*s*-triazine] are known to control many aquatic weeds when applied to water provided there is a long period of contact between plant and herbicide (1, 5, 6, 9). Others (3, 7) have observed that triazines were generally ineffective for control of aquatic weed in irrigation canals when applied preemergence to the soil. Several reasons for the apparent lack of phytotoxicity to these species may be postulated; these include excessive leaching, minimal absorption, lack of translocation, and detoxification by the root system. Velpar performed in much the same manner as other triazines studied, i.e., little or no activity when placed in the soil, and relatively slow to produce symptoms of phytotoxicity when applied pre- or postemergence in water.

Fluridone was found to be a very effective aquatic herbicide when applied to soil or water as a preemergence treatment. In preemergence soil and water treatments, the first phytotoxic symptoms were apparent when plants emerged 3 to 5 days after treatment. The observed phytotoxic effects were emergence of chlorotic plants, followed by retardation of growth. When fluridone was added to the water prior to plant emergence, growth suppression was followed by plant necrosis and decomposition. Excellent control was obtained with fluridone at 0.25 ppmw.

Soil incorporation of fluridone appeared to reduce the herbicide's effectiveness to some degree. Although albescent plants emerged and growth was severely suppressed, necrosis and decomposition did not occur. Plants receiving preemergence treatment in milk cartons at 1.12 kg/ha and then submersed in water emerged chlorotic and remained stunted for about 2 weeks. However, after 2 weeks, the plants regained their normal green color and growth resumed. At the end of 1 month, the plants appeared normal when compared with those in the control vessels. Plants treated similarly in milk cartons at 5.6, 11.2 and 22.4 kg/ha were not dead 1 month after treatment. They remained stunted and the leaf margins retained their characteristic green color. Our results are generally in agreement with those of Waldrep and Taylor (8). Those researchers demonstrated that fluridone controlled a wide variety of grass and broadleaf weeds and the compound was more active preemergence than postemergence. The chlorotic appearance observed in susceptible plants is characteristic of the symptoms of injury observed in the species studies thus far.

Studies on the fate of fluridone in soil and water, the relationship between herbicide activity and growth stage of the target plant, and the effects of temperature, light, and soil type are currently underway. Preliminary results indicate that fluridone is toxic to the test plants during the first 2 weeks after emergence. Bioassays now underway indicate that fluridone may persist in water and soil for long periods of time.

Field Trials

Pond 1. Treatment of Pond 1 with Velpar resulted in complete control of watermilfoil. Seven days after treatment, 50% of the milfoil was slumped to the bottom of the pond. The remaining plant material exhibited varying degrees of phytotoxicity. At the same time, 25% of the blurush (*Scirpus* sp.) surrounding the pond was chlorotic. Complete control of the watermilfoil and bulrush was attained 14 and 21 days after treatment, respectively. Large trees located around the pond were not noticeably affected by the treatment. Numerous bluegill and bass were killed 5 days after treatment. Since the median tolerance limit (TL_{50}) of Velpar for fish is approximately 400 ppmw, the fish mortality was probably due to depletion of dissolved oxygen from the water.

Pond 2. Total weed control in Pond 2 treated with buthidazole occurred in a shorter period of time than in Pond 1 (Velpar-treated pond). One week after treatment, all the submersed weeds were slumped to the bottom of the pond. All of the bulrush and small willow trees surrounding the pond were a brownish-white in color. The aquatic vegetation was very dense at the time of treatment. The mortality of bluegill was high during the test. The TL_{50} of bluegill to buthidazole is reported to be 122 ppmw; consequently it was presumed that the death of bluegill was caused by decomposition of the dead plants and depletion of dissolved oxygen.

Pond 3. Sago pondweed in Pond 3 exhibited phytotoxic effects of the herbicide after 7 days. However, significant slumping of the plant material did not occur until 14 to 18 days after treatment. *Chara* was not effected by the buthidazole and no fish mortality was observed.

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PLUG PLANTING AS A METHOD OF INCREASING DIRECT-SEEDED TOMATO TOLERANCE TO SOIL APPLIED HERBICIDES

F. M. Ashton, H. L. Carlson, and R. K. Glenn[1]

Numerous experiments have been conducted over the past few years to evaluate the use of preplant soil-applied herbicides for control of nightshade species in tomatoes. Unfortunately, the most promising nightshade controlling treatments have proved to be, at best, only marginally selective in direct-seeded tomatoes. Accordingly, a field experiment was conducted on the U. S. Davis Campus to evaluate plug planting as a method of increasing tomato tolerance to preplant nightshade controlling herbicides. Plug planting refers to a planting mehtod in which small amounts of premixed crop seed and planting media are mechanically inserted into the soil. Plug planting, in theory, should result in increased crop tolerance to preplant herbicides due to both the physical separation of the germinating seed from the herbicide and the binding of the herbicide to adsorptive substances in the planting medium. Plug planting should also give precision-spaced planting and reduced soil crusting problems.

On June 1, 1977 each of the herbicide treatments listed in Tables 1 and 2 were applied to 2.3 x 4.6 m plots. The treatments were applied with a CO_2 pressure sprayer and immediately incorporated 5 cm deep into dry Yolo fine sandy loam with a power-driven rototiller. Following the herbicide application, each plot was divided into three 0.8 x 4.6 m subplots. One

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Table 1. Effect of Plug Planting on Tomato Vigor in Preplant Herbicide Treated Plots. U.C. Davis (T-27-77)[1]

		Tomato Vigor[3]					
		Evaluated 7/5/77			Evaluated 7/19/77		
Herbicide	Rate (kg/ha)[2]	Direct seed	Plug plant	Plug plant+ carbon	Direct seed	Plug plant	Plug plant + carbon
pebulate	9.0	6.3	7.0	8.5*[4]	7.3	8.8*	9.5*
pebulate	13.4	4.5	7.0*	8.8*	6.3	8.3*	9.3*
pebulate	17.9	4.0	6.5*	8.3*	6.5	8.3*	9.0*
chloramben	4.5	8.3	6.8	9.0	9.3	7.3	9.3
chloramben	9.0	6.8	3.5	7.5	7.5	3.5	9.0*
chloramben	13.4	6.8	4.5	8.3*	6.5	6.5	8.3*
metribuzin	1.1	7.8	8.3	8.7	9.5	9.0	9.0
metribuzin	2.2	4.5	7.3*	8.3*	7.8	8.3	9.0
metribuzin	3.4	4.0	5.5	6.8*	7.0	8.0	8.5*
alachlor	2.2	6.5	7.5	9.0*	8.0	7.5	8.5
alachlor	4.5	2.3	6.3*	8.3*	5.0	7.3*	8.8*
alachlor	6.7	0.8	5.8*	7.3*	2.8	7.3*	8.3*
bifenox	2.2	9.0	9.0	9.0	8.8	8.0	8.3
bifenox	4.5	6.8	7.8	8.3*	7.3	7.5	7.5
bifenox	6.7	6.5	7.0	8.5*	8.0	8.3	9.3
metolachlor	2.2	6.5	8.0*	9.0*	7.0	8.3	8.3
metolachlor	4.5	6.0	7.5*	9.5*	7.3	8.0	9.3*
metolachlor	6.7	2.5	7.5*	8.3*	5.5	8.0*	8.5*
ethafluralin	1.1	1.0	7.0*	8.5*	0.8	8.0*	9.0*
ethafluralin	2.2	0.0	6.0*	7.8*	0.0	7.0*	8.5*
ethafluralin	3.4	0.0	0.0	8.5*	0.0	0.0	8.3*
napropamide	2.2	8.5	7.5	8.8	9.5	8.5	8.8
control	---	5.5	6.3	6.5	3.3	3.3	3.0
control (hand weeded)		8.5	7.3	8.5	9.0	8.3	9.3
LSD (5%)[5]			1.4			1.3	

[1]Herbicide treatments applied 6/1/77; trial planted 6/6/77.

[2]To convert kg/ha multiply by 0.9

[3]Vigor ratings are the average of 4 replications based on a 0 to 10 scale. 0 = all dead tomatoes, 10 = no injury.

[4]Means followed by asterisk (*) are significantly higher than means for direct seeded tomatoes in the same herbicide treatment.

[5]Given LSD is for comparing all means for the farticular evaluation date.

Table 2. Effect of Plug Planting on Tomato Stand in Preplant Herbicide Treated Plots. U.C. Davis (T-27-77)

Herbicide	Rate (kg/ha)[1]	Tomato Stand[2] Direct seed	Plug plant	Plug plant + carbon
pebulate	9.0	7.3	7.5	8.8
pebulate	13.4	5.0	6.0	7.8
pebulate	17.9	7.5	8.0	8.5
chloramben	4.5	9.0	3.0	8.0
chloramben	9.0	7.0	1.0	6.5
chloramben	13.4	5.0	1.5	6.5
metribuzin	1.1	7.5	6.8	6.5
metribuzin	2.2	2.5	3.5	6.3
metribuzin	3.4	2.8	2.0	3.8
alachlor	2.2	7.3	6.5	7.3
alachlor	4.5	2.5	5.5	7.5
alachlor	6.7	0.8	3.8	8.3
bifenox	2.2	8.5	4.8	6.8
bifenox	4.5	5.5	5.3	6.8
bifenox	6.7	4.5	5.0	5.5
metolachlor	2.2	6.5	5.0	8.0
metolachlor	4.5	2.5	5.5	6.3
metolachlor	6.7	1.8	6.8	7.0
ethafluralin	1.1	0.3	4.3	6.5
ethafluralin	2.2	0.0	3.5	7.3
ethafluralin	3.4	0.0	0.0	6.5
napropamide	2.2	8.7	6.5	8.0
control	---	7.5	5.5	6.0
control (hand weeded)	---	8.0	5.8	8.0
LSD (5%)[3]		2.0		

[1]To convert kg/ha to lb/A multiply by 0.9

[2]Stand ratings are the average of 4 replications based on a 0 to 10 scale where 0 = all tomatoes dead and 10 = 100% stand.

[3]LSD = 2.0 for comparing all means on table.

subplot was direct-seeded with tomatoes. The second subplot was plug planted with a planting medium consisting of tomato seeds and a dry mixture of 50% fine vermiculite and 50% sphagnum peat. The third pubplot was plug planted with the same planting medium plus 5% activated carbon by weight. The carbon was added to increase the adsorptive capacity of the planting medium. The planting mixtures were inserted into the soil yielding a cylinder about 5 cm in diameter and 5 cm deep with the top at the soil surface. Approximately 125 ml of the planting mixture was used at each planting site. Sufficient seed was added to the planting mixtures to give 6 to 8 tomato seeds at each planting site. Each planting site was spaced 25 cm apart down the seed row. The plug planting was accomplished using a tractor mounted commercially modified transplant machine. The plots received the firt furrow irrigation on June 6, 1977. Tomato variety VF-145-7879 was used. Each treatment was replicated four times.

The experiment was evaluated for tomato stand and vigor on July 5 and July 19, 1977. The method of planting had a marked effect on the tolerance of tomatoes to the herbicide treatments. Tomato vigor and stand values for each planting method and herbicide treatment appear in Tables 1 and 2. The average vigor and stand values of all treatments for the three planting methods are given in Table 3. In general, tomatoes which were plug planted had significantly higher vigor rating than those planted by direct seeding. Furthermore, the addition of 5% activated carbon to the planting medium significantly increased tomato vigor over that obtained with the planting medium alone. On the trial average, there was no significant stand difference between direct-seeded tomatoes and tomatoes which were plug planted without carbon; however the addition of 5% carbon to the planting medium resulted in significantly better tomato stands than were attained with the other planting methods.

Table 3. Average effect of plug planting on tomato stand and vigor in several preplant herbicide treatments. U. C. Davis (T-27-77)[1]

Planting method	Stand	Tomato vigor 7/5/77	Tomato vigor 7/19/77
Direct seeded	4.92	5.12	6.22
Plug planted	4.72	6.50	7.17
Plug planted + carbon	6.98	8.31	8.50
LSD (5%):	0.34	0.22	0.19

[1]Vigor and stand values are the average of values attained from 96 plots established over the 24 treatments listed on table 1. Means are based on a 0 to 10 scale where 0 = all dead tomatoes and 10 = 100% stand or no tomato injury.

The most marked differences between plug planting and direct-seeded planting occurred in the alachlor, ethafluralin, metolachlor, and pebulate treated plots. Indeed, dramatic herbicide safening was evident in the ethafluralin treated plots which were plug planted with carbon.

The plots were evaluated for weed control on July 19, 1977. The most prominent weeds in the study area were common purslane and barnyardgrass. Other weeds present were hairy nightshade, groundcherry and redroot pigweed. In general, the pebulate, alachlor and ethafluralin treatments resulted in excellent weed control except for purslane. The control of weeds by the chloramben treatments was surprisingly poor. Apparently, this herbicide loses effectiveness when mechanically incorporated. The napropamide treat-

Table 4. Weed Control With Preplant Herbicide Treatments. U.C. Davis (T-27-77)

Herbicide	(kg/ha)[1]	Weed Control[2]				
		Purslane	Lambs-quarter	Ground-cherry & Hairy night-shade	Pigweed	Barn-yard-grass
pebulate	9.0	9.9*[3]	9.8	9.9	9.8	9.9*
pebulate	13.4	10.0	10.0	10.0	10.0	9.8*
pebulate	17.9	9.9*	10.0	10.0	10.0	9.9*
chloramben	4.5	9.1	9.9	8.9	8.5	7.3
chloramben	9.0	9.9	10.0	8.3	9.8	7.3
chloramben	13.4	10.0	10.0	9.3	9.8	8.3
metribuzin	1.1	10.0	10.0	10.0	10.0	9.1
metribuzin	2.2	9.9	10.0	10.0	10.0	9.9
metribuzin	3.4	10.0	10.0	10.0	10.0	9.9
alachlor	2.2	9.3*	9.8	9.5	10.0	9.4
alachlor	4.5	9.9*	9.8	9.7	10.0	9.8
alachlor	6.7	9.8*	9.9*	9.9	10.0	9.7
bifenox	2.2	8.3*	9.8	8.0	5.2	3.8
bifenox	4.5	10.0	9.8	8.8	6.3	3.8
bifenox	6.7	10.0	9.9	9.3	7.8	6.0
metolachlor	2.2	6.3	9.1	10.0	9.9	10.0
metolachlor	4.5	8.0	9.9	10.0	9.9	10.0
metolachlor	6.7	9.9	9.8*	10.0	10.0	9.9
ethafluralin	1.1	9.7*	10.0	10.0	10.0	10.0
ethafluralin	2.2	9.9*	10.0	10.0	10.0	10.0
ethafluralin	3.4	9.9*	10.0	10.0	10.0	10.0
napropamide	2.2	8.9*	10.0	5.0	9.8	9.9
control	---	0.0	5.3	5.3	3.0	4.5
control (hand weeded)		9.6	10.0	9.9	9.7	9.6
LSD (5%)		0.75	0.60	0.80	1.2	0.85

[1]To convert kg/ha to lb/A multiply by 0.9

[2]Weed control ratings are the average of 12 replications and are based on a 0 to 10 scale where 0 = no control and 10 = 100% control.

[3]Control values followed by an asterisk (*) were lightly reduced due to the occasional occurrence of weeds in the plug planted clumps.

ment, which was included as a relatively non-phytotoxic standard for tomato vigor, resulted in good weed control except for groundcherry and hairy nightshade.

A slight reduction in the control of some of the weeds was observed in the plug planted subplots. This reduction was due to the occasional occurrence of escaped weeds growing in the plug planted clumps. Apparently, a few weeds were also protected from the herbicide by the plug planted medium. In most cases this reduction in weed control was minimal. However, even the slight decrease in purslane control in the plug plantings was statistically significant as evidenced by the combined averages of all treatments (table 5).

Table 5. The average effect of tomato plug planting on the control of purslane in several preplant herbicide treatments. U.C. Davis (T-27-77)

Planting method	Purslane control[1]
Direct seeded	9.25
Plub planted	9.12
Plug planted + carbon	8.91
LSD	0.12

[1]Control ratings are the average of values attained from 96 plots established over the 24 treatments listed on table 1. Ratings are based on a 0 to 10 scale where 0 = no control and 10 = 100% control.

THE EFFECT OF PRE AND POSTPLANT WEED CONTROL IN FALL PLANTED ALFALFA

W. D. McClellan, D. Tisher and V. Schweers[1]

Preplant and postemergence herbicide treatments were applied to fall planted alfalfa in 1976-77 to determine what effect they had on weed control, first season yields and stand persistence. Early harvest of seedling alfalfa was also evaluated as a weed control method. Prior to the first harvest, shepherd's purse (*Capsella bursapastoris L.*) and london rocket (*Sisymbrium irrio L.*) were the major weeds present. Preplant applications of EPTC (1.9 kg ai/ha) and benefin (.94 kg ai/ha) decreased weed yields 26% and 12% respectively in the first harvest; the postemergence sprays of dinoseb (.63 kg ai/ha) and 2,4 DB ester (.63 kg ai/ha) alone reduced weed

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yields by 80% and 74% respectively. Postplant treatments applied in addition to the preplant treatments reduced weed yields as average of 93%. At first harvest, the preplant treatments produced significantly higher hay yields than the postemergence treatments. The difference in yield was due to high weed populations in the plots without postemergence treatments. First harvest yields of alfalfa alone were highest in the plots treated with dinoseb. At the second and subsequent harvests weed infestations represented less than 0.5% of the hay yields in all plots. Stand counts taken prior to the first harvest showed a 32% reduction in alfalfa plants per square foot in the untreated plots compared to plots receiving weed control treatments. At the end of the season stand counts showed no significant differences. Data from handweeded areas indicate that the preplant herbicides did not adversely effect plant vigor or stand persistence. Total seasonal yields were highest in the untreated control due to the high weed populations present during the first harvest. Weed control treatments did not increase first season yields of alfalfa in this trial.

CONTROL OF BROADLEAF WEEDS IN SUGARBEETS WITH GLYPHOSATE

E. E. Schweizer[1]

ABSTRACT: Annual broadleaf weeds that escape cultivation and herbicidal treatments applied in sugarbeet compete with the crop. Since even low densities of weeds can reduce root and sucrose yields, we conducted field studies to determine the effectiveness of glyphosate [*N*-(phosphonomethyl) glycine] to control or minimize the competitiveness of low densities of common lambsquarters, kochia, and redroot pigweed. These weeds were spaced alternately within the row to achieve broadleaf densities of 0, 6, 12, 18, and 24 plants per 30.5 m of row. On June 23, glyphosate was sprayed 10 cm above the sugarbeet canopy with a recirculating sprayer at 1.7 kg/ha and at a volume of 187 L/ha. The average height of sugarbeets was 45 cm, common lambsquarters 85 cm, kochia 70 cm, and redroot pigweed 40 cm. Many redroot pigweed plants and a few other broadleaf plants, were not sprayed because they were not tall enough to intercept any spray. Of those that were sprayed, some died within 2 weeks and other continued to die slowly, until by late September, 58% of the common lambsquarters, 77% of the kochia, and 65% of the redroot pigweed had died. Less than 3.5% of the sugarbeet plants were injured by glyphosate and only 0.2% of those died. Weed competition was reduced significantly by glyphosate. Thus, root yields were reduced only 8, 10, 15, and 19% where the original densities were 6, 12, 18, and 24 plants per 30.5 m of row. In a comparable study in which these broadleaf weeds were not treated with glyphosate, root yields were reduced 20, 35, 43, and 54% respectively.

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A NEW HERBICIDE SAFENER WHICH PERMITS EFFECTIVE GRASS CONTROL IN SORGHUM

W. E. Davidson, S. A. Gagnon, M. D. Christensen and J. E. Dorr[1]

Present day herbicides often do not provide the consistent, broad-spectrum grass control required to maintain high yields in sorghum. This can be attributed to the difficulty to control grasses that are prevalent. This includes seedling johnsongrass (*Sorghum halepense* [L.] Pers.), shattercane (*S. bicolor* [L.] Moench.), *Echinochloa* spp., and broadleaf signalgrass (*Brachiaria platyphylla* [Griesb.] Nash).

Chemical antidotes which would allow the use of more effective grass herbicides in grain sorghum have previously been studied (1, 5, 7, 8, 9, 13, 14). The most promising of these, 1, 8 - naphthalic anhydride, was not consistently protective (5, 7, 9, 14). A more effective antidote has been discovered which will permit the safe use of metolachlor in grain sorghum and as a consequence, allow the control of a broader spectrum of grasses. This paper introduces this new antidote.

The safener is CGA-43089 and was synthesized in the laboratories of CIBA-GEIGY in Basle, Switzerland. A patent has been allowed in the U. S. and foreign countries. Chemically, the substance is α-(cyanomethoximo)-benzacetonitrile. Pertinent chemical and physical properties of CGA-43089 are revealed in Table 1.

Though the toxicological evaluation of CGA-43089 has not been completed, the results to date reveal no detrimental effects.

Results and Discussion

The safening properties of CGA-43089 were first observed in 1974 in greenhouse trials and confirmed in U. S. field trials in 1975. The effect has been proven to be quite specific, as sorghum is the major crop species found to be adequately protected. The results of the first field test with CGA-43089 are presented in Table 2.

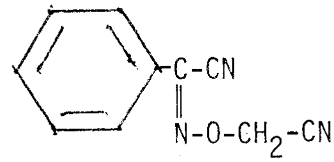
In this test, CGA-43089 was mixed directly with the herbicide and applied preemergence to the sorghum. One can see that protection from herbicide effects was directly related to the rate of the safener. However, it required at least 6 kg/ha of CGA-43089 for adequate sorghum safety to 2 kg/ha of metolachlor [2-chloro-*N*-(2-ethyl-6-methylphenyl)-*N*-(2-methoxy-1-methylethyl)acetamide]. In another test, it was shown that seed treatment with the safener is a superior method of protecting the sorghum. This is illustrated by the results in Table 3. The sorghum seeds were treated, prior to planting with CGA-43089. The seed was treated at rates ranging from 0.62 g to 3.75 g/kg of seed. Virtually complete safening resulted with seed treatment rates in the range of 0.62-1.25 g to a metolachlor rate of 4 kg/ha.

At the 1.88 g/kg level of safener, sorghum tolerance started to decrease. This is attributed to the phytotoxicity of the safener itself. Without the CGA-43089 seed treatment, metolachlor causes severe sorghum injury in the form of stand loss and twisted and stunted plants.

[1]Agricultural Division, CIBA-Geigy Corporation, Covina, CA.

Table 1. Chemical and Physical Properties of the Sorphum Seed Safener, CGA-43089.

Chemical Structure



α-(cyanomethoximino)-benzacetonitrile

Physical: crystalline solid, white, odorless

Melting point: 55-56 C

Solubility: 95 ppm in water at 20 C; soluble in most organic solvents.

Oral LD_{50} in rats of both sexes + 2,277 mg/kg

Table 2. Grain Sorghum Tolerance to Tank Mixtures of Metolachlor and CGA-43089 Applied Preemergence.

Chemical Treatment	Rate (kg/ha)	Phytotoxicity Rating[1] 6/11	Phytotoxicity Rating[1] 8/21
metolachlor	2.0	4.0	4.0
metolachlor + CGA-43089	2.0 + 2.0	4.0	4.0
metolachlor + CGA-43089	2.0 + 4.0	4.0	3.0
metolachlor + CGA-43089	2.0 + 6.0	3.7	2.7
metolachlor + CGA-43089	2.0 + 8.0	2.7	1.3
untreated	---	0.0	0.0

[1]Phytotoxicity rating: 0 = no injury; 4 = unacceptable injury; 10 = total kill

Data source: J. W. Peek, CIBA-Geigy, Nebraska

Expanded field testing over the last two years has further verified the protective properties of CGA-43089. In 1976, a grain hybrid was treated with a mixture of CGA-43089 and Ortho 753, a standard protectant used for insect and disease control. The results from several field tests at three levels of CGA-43089 are depicted in Figure 1. Virtually complete sorghum protection was achieved from a 3 kg/ha rate of metolachlor at the 1.25 g/kg level of CGA-43089. The insecticide/fungicide mixture had no antagonistic effect on the safening properties of CGA-43089. Further work in 1977 was conducted. One level of CGA-43089 was selected, 1.5 g/kg, and applied to three different hybrids of grain sorghum. The phytotoxicity results from this program are summarized in Table 4.

Table 3. The Effect of a Seed Treatment with CGA-43089 on Grain Sorghum Tolerance to Metolachlor Applied Preemergence.

Preemergence Treatment	Rate (kg/ha)	Phytotoxicity Rating[1] CGA-43089 Seed Treatment Rate, g/kg seed				
		0.0	0.62	1.25	1.88	3.75
untreated control	---	0.0	0.0	0.0	1.3	2.7
metolachlor	2.0	6.3	0.3	0.0	0.7	3.0
metolachlor	4.0	8.3	0.0	0.3	1.0	4.0

[1]Pytotoxicity rating: 0 = no injury, 4 = unacceptable injury, 10 = total kill.

Data source: J. W. Peek, CIBA-Geigy, Nebraska

Table 4. Direct Domparisons of Sorghum Phytotoxicity[1] from Metolachlor Alone Applied Preplant Incorporated or Preemergence in 1977 Field Tests Over Normal Seed and Seed Pretreated with CGA-43089.

Metolachlor rate (kg/ha)	Normal seed		Seed pretreated with CGA-43089 at 1.5 g ai/kg
0.0	0.1	(34)[2]	0.1
1.5	4.8	(23)	0.2
2.0	4.9	(14)	0.5
2.5	5.6	(10)	0.5
3.0	6.9	(14)	0.7
4.0	9.1	(4)	2.1
5.0	8.3	(3)	2.5

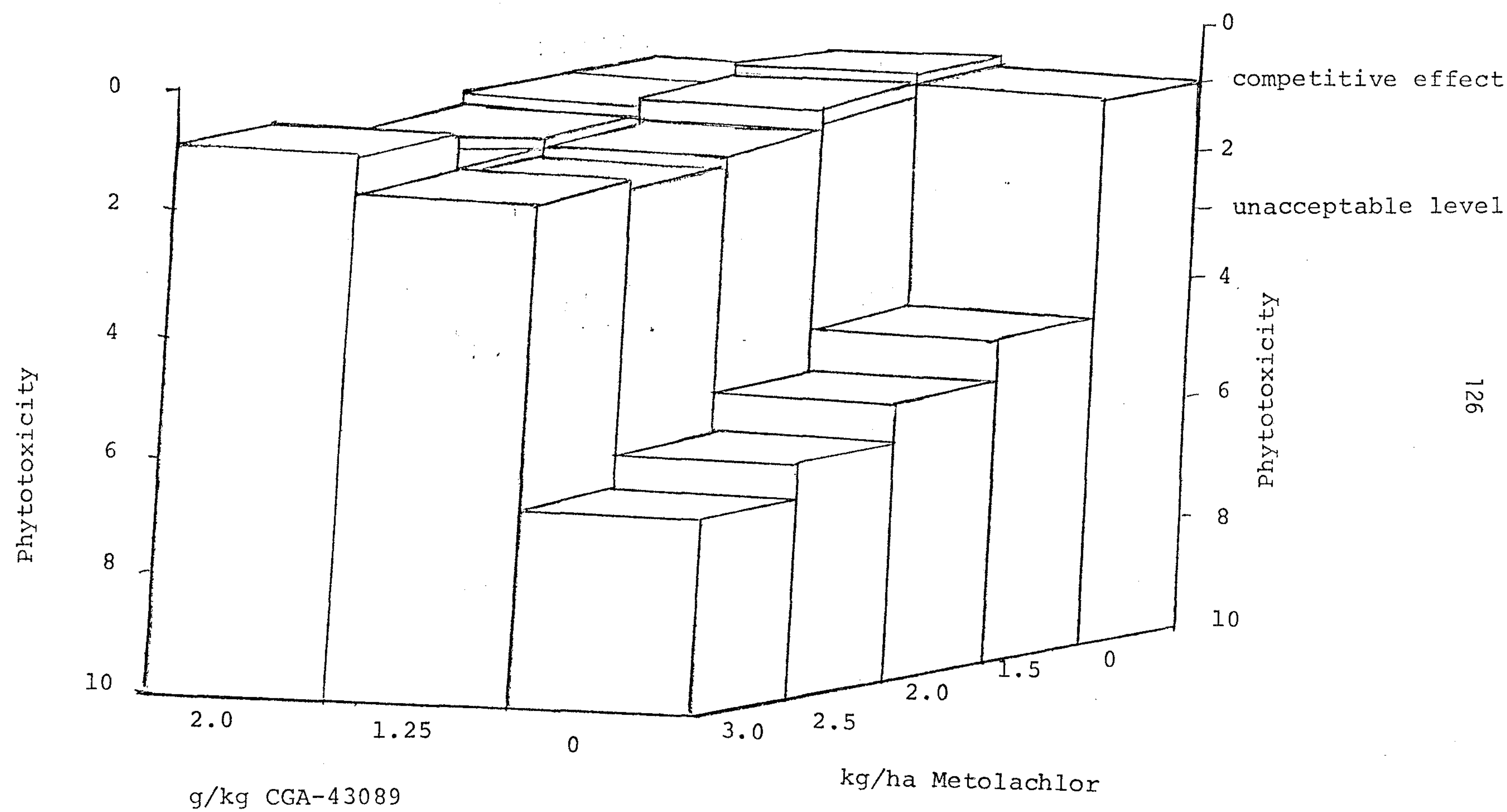
[1]Sorghum phytotoxicity rated on a 0 - 10 scale where: 0 = no injury, 4 = just unacceptable injury, and 10 = complete kill.

[2]Numer of test comparisons in average.

The 1.5 g level of CGA-43089 was found to provide adequate protection in excess of 3 kg/ha of metolachlor. Sorghum is tolerant to this level of the safener.

Numerous sorghum hybrids have been evaluated for their tolerance to the safener and metolachlor. Though differences have been noted between grain sorphum varieties in their response to metolachlor, none showed sufficient tolerance for commercial production without the safener. Some hybrids are also more readily protected than others. However, no hybrid

FIGURE 1: Summation of 1976 results sorghum tolerance to CGA-43089.



tested to date shows insufficient tolerance to metolachlor in the presence of CGA-43089. Forage of silage varieties are more susceptible to injury.

The method of herbicide treatment does not influence the degree of CGA-43089 protection, nor does the safener have a detrimental effect on the magnitude of weed control. Effective weed control results in sorghum yield increases. These points are illustrated in the results from a 1977 field test conducted in Nebraska (Table 5). Adequate protection was afforded sorghum to both preemergence and incorporated applications of metolachlor. Green foxtail (*Setaria viridis* [L.] Beauv.) was the major grass species and it was controlled extremely well by all treatments. Shattercane (*Sorghum bicolor* [L.] Moench) was planted at the end of the plots for bioassay purposes. Control of this species with metolachlor is usually of a suppressive nature, although, this is better than offered with current standards. A Duncan's Multiple Range test revealed no differences in the yields from various herbicide treatments on protected sorghum and the hand-weeded check. In essence, not only was metolachlor effective, but CGA-43089 also provided complete protection. The yield from the unprotected sorghum was significantly reduced by metolachlor--incorporation causing the greatest reduction.

In summary, CIBA-Geigy has discovered a chemical, CGA-43089, which will protect grain sorghum from the injurious effects of the herbicide metolachlor. Adequate tolerance is achieved with a seed treatment level of 1.25 to 1.50 gm/kg of seed. As a result, effective grass control can be achieved in sorghum with metolachlor with respondent yield increases.

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Table 5. Weed control and crop response of protected (P) and unprotected (UP) grain sorghum to preemergence and preplant incorporated applications of metolachlor and atrazine treatments. Protected sorghum treated with CGA-43089, 1.5 g/kg of seed. York, Nebraska - 1977.

Herbicide Treatment	Rate Lb. ai/A	Weed Control [a/] Green Foxtail	Weed Control [a/] Shatter-cane	Crop Response Phyto [b/] P	Crop Response Phyto [b/] UP	Crop Response Yield, cwt/A P	Crop Response Yield, cwt/A UP
Metolachlor - Pre	2.0	10.0	6.0	0.7	4.3	73.0	66.4
Metolachlor - PPI	2.0	9.2	2.7	0.7	5.7	70.3	50.6
Metolachlor + atrazine - Pre	1.5 + 1.2	9.8	4.7	0.3	3.7	82.5	68.0
Metolachlor + atrazine - PPI	1.5 + 1.2	9.6	2.3	1.0	4.7	71.3	57.3
Atrazine - Pre	2.4	9.1	2.3	0.0	1.0	73.6	71.9
Propachlor + atrazine - Pre	3.2 + 1.2	9.6	1.0	1.0	2.0	72.6	73.4
Hand-weeded check	-	10.0	10.0	0.0	1.5	72.0	63.3
Non-weeded check	-	0.0	0.0	0.0	1.4	38.5	33.8

*Shattercane seeded at end of plot; no affect on yield

a/ Weed control rating:
0 = no control
10 = complete control

b/ Phytotoxicity rating:
0 = no injury
4 = unacceptable injury
10 = complete kill

Data Source:
L. Stahlberg
CIBA-GEIGY Corp.

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WEED CONTROL IN A NATIVE RUBBER CROP (*PARTHENIUM ARGENTATUM* GRAY).

J. W. Whitworth[1]

ABSTRACT: With the resurgence of interest in the production of rubber from guayule, it seems appropriate to make information available on weed control which was developed in 1952 but never published.

Guayule is a perennial shrub which grows wild in the semi-arid regions of Northern America and has been a commercial source of rubber since 1910. With the depletion of stands in Mexico and Texas, plantations were established in California. In 1942, the Emergency Rubber Project planted 32,000 acres of guayule in the United States. With the end of World War II, these plantings were destroyed, but the Korean conflict brought renewed interest and in 1952, 885 acres were grown under contract near Crystal City, Texas. Methods of weed control from the 1942 project were refined and modified for use.

The stove oil used on the old project as a post-emergence selective apray was not available in Texas in 1951, and a naphtha tradenamed Varsol (Exxon) was substituted. Oiling operations were carried out on 770 acres using Varsol at 30 to 40 gal/A while 14 experiments investigated better methods.

Excellent weed c ontrol was obtained on oil-susceptible weeds at or near the cotyledon stage. Guayule survival at this stage averaged 86% with 30 gal/A and 63% with 40 gal/A. Weed kills were poor on large weeds and on oil-resistant species. Guayule survival also improved with age and plants at 5, 7, 9 and 10 days old showed survivals of 61, 78, 85 and 90 percent when treated with 30 gal/A of Varsol. Oilings applied outside of the 60 to 90 F range markedly reduced guayule stands. Kerosene proved more selective than Varsol. Undoubtedly, the dinitroanilines or other new herbicides will prove selective on guayule, but like the oils, also selective on many weed species.

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FLURIDONE, A NEW BROAD SPECTRUM COTTON HERBICIDE

L. G. Thompson and M. W. Hammond[1]

Fluridone, [1-methyl-3-phenyl-5-([3-trifluoromethyl]phenyl)-4(1*H*)-pyridinone], coded EL-171, has been found by the Lilly Research Laboratories to be particularly effective in controlling a broad spectrum of annual grass and broadleaf weeds. Fluridone is a white crystaline solid with a melting point between 153 and 155 C. The vapor pressure at 25 C is less than $1x10^{-7}$mm Hg, which suggests relative stability on the soil surface. Fluridone has a water solubility of approximately 11-12 ppm at pH 7 and is moderately susceptible to photodecomposition by ultraviolet irradiation.

Preliminary toxicological data indicate that fluridone has a low order of toxicity. For example, the LD_0 is >10 g/kg for rats and LD_{50} in mice is >10 g/kg. Dermal, eye and inhalation toxicity studies have also substantiated the low order of mammalian toxicity.

Field trials have shown fluridone to be a very selective herbicide for preemergence cotton weed control. It does not control established weeds. When fluridone is surface applied preemergence, adequate rainfall or irrigation is necessary to move the compound into the weed germination zone. Characteristic injury symptoms to fluridone are chlorosis, retardation of growth and eventual necrosis and death.

Field research conducted in the Western states from 1975-1977 has indicated that fluridone provided control of a large number of annual grass and broadleaf weed species in cotton. Preplant incorporation of fluridone at 0.2-0.5 lb/A has provided excellent control of barnyardgrass (*Echinochloa crus-galli*), pigweed (*Amaranthus* spp.), lambsquarters (*Chenopodium* spp.), nightshade(*Solanum* spp.), groundcherry (*Physalis* spp.), morningglory (*Ipomoea* spp.), cocklebur (*Xanthium* spp.), mustard (*Brassica* spp.), and sunflower (*Helianthus annus*). Perennial weeds such as rhizome johnsongrass (*Sorghum halepense*) and yellow nutsedge (*Cyperus esculentus*) have also been effectively controlled with slightly higher rates of fluridone (>0.5 lb/A). Cotton, on the other hand, exhibits true physiological tolerance to fluridone. However, rates above 1 lb/A have resulted in slight mottled chlorosis to cotton seedlings early in the growing season, but this condition usually disappears within 4 to 6 weeks after emergence.

Both fall and spring applications of fluridone, either pre- or postbed incorporated prior to planting cotton, have been evaluated for annual weed control. Trials conducted at the Lilly Research Station, Fresno, California, on a medium soil indicate that rates as low as 2.0 lb/A will provide weed control (80-100 percent) throughout the growing season. The predominant weed species present were barnyardgrass, lambsquarters, pigweed, groundcherry, and mustard.

To illustrate the herbicidal potential of fluridone, average weed control percentages were calculated for all preplant incorporated cotton trials. These trials have been conducted in California and Arizona on various soil types and include weed control ratings on barnyardgrass, pigweed, lambsquarters and nightshade species over the entire season.

Average weed control data on coarse soil are presented in Table 1. At rates of 0.2 to 0.4 lb/A fluridone provided 90+ percent control.

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[1]Plant Science Representative and Technical Associate, Lilly Research Laboratories, Fresno, CA

Table 2 illustrates the type of weed control obtainable on medium soils. The data represent the average of ten prebed and five postbed incorporated trials. Weed control in the prebed trials was somewhat better than the postbed trials; however, overall weed control was good to excellent regardless of time of incorporation. At the rates shown, fluridone was more effective on the broadleaf weeds than on barnyardgrass.

Table 1. Average Percent Weed Control with Fluridone on Coarse Soils

		Rate (lb/A) 0.2 - 0.25			0.3			0.38 - 0.4		
Treatment	No. trials	BYG	BLW	NS[1]	BYG	BLW	NS	BYG	BLW	NS
PPI										
Prebed	4	97	94	97	96	97	97	97	96	98
Postbed	2	90	90	--[2]	--	100	--	89	97	--

[1]Weed species: BYG = barnyardgrass; BLW = broadleaf weeds of pigweed and lambsquarters; and NS = nightshade.

[2]Weed species not present.

Table 2. Average Percent Weed Control with Fluridone on Medium Soils

		Rate (lb/A) 0.2 - 0.25			0.3			0.38 - 0.4		
Treatment	No. trials	BYG	BLW	NS[1]	BYG	BLW	NS	BYG	BLW	NS
PPI										
Prebed	10	90	97	97	91	91	99	85	99	98
Postbed	5	77	92	97	79	86	100	77	96	93

[1]Weed species: BYG = barnyardgrass, BLW = broadleaf weeds of pigweed and lambsquarters, and NS = nightshade.

Average percent weed control on fine textured soils also indicates >90 percent control. of the broadleaf species for all treatments (Table 3). However, 0.3 lb/A or higher of fluridone was found to be necessary to obtain excellent control of barnyardgrass.

The effectiveness of fluridone for perennial weed control in cotton has also been examined. A preplant soil incorporated trial conducted near Bakersfield, California in an area heavily infested with yellow nutsedge indicated that at least 1 lb/A was required to provide excellent control (Table 4). However, good control was attainable with rates as low as 0.6 lb/A.

Table 3. Average Percent Weed Control with Fluridone on Fine Soils.

		Rate (lb/A)								
		0.2 - 0.25			0.3			0.38 - 0.4		
Treatment	No. trials	BYG	BLW	NS[1]	BYG	BLW	NS	BYG	BLW	NS
PPI										
Prebed	4	69	99	96	89	99	98	90	90	99

[1]Weed Species: BYG = barnyardgrass, BLW = broadleaf weeds of pigweed and lambsquarters, and NS - nightshade and groundcherry.

Table 4. Percent Yellow Nutsedge Control with Fluridone Preplant, Soil Incorporated in Cotton.

Treatment	Rate (lb/A)	Percent Control
fluridone	0.2	62
fluridone	0.3	74
fluridone	0.4	76
fluridone	0.6	80
fluridone	0.8	86
fluridone	1.0	90

Rhizome johnsongrass control was evaluated with fluridone in 1975 at the Lilli Research Station, Fresno, California (Table 5). Rates of 0.5, 1 and 2 lb/A were preplant incorporated in a heavily infested area. The 1 and 2 lb/A rates provided acceptable control the first year; however, 100 percent control was achieved the second year at 2 lb/A with no reapplication.

Table 5. Percent Rhizome Johnsongrass Control with Fluridone Preplant Soil Incorporated in Cotton.

	Rate (lb/A)	Percent Control	
Treatment		1975	1976
fluridone	0.5	65	18
fluridone	1.0	85	65
fluridone	2.0	90	100

Additional research with fluridone is being continued throughout the major cotton-producing areas of California and Arizona so that the full potential of this experimental cotton herbicide can be demonstrated.

RESEARCH RESULTS ON NUTSEDGE AND AMERICAN BLACK NIGHTSHADE IN SAN JOAQUIN VALLEY COTTON

Harold M. Kempen, Joseph Woods and James E. Hill[1]

Most annual weed species in cotton are regularly contolled by dinitroaniline herbicides; but after 15 years of this usage two weeds, nutsedge (*Cyperus* spp.) and nightshade (*Solanum* spp.), have become rather widespread in the San Joaquin Valley (4).

Growers use cultural techniques and rotation to keep nutsedge under control in most fields or utilize MSMA or DSMA to control bad infestations in emerged cotton. Several cultural techniques are used. Subsurface shearing of nutsedge shoots immediately before planting delays nutsedge emergence for 5 to 10 days, and according to Stoller (10) reduces the vigor of regrowth from tubers. When coupled with early, close cultivation of good stands, this aids in reducing competition for soil moisture. Earlier irrigation prevents cotton stand loss and older cotton is more competitive against nutsedge. If cotton stand loss is avoided, one can obtain maximal yields even with moderately high populations of nutsedge. Growers have also found that hand-weeding costs $25 to $50/acre and will reduce cotton stands in heavily infested fields. Thus they prefer postemergence DSMA or MSMA sprays over hoeing even though the herbicide can retard cotton when it is semi-droughty.

Rotation is the other major method for reducing nutsedge stands (5). Cereal crops followed by dry-fallowing can eliminate purple nutsedge (*C. rotundus*) if soil moisture can be depleted (2). Best crop/herbicide combinations against nutsedge include: 1. carrots/linuron, 2. potatoes/EPTC, 3. corn/butylate or alachlor, 4. cotton/MSMA and 5. alfalfa/EPTC. Good stands are always a requisite of success. Some poor rotational crops are: onions, peppers, garlic, beets and tomatoes.

Nightshade species have only recently become widespread in cotton. *S. nodiflorum* is most prevalent in the San Joaquin Valley but *S. sarachoides* also is present. These nightshades germinate after February 1, and are a serious problem in seedling cotton. Later in the season tillage and crop competition provide control.

The rapid spread of nightshade seems to be due to prolific seed production (7); viability of seeds in both green and ripe berries; the production of seed in at least 10 different crops; and the distribution by wind, water, animals (1), birds (Roberts--personal communication) and machinery. Once seeds contaminate cultivated soils, Roberts (9) found they will remain for many years.

The similarity of nightshade to young cotton makes it difficult to rogue out in this crop. Emergence of this weed is greatly reduced if no rains occur after planting, but considerable numbers do still emerge; especially in loam and clay loam soils.

The following studies were conducted during 1975, 1976 and 1977 to explore potential chemical techniques for controlling nutsedge and nightshade in Acala cotton.

Materials and Methods

Herbicides we tested on nutsedge included perfluidone, prometryn, methazole, alachlor, metolachlor, H 22234, H 26910, H 25893, Dowso 295,

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Dowco 333, fluridone, MSMA, DSMA, H 26905, cyperquat, MBR 16349, R 12001, and R 24315. Used on nightshade were MSMA, DSMA, fluridone, fluometuron, prometryn, diuron, cyanazine, dinitramine, trifluralin, methazole, ethalfluralin, H 26910, H 26905, metolachlor, MBR 16349, R 12001, R 24315, HOE 29152, SN 55365 and SN 58132 (6,7,8).

Types of trials included were: 1. preplant incorporated before pre-irrigation, 2. preplant rototilled just before planting, 3. preplant ROCAP incorporated, 4. pre-emergence followed by sprinkling and 5. post-emergence.

In 1. preplant trials, herbicides were applied in January or February, then disked twice 3-6" deep before beds were listed for pre-irrigation. Beds were knocked down flat about April 1, and the cotton seed was planted 1 1/2" deep into most soil. 2. In the rototilled trials beds were knocked down after the pre-irrigation, and immediately followed by spray application, rototilling and planting. 3. ROCAP trials were done with a special sled-mounted unit which used two ROlling Cultivators At Planting. In sequence from the front of the unit was a dirt pushed to remove the bed top, a spray nozzle to spray a 12-14" band, two rolling cultivators in tandem set to run 1/12" deep on the knock-down bed, and the planter. 4. Pre-emergence trials were purposely sprinkled to measure cotton tolerance under rainfall on sprinkled-up conditions.

Not all herbicides tested are included in the following discussion. Those which are promising and are still being pursued by the manufacturers are discussed.

In general soils in these trials were sandy loams, some close to being loamy sands. Organic matter was usually very low, from 0.1% to 0.5%.

The black nightshade present in these trials was identified to be American black nightshade (*S. nodiflorum*) by taxonomists at the University of California, Davis.

Results and Discussion

Nutsedge. When candidate herbicides were disked in preplant, control was achieved, but rates required (Table 1) were about twice those needed if applied at planting (Tables 2 & 3). Also injury to cotton seemed more evident, even though little or none occurred in trial "C". As a result, future emphasis was placed on at-planting trials with relatively short-lasting candidates, H 26910, alachlor and Dowco 295.

Results in Table 2 show that consistent control was obtained with alachlor, H 26910 and Dowco 295 when rototilled into moist soil at planting. Cotton tolerance was marginal in test "D" with alachlor at 2 lb/A, as also has been found in later trials. H 26910 was obviously safer than alachlor. In trial "E", where half the treated soil was removed at planting, no injury was evident from any rates tested.

Yellow nutsedge (*C. esculentus*) control was generally good with alachlor and Dowco 295 adequate at 1 lb/A; but with H 26910, 2 lb/A were needed. H 26910 and alachlor were poor against purple nutsedge, unlike Dowco 295. Fluridone was ineffective against nutsedge using the ROCAP or rototilled technique.

ROCAP incorporated trials (Table 3) fortified our previous experience that shallow incorporation of these herbicides increased safety. Usually the ROCAP technique provides less depth of incorporation and perhaps less thorough incorporation. Cotton tolerance was satisfactory in all four tests at rates included, even though rains occurred before cotton emergence

Table 1. Preplant Herbicides Disked in Before Pre-irrigation for Nutsedge Control

		Nutsedge control (%)[1]			Cotton stand (%)		Injury (%)
Treatment	lb/A	A	B	C	A	B	C
untreated	---	10	37	17	90	60	3
trifluralin	0.75	0	43	20	70	57	7
H 26910	2.0	62	95	77	77	37	13
H 26810	4.0	77	100	67	80	23	27
ethalfluralin	1.0	0	63	--	73	33	--
ethalfluralin	2.0	0	60	--	50	13	--
alachlor	2.0	--	--	30	--	--	7
Dowco 295	2.0	--	--	93	--	--	13

[1] Yellow nutsedge in Trials A & B, purple nutsedge in C.

A: Sandy loam; cold weather; rains after planting; treated 2/7/75; planted 3/30/75

B: Sandy loam; cold weather; rains after planting; crusted severely; treated 1/29/75; planted 4/13/75

C: Sandy loam soil; rains after planting; treated 3/10/76; planted 4/5/76

in two out of four trials. When sprinkled repeatedly (Table 4), cotton injury was increased to unacceptable levels with Dowco 295 at 1 lb/A or alachlor at 2 lb/A. H 26910, however, was not injurious. Cotton recovery did occur in all cases, however. Of interest, also, in trial "N" was the increased safety of pre-emergence application of all these herbicides over ROCAP incorporated applications.

We would conclude that H 26910 at 2 lb/A could be an acceptable herbicide against yellow nutsedge if rototilled-in or ROCAP incorporated at planting. Alachlor or Dowco 295 at 1 to 1 1/2 lb/A would be acceptable in most San Joaquin Valley situations, but stunting would occur with heavy rains after planting. It probably would be wise to avoid loamy sands with these two herbicides. Perhaps Dowco 295 could be utilized as a preplant disked-in herbicide applied before pre-irrigation. Yet our experience with alachlor would indicated that injury would sometimes occur if Dowco 295 were used this way. Further studies are needed to evaluate Dowco 295 disked-in, as well as other techniques to utilize fluridone or H 22234, since these materials may be registered whereas H 26910 may not. Perhaps the safer analogs of H 26910, "H25893", and of Dowco 295, "Dowco 333", should be re-evaluated.

Table 2. Preplant Herbicides Rototilled into Moist Soil before Planting Cotton for Yellow Nutsedge control

		Nutsedge control (%)			Cotton injury (%)		
Treatment	lb/A	D	E	F	D	E	F
untreated	---	13	--	0	0	0	3
trifluralin	0.75	30	--	--	10	--	--
alachlor	2.0	80	70	47	37	0	7
alachlor	4.0	--	90	63	--	0	10
alachlor	8.0	100	--	--	80	--	--
H 26910	1.0	63	--	42	13	--	--
H 26910	2.0	83	60	43	13	0	7
H 26910	4.0	92	93	63	20	0	13
Dowco 295	1.0	--	95	47	--	0	10
Dowco 295	2.0	--	97	50	--	0	10
Dowco 295	4.0	100	100	73	40	0	10
fluridone	0.5	--	70	--	--	0	--
H 22234	2.0	--	--	33	--	--	3
H 22234	4.0	--	--	50	--	--	7

D: Loamy sand; Normal temperatures; trace of rain after planting 4/8/75; rototilled 3"; no soil removed

E: Sandy loam; normal temperatures; 0.55" of rain three weeks after planting; rototilled 4"; 2" removed when planting 4/16/76

F: Loam; warm temperatures; treated 4/19/77; rototilled in 5" but 2" removed when planting; trifluralin applied at 1/2 lb before pre-irrigation; no rain until 5/9/77

Table 3. ROCAP Incorporated Herbicides when Planting Cotton into Moist Soil for Yellow Nutsedge Control

		Nutsedge Control (%)				Cotton Injury (%)			
Treatment	lb/A	G	H	J	K	G	H	J	K
untreated	---	23	65	40	0	17	0	10	5
trifluralin	0.75	--	73	40	--	--	0	5	--
H 26910	2.0	83	80	63	13	17	7	7	3
H 26910	4.0	80	83	80	35	10	0	3	8
Dowco 295	0.5	--	--	73	40	--	--	7	10
Dowco 295	1.0	--	92	85	48	--	10	13	10
Dowco 295	2.0	--	93	--	85	--	0	--	5
Dowco 295	4.0	--	97	--	90	--	30	--	18
alachlor	1.0	43	--	77	--	3	--	7	--
alachlor	2.0	87	96	85	--	20	2	10	--
H 22234	2.0	82	--	--	--	13	--	--	--
H 22234	4.0	93	--	--	--	17	--	--	--
fluridone	0.5	--	78	--	--	--	0	--	--
fluridone	0.1	--	53	--	--	--	3	--	--

G: Sandy loam; cold weather; rain five times in 25 days after planting (3/31/75); yellow nutsedge

H: Sandy loam; Normal temperatures; rains 2, 7 and 30 days after planting (4/6/76); yellow nutsedge

J: Sandy loam; warm temperatures; no rains until 38 days after planting (4/1/77); yellow nutsedge

K: Sandy loam; warm temperatures; no rain for 16 days after planting (4/14/77); purple nutsedge

Table 4. Tolerance of Cotton to Pre-emergence and ROCAP Incorporated Herbicide Applications Under Sprinkler Irrigation

		Cotton Injury (%)			
		Pre-emergence			ROCAP
Treatment	lb/A	L	M	N	N
Untreated	---	--	16	0	5
trifluralin + prometryn	1.0 + 1.6	--	23	0	35
methazole	2.4	--	20	5	25
diuron	1.0	--	30	--	--
H 26910	2.0	0	0	0	15
H 26910	4.0	3	3	5	20
Dowco 295	0.5	--	--	10	30
Dowco 295	1.0	--	--	5	45
Dowco 295	2.0	--	18	15	35
Dowco 295	4.0	--	23	25	55
alachlor	2.0	23	25	15	35
alachlor	4.0	--	32	25	40
fluridone	0.5	--	20	5	20
fluridone	1.0	--	15	10	15

L: Sandy loam; planted 3/29/75; sprinkled with 1/4" on 4/2/75 plus rains on 4/6, 4/11, 4/15 and 4/17

M: Sandy loam; planted 3/24/76; treated 4/2/76; sprinkled 4/7/76 with rain 4/8, 4/13 and 5/6

N: Sandy loam; planted 4/5/77; sprinkled 4/9 and 4/15 and weekly thereafter

American black nightshade. Preplant trials applied before pre-irrigation were limited to compounds not yet registered. Growers have utilized prometryn for nightshade control but results have been erratic. We believe that this is due to lack of rains after planting, which occurs about 50 percent of the time in the San juaquin Valley, but also due to much of the material being gone by the time the cotton is planted.

Results in Table 5 were inconclusive because of poor nightshade populations. Other studies we conducted in tomatoes (not reported here) did indicate Dowco 295 is very safe on *Solanum* species but H 26910 is not.

Herbicides applied with the ROCAP technique were usually safe, but Table 6 shows that in trial "R" inadequate control resulted when no rains occurred after planting with prometryn, methazole or diuron. The same results

Table 5. Preplant Herbicides for Nightshade Control in Cotton Applied Before Pre-irrigation

Treatment	lb/A	Nightshade/10 ft P
untreated	---	24
H 26910	2.0	11
H 26910	4.0	6
Dowco 295	2.0	4
Dowco 295	4.0	13
Dowco 295 + trifluralin	2.0 + 0.75	5
H 26905	2.0	8
H 26905	4.0	1

Loam soil; disked-in 2/18/76; planted into moist soil on 4/12/76; rainfall on 4/13 and 5/6/76; no cotton injury was evident

occurred here with cyanazine, fluridone and fluometuron (not included in Table 6). Obviously, incorporation of these herbicides into moist soil is not good enough. However, with ethalfluralin and alachlor, results were very good and with dinitramine and H 26910 were at an acceptable level.

Though these studies are limited, they do point out that soil moisture is the key, and that certain herbicides work quite will when incorporated into moist soil. We believe a combination of one of these materials plus prometryn could give nightshade control and exhibit adequate safety in situations when rains occur or do occur after planting cotton. Further studies will prove or disprove the value of this combination.

Post-emergence techniques also may permit control of nightshade in cotton. Fluometuron is used mainly as a salvage treatment. The potential for injury with this material is reflected in Table 7. MSMA is not used by growers for nightshade control, though these trials indicated it did retard nightshade severely without too much cotton injury. Fluridone was surprisingly active, but was too toxic to cotton when wetting agent was included. SN 58132 was active on nightshade but more toxic to cotton than desired.

Further studies will evaluate ways to increase safety with these post-emergence herbicides.

Table 6. ROCAP Incorporation of Herbicides for Black Nightshade Control in Cotton

Treatment	lb/A Q	Number of black nightshade Q	lb/A R	Control (%) black nightshade R
untreated	---	10	---	33
prometryn	1.2	0	0.8	67
prometryn	2.4	0	1.6	62
diuron	0.8	0	0.4	45
diuron	1.6	0	0.8	40
methazole	1.5	0	1.2	35
methazole	3.0	0	2.4	55
H 26910	2.0	2	2.0	72
H 26910	4.0	0	4.0	80
alachlor	2.0	0	2.0	85
alachlor	4.0	0	4.0	92
dinitramine	1.5	0	1.0	75
dinitramine	1.5	3	2.0	85
ethalfluralin	0.75	0	1.5	83
ethalfluralin	1.5	0	3.0	92
Dowco 295	---	--	1.0	30
Dowco 295	---	--	2.0	50

Q: Heavier sandy loam; incorporated with only one rolling cultivator into moist soil on 3/24/76; rainfall on 4/3, 4/8, 4/13 and 5/6/76; no injury to cotton was evident.

R: Heavier sandy loam; incorporated on 4/6/77; no rain after treatment until 5/8/77; rated 4/18/77; no injury to cotton was evident except from higher rates of dinitramine and ethalfluralin.

Table 7. Post-emergence Herbicides for Nightshade Control in Cotton

Treatment	lb/A	Nightshade control (%)		Cotton injury (%)		Yield (bales)
		S	T	S	T	T
untreated	---	27	10	23	8	1.93
fluometuron	2.0	83	100	50	45	1.28
fluometuron	4.0	100	100	63	58	1.28
MSMA	2.0	90	45	27	25	---
MSMA	3.0	93	68	30	33	---
fluridone	0.05	--	83	--	38	1.74
fluridone	0.1	100	88	53	45	1.56
fluridone	0.2	100	--	60	--	---
SN 58132	1.5	--	95	--	33	1.38
SN 58132	3.0	--	100	--	48	1.19
LSD .05						.36

Note: Wetting agent at 1/2 % added to each herbicide.

S: Treated 4/27/76 when cotton was at late cotyledon stage and nightshade 1/4 to 1/2"; evaluated 29 days later

T: Treated 4/27/77 when cotton was one true leaf and nightshade was 1/2" tall; evaluated 21 days later.

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PURPLE AND YELLOW NUTSEDGE SEED PRODUCTION, GERMINATION, AND CONTROL[1]

R. J. Thullen and P. E. Keeley[2]

ABSTRACT. Both purple (*Cyperus rotundus* L.) and yellow nutsedge (*C. esculentus* L.) produced a large number of flowers per inflorescence. Although yellow nutsedge produced seed, purple nutsedge had almost none. The few seeds produced by purple nutsedge did not germinate, but the seeds of yellow nutsedge were viable, germinating up to 90%. The best temperatures for germination were 100 F day temperature and 90 F at night. The seed germinated better with a period of light than in total darkness. Seedlings were capable of reaching the soil surface from 1 inch depth, but more emerged from shallower depths. In a greenhouse herbicide study, pendimethaline [*N*-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine] and dinitramine (N^4,N^4-diethyl-α,α,α-trifluoro-3,5-dinitrotoluene-2,4-diamine) controlled yellow nutsedge seeds at 0.50 lb/A active ingredient (ai), or less, while 2.0 lb/A ai of trifluralin (α,α,α-trifluoro-2,6-dinitro-*N*,*N*-dipropyl-*p*-toluidine) or profluralin [*N*-(cyclopropylmethyl)-α,α,α-trifluoro-2,6-dinitro-*N*-propyl-*p*-toluidine] was needed.

Introduction

In a weed survey published in 1975, 25% of the San Joaquin Valley cotton growers thought that many new weed infestations resulted from seeds in irrigation water (3). Irrigation water was the most frequently mentioned source of new weed problems (3) and many growers felt that purple and yellow nutsedge were spread by seeds in irrigation water.

The role of seeds in the spread of nutsedge in North America was not certain (1) and was complicated by the use of the word 'seedling' to describe the sprout from a tuber. In the authors' experience, from conversations with scientists and extension personnel and from scientific literature (2,4), true seedlings were seen very infrequently and then most often the seedlings were growing in frequently watered gardens. While some onion fields were thought to have been infested by seeds of nutsedge, there has been no real evidence.

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[1]This paper reports the results of research only. Mention of a pesticide in this paper does not constitute a recommendation by the USDA nor does it imply registration under FIFRA.

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Literature references for both purple and yellow nutsedge suggested that viable seed was produced (1,2,4). However, the lack of reliable observations of seedlings in fields caused us to question whether viable seed was being produced in the San Joaquin Valley. Also, if viable seed was produced, were the farmers inadvertently controlling it with herbicides commonly used for weed control, particularly trifluralin?

Materials and Methods

The number of flowers per inflorescence for purple and yellow nutsedge were estimated from 10-inflorencence samples collected during September from 11 fields near Shafter, CA. Spikelets were counted in each flower head and flowers were counted on 10 typical spikelets. Each inflorescence was threshed and separated individually and seeds were counted.

Seeds used for the temperature and light study, the depth of emergence study, and the herbicide study were from bulk collections made September 1974, October 1975, and October 1976. Each bulk collection was from one area of a single field. The 1974, 1975, and 1976 seed germinated at 46, 52 and 80%, respectively, with 11 hrs of light at 90 F day and 80 F night temperatures.

For the temperature and light study, 50 seeds were germinated on filter paper in white plastic pint containers with clear plastic lids or in black plastic pint containers with aluminum foil covered lids. The seeds were germinated in growth chambers at 70, 80, 90, or 100 F day temperature and 60, 70, 80, or 90 F night temperature, respectively, with an 11 hour day. The seedlings were counted at 14 day intervals for 12 weeks.

For the depth of emergence study, 50 seeds per quart container, with 6 replications of each treatment, were placed on Hesperia fine sandy loam soil and covered with 1/8, 1/4, 1/2, 1, or 2 inches of soil. The containers were placed in a greenhouse. Emerging seedlings were counted at 14 day intervals for 12 weeks.

For the herbicide study, the lower half of quart containers was filled with untreated Hesperia fine sandy loam soil while the upper half was filled with treated or untreated soil and 50 seeds were covered with 1/4 inch of treated or untreated soil. The treatments were replicated 4 times and there were 16 untreated checks. The containers were placed in a greenhouse. In addition to untreated soil, soil was treated with trifluralin; profluralin; or pendimethalin at 0.25, 0.50, 1.0, or 2.0 lb/A ai; or dinitramine at 0.17, 0.34, 0.67, or 1.34 lb/A ai. Each herbicide was sprayed on an individual portion of soil and mixed in a concrete mixer for 5 minutes. Emerging seedlings were counted at 14 day intervals for 12 weeks.

Results and Discussion

Purple Nutsedge. Purple nutsedge inflorescences were collected in 1974 and 1976. There were very few inclorescences produced in 1975, so few that it was impossible to collect 10 flower heads from one field even though it was a hundred acres, or more, in size. The reason for the lack of flower production in 1975 is not known.

For the two years when inflorescences were produced, estimated numbers of flowers produced by purple nutsedge ranged from 150 to 1800 per inflorescence. However, seed production was almost nothing. Only 43 seeds were found in 170 purple nutsedge flower heads and none of these seeds germinated.

Yellow Nutsedge. Yellow nutsedge inflorescences were collected in 1974, 1975, and 1976. The estimated number number of flowers in a head ranged between 200 and 14,000. Most inflorescences contained a few thousand flowers. Seed production varied greatly, from entire fields with no seeds to fields where the flower heads had up to 30% seed. Commonly, 1 to 5% of the flowers of many sample areas produced seed. Like seed production, seed germination varied greatly. Yellow nutsedge seed germinated from 0 to 90%.

Non-dormant yellow nutsedge seed was germinated under a variety of temperatures. Day temperature of 100 F with a 90 F night temperature was best. Also, nutsedge seeds germinated at least 3-fold more with 11 hours of light than in complete darkness.

Seedlings from the depth of emergence study emerged from 1 inch, with an occasional seedling emerging from the 2 inch depth (Table 1). However, seedling emergence from the shallowest depth (1/8 inch) was poor. This poor emergence was expected because the seed had not germinated will in complete darkness.

Table 1. Three Year Emergence Study of Yellow Nutsedge Seedlings from Five Soil Depths.

Planting depth (inches)	Percent emergence after 12 weeks		
	1974 seed[1] (%)	1975 seed (%)	1976 seed (%)
1/8	11 a[2]	8 a	13 a
1/4	9 ab	4 b	4 b
1/2	6 bc	0 c	3 b
1	2 cd	0 c	1 b
2	0 d	0 c	1 b

[1]Fifty seeds from (Sept. 1974, Oct. 1975, and Oct. 1976) bulk collections were planted per pot (quart) at each depth. The 1974 seed was planted 5/1/75, the 1975 seed 5/34/76, and the 1976 seed 4/12/77. Each test was replicated six times.

[2]Means within columns followed by the same letter do not differ at P = .01 according to Duncan's multiple range test.

In the herbicide study, germination of seed in untreated soil and covered with 1/4 inch of untreated soil was poor, but somewhat better than in the depth of emergence study for the same depth of planting. However, seedlings which did emerge grew well and appeared normal. Also, seedlings which grew in any of the soils treated with one of the four substituted dinitrobenzamine herbicides were vigorous normal plants.

Dinitramine gave control with the lowest rate. Only 0.17 lb/A ai was needed to reduce emergence from that of the untreated control (Table 2). Pendimethalin controlled nutsedge seedling emergence, but required 0.50 lb/A ai. Because 2.0 lb/A ai of trifluralin or profluralin was needed for a significant reduction in seedling emergence, these treatments were

Table 2. Percent of Yellow Nutsedge Seedlings Emerged from Soil Treated with Varying Rates of Four Substituted Dinitrobenzamine Herbicides.[1]

Treatment	Rate (lb/A ai)	Emergence (%)
untreated	---	12.5 abc[2]
trifluralin	0.25	9.0 bc
trifluralin	0.50	10.5 bc
trifluralin	1.00	8.2 bcd
trifluralin	2.00	1.5 ef
profluralin	0.25	17.2 a
profluralin	0.50	9.5 bc
profluralin	1.00	13.5 ab
profluralin	2.00	1.5 ef
pendimethalin	0.25	6.8 cde
pendimethalin	0.50	0.2 f
pendimethalin	1.00	0.0 f
pendimethalin	2.00	0.0 f
dinitramine	0.17	2.5 def
dinitramine	0.34	0.2 f
dinitramine	0.67	0.0 f
dinitramine	1.34	0.0 f

[1]The percent was the average of three greenhouse experiments of 50 seeds per pot and replicated four times with 16 untreated controls.

[2]Means followed by the same letter do not differ at P = .01 according to Duncan's multiple range test.

considered ineffective. A rate of 2.0 lb/A ai was above general label recommendations. Profluralin failed to control seedling nutsedge consistantly at rates less than 2.0 lb/A ai in all three experiments, but trifluralin appeared to control seedling emergence at 0.5 lb/A ai in two tests and totally failed to control seedlings in a third. As a result, the question of control of nutsedge seedling control by trifluralin was not answered.

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COMPARISON OF FOUR CROPPING SYSTEMS FOR YELLOW NUTSEDGE CONTROL

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ABSTRACT: During 1975 to 1977, four cropping systems were evaluated for the control of yellow nutsedge. In 1975 and 1976, the four systems consisted annually of (1) alfalfa treated with three water-run applications of EPTC at 2 lb/A; (2) barley double cropped with silage corn, in which corn received a preplant application of butylate at 3 lb/A; (3) barley followed by chemical fallow, in which three post-barley irrigations were used and emerged nutsedge plants were treated with three 2 lb/A applications of glyphosate; and (4) continuous cotton treated with two postemergence applications of 2 lb/A of MSMA. Cotton, treated with two applications of MSMA, was grown in all systems in the last year of the study. The effectiveness of each system was determined by counting firm tubers and shoots of nutsedge and sprouting tubers at regular intervals throughout the study. Final counts were taken following cotton harvest in the fall of 1977.

As indicated by nutsedge shoot counts and crop yields, all cropping systems provided measurable control of nutsedge without crop loss. Tuber counts declined annually for the four cropping systems reaching 5, 8, 12, and 17% of the initial counts, respectively, at the conclusion of the study. Counts at the initiation of the study averaged 26 tubers/ft^3 of soil. Firm tubers collected from systems 1, 2, and 4 commonly sprouted at the rate of 70%, compared to 18% for tubers collected from fallow plots treated with glyphosate. At the end of the experiment, plant counts for the four systems (1, 2, 3, and 4) averaged 6, 10, 3, and 20 shoots/m^2, respectively. This compared to 100 shoots/m^2 when the study was initiated. The low sprouting percentage of tubers from the barley-chemical fallow system probably accounts for the relatively few nutsedge plants remaining in this system at the conclusion of the study.

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FACTORS AFFECTING THE ACTIVITY AND MOVEMENT OF PENDIMETHALIN

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ABSTRACT: Environmental factors have been shown to directly influence the activity and movement of herbicides. Greenhouse and field research was conducted to study some of these factors as they relate to pendimethalin.

The effect of temperature in a controlled growth chamber following a preemergence application of pendimethalin [*N*-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine] to corn, suggests that as the temperature increased, the phytotoxicity to the corn increased. The greatest amount of leaf curling and twisting and lateral root pruning occurred at 60 to 65 F.

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Soil types did not greatly influence the leachability of pendimethalin. The majority of the pendimethalin remained in the upper three inches of the soil. A slight increase in downward movement was noted in a silt loam soil as compared to the other soils tested. In some instances a small increase in leaching was shown with the increased application rate of pendimethalin.

In the field study the amount of water applied seven days after application of pendimethalin had only a slight effect on the growth of the corn. Chemical analysis of the soil, at various depths indicated the majority of the pendimethalin remained in the upper three inches of the soil profile. Weed control decreased rapidly as the application of water was increased.

Methods and Procedures

To study the influence of temperature on the phytotoxicity of pendimethalin to corn, a replicated series of flats were planted to corn (Pioneer Brand 3785) and pendimethalin applied preemergence at rates equivalent of 1.0, 2.0, and 4.0 lb ai/A. The flats were placed in a temperature controlled growth chamber. Temperature regimes of 50 to 55 F, 55 to 60 F and 60 to 65 F were observed. Upon the untreated plants reaching 8 inches in height, the corn plants were harvested and leaf length, root length and dry weight measurements taken.

The leachability or movement of pendimethalin was determined by utilizing Polyvinyl Chloride (PVC) plastic pipes, 6 inches in diameter and 16 inches in length, which were filled with three soil types, a loam, a sandy loam and a silt loam. Pendimethalin was applied to the surface of each at rates equivalent to 1.5 and 3.0 lb ai/A. The volume of water necessary to move through the columns were added. The columns were then separated vertically and corn seed planted every two inches as an indicator plant. Leaf length, root length and dry weight were used to indicate the herbicide movement.

To coordinate the greenhouse leaching study with field conditions pendimethalin was applied to a replicated series of plots at rates equivalent to 1.0, 1.5 and 3.0 lb ai/A. Seven days after planting and application of pendimethalin, water was applied through an oscillating sprinkler at .25, .50, and 1.0 inches. The corn was harvested fpr silage and plant height following a 113 day growth period. Data for ear yield was taken after the growing season. Weed control data was obtained by clipping a 48 sq. ft. area.

Results and Discussion

The greatest reduction, when compared to the nontreated plants, was on the corn grown at 60 to 65 F after application of a rate equivalent to 4.0 lb ai/A of pendimethalin. A reduction of 63% in plant height, 35% is root length and 30% in dry weight was recorded from the corn grown under these conditions.

Pendimethalin proved to be very immobile in all soil types studied. A slight reduction in corn growth in the upper two inches of the tube was noticed. Laboratory analysis varified that pendimethalin remained in the upper three inches of the soil.

Immobility of the pendimethalin following increased application rate of water was observed. A slight decrease in dry weight of foliage and ear production was recorded with the increased amount of water applied. The more drastic response was the relationship of increased water application and decreased weed control.

Conclusion

The phytotoxicity of pendimethalin to corn, increases slightly as the temperature at planting and early growth increases. Pendimethalin was evaluated as to its movement and phytotoxicity. It was found that pendimethalin is relatively immobile in the soil. The amount of water received or applied within seven days after planting and application of pendimethalin has little effect on corn production. As the amount of water applied within seven days after planting and application of pendimethalin increased, the weed control decreased.

EFFECT OF TEMPERATURE ON THE RATE OF DEGRADATION OF DINITRAMINE IN TWO SOILS

John A. Poku and R. L. Zimdahl[1]

ABSTRACT: Rate of dinitramine [*N,N*-diethyl-4-(trifluoromethyl)-5-amino-2, 6-dinitroaniline] degradation was measured in a loamy sand and clay loam soil held at 80% field capacity at 10, 20, 30 and 40 C. Each soil was treated with 10 ppmw dinitramine in the laboratory and samples for chemical analysis were taken weekly for the first month and monthly thereafter for a total of six months. In loamy sand soil rate of degradation increased with increasing temperature. However, in clay loam soil rate of degradation increased to 30 C and decreased at 40 C. Soil degradation of dinitramine followed first-order kinetics with half-lives of 30.1, 6.0, 4.3 and 5.0 weeks at 10, 20, 30 and 40 C respectively in clay loam soil. Half-lives in loamy sand soil were 30.1, 7.5, 3.8 and 3.3 weeks at 10, 20, 30 and 40 C respectively. Rate of degradation in laboratory and field studies will be compared.

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SOIL FACTORS AFFECTING PHYTOTOXICITY OF SIMAZINE AND TERBACIL

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ABSTRACT: Pre-plant applications of simazine [2-chloro-4,6-bis(ethylamino)-*s*-triazine] and terbacil [3-*tert*-butyl-5-chloro-6-methyluracil] were studied on 12 widely variable soil types. Perennial ryegrass (*Lolium perenne* L.) was used as an indicator plant in greenhouse bioassays. Simple correlation and multipe regressions were used to compare 50% growth reduction (GR_{50}) of the control with soil properties. On similar soil types, an average of 10 times more simazine was required than terbacil to reduce growth by 50%. Organic carbon and moisture content at saturation were the two most highly correlated soil factors for GR_{50} of simazine, whereas GR_{50} values of terbacil were most highly correlated with weight/volume ratio, saturation percentage, and organic carbon, respectively. A significant correlation was also found between GR_{50} values and moisture content at field capacity (0.1 bar). No significant correlation was found between clay content and the GR_{50} for either herbicide.

For predicting GR_{50} values from easily measured soil characteristics, saturation percentage and saturation percentage plus 15 bar moisture accounted for 69% and 77% of the variation in GR_{50} values of simazine. Weight/volume ratio and saturation percentage in combination with 15 bar moisture content accounted for 81% and 88% of the variation in GR_{50} value of terbacil. For both simazine and terbacil the combination of saturation percentage and 15 bar moisture content explained slightly more variation in GR_{50} values than did organic carbon alone. This study suggests the possibility of using saturation percentage, 15 bar moisture content, and weight/volume ratio to recognize potential field application problems.

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CUPRINA: A POTENTIAL NEW WEED PROBLEM

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Crupina vulgaris is a winter annual weed of the family Compositae. Although this plant is a field and roadside weed in the Mediterranean region from Spain to Hungary, Rumania and Russia, it is listed in the U.S.D.A. Handbood #498, Economically Important Foreign Weeds, Potential Problems in the United States. In the 1969 edition of Flora of the Pacific Northwest, Hitchcock reports this plant as occurring in north Idaho near Grangeville. This is the only reported occurrence in the United States. The infestation area is characterized by deep canyons and steep slopes. The ridgetops and rolling slopes surrounding the area are agricultural in an annual cropping system, principally wheat and barley. The infested area borders cropland at many locations but as yet *C. vulgaris* has not been found within the cultivated area. The area of infestation is

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approximately 2500 acres of rangeland consisting of annual and perennial grasses and forbes with deciduous brush and conifers, principally Ponderosa pine, scattered sparsely throughout. The soil in the area is moderately well to well drained, slightly acid to mildly alkaline, rocky to silty loam from wind laid silt and in place basalt. Rainfall is from 15 to 30 inches and the mean annual temperature is 46 F. The evelation of the infested area ranges from about 1200 feet at the Clearwater River to 3500 feet at the border with cropland.

The seeds are about 4 mm long by 3 mm wide. The pappus consists of several rows of barbed hairs up to 10 mm long. The entire weed is covered with dense hairs, shading from black at the base to silvery fawn at the apex. Seeds are dropped throughout the summer and germinate after the fall rains begin. The cotyledon leaves are quite large and in the field lay closely to the ground. Some true leaves may be produced during the fall and even during the winter if temperatures are favorable. The fiberous root system develops quickly and is quite dense. Stand density is proportional to seeding rate as viability is 90 to 95%. Significant growth begins in the spring as temperature increases, usually about April 1. The lowest leaves are usually entire, oblanceolate to rotund and 1 to 3 cm in length. The other leaves are bipinnatified or pinnatified, to 7 cm in length. The margins are glandular and scabrous.

Bolting begins when the day length is between 21 and 16 hours. The first flowers appear 4 to 6 weeks after bolting. Each head contains four sterile ray flowers with 2 to 4 fertile flowers. The first flowers to appear are terminal with lateral branches and flowers appearing later. Under field conditions, plants attain a height of from 10 to 40 inches with the shorter plants producing 5 to 10 heads and taller plants producing up to 130 heads. Production can be over 400 seeds per plant, averaging about 150. The seeds are relatively heavy and are not appreciably dispersed by wind. They are bouyant and can easily be transported by water. Mature seeds fall to the ground base end first and are buried to the pappus in the dry, light soils characteristic of the area. With the pappus removed, the seed is approximately the same size as wheat and barley.

Chemical control. On October 4, 1977 chemical treatments consisting of glyphosate, dicamba, 2,4-D amine and picloram were applied to plots on a dense stand (54 plants/ft^2) of *C. vulgaris* rosettes. On January 18, 1978 the plots were analyzed for control by actual counts. The following treatments resulted in 100% control: glyphosate at 2 and 6 lb/A; dicamba at 1 and 4 lb/A; and picloram at 0.25 and 1 lb/A. A control of 25% was affected by 1 lb/A of 2,4-D amine and 4 lb/A of 2,4-D amine resulted in a 50% control of *C. vulgaris* rosettes.

Photoperiod study. Plants of *C. vulgaris* in the rosette stage were collected from the infested area on January 19, 1978 and transplanted into 6 inch pots in the greenhouse. Plants were placed in photoperiod chambers with 8, 12, 16 and 20 hours of light. The remainder of the 24 hour period was dark. The plants began to bolt after 2 days fo exposure to the 16 and 20 hour periods. The first flowers appeared after 26 days in the 20 hour period and after 30 days in the 16 hour period. The first flower was noted in the 12 hour day length after 41 days. Three days later, the first mature seed was collected from the 16 hour day length. Plants in the 20 hour day length produced an average of 6.5 seeds per plant after 50 days and plants in the 16 hour day length had produced 2.8 seeds per plant.

Height of plants was also affected by varying day length. Plants in the 20 hour day length gave the greatest response, increasing 16.7 inches in 49 days compared to 11.9 inches increase in 16 hour days, 3.6 inches increase in 12 hour days and 0.4 inches in 8 hour days.

Rooting study. All leaves, including cotyledon leaves, have the capacity to produce roots after being removed from the stem. All leaves which were placed in a mist bench produced callouses and eventually roots. No stem formation has been noted at this time hawever.

Conclusion. *C. vulgaris* is a vigorous annual weed. Little is known about its biology and even less is known as to its competitive ability under cultivated situation. The area of infestation is adjacent to cropland and poses a possible serious threat to agriculture in the area. The fact that it has taken over 2500 acres of rangeland is in itself a justification for futher study.

THE BIOLOGY, DISTRIBUTION AND CONTROL OF A NEW WEEDY GRASS SPECIES, *NARDUS STRICTA* L.

D. L. Isaacson[1], J. K. Kearney[1] and Hiram G. Larew[2]

ABSTRACT: *Nardus stricta* L., a weed of European montane pastures, is a species of low productivity and low palatability. Pioneering infestations have been reported from Idaho and Oregon. This weed has potential to become an important pest in western North American pastures and range.

A profile of the biology and control of *N. stricta*, commonly called matgrass, was developed in order to provide background information of value in planning eradication and/or control efforts. Most current research on this species is conducted in central and eastern Europe, where it is hav been found that the most efficient control is obtained by use of nitrogenous fertilizers in conjuction with reseeding and light cultivation.

Introduction

Matgrass is a perennial grass of low palatability widely distributed in Europe and temperate Asia. It has been sparingly introduced in eastern North America, but is sometimes regarded as native in Newfoundland as well as Greenland. Cattle and sheep avoid matgrass because of its stiff, sharp leaves, and this provides a competitive advantage to this species where grazing is practiced.

Because of this low palatability, as well as an apparently broad habitat suitability and the scarcity of methods for selective control of a single species of grass from pastures and range, *N. stricta* has the potential of becoming an important pest of many livestock-producing areas of western North America. Pioneering infestations have been reported in Idaho (2) and Oregon (1).

The purpose of this article is to present a profile of the biology and control of matgrass from which control and/or eradication alternatives may be formulated. The profile is based on a review of literature emphasizing current research efforts. Since these efforts are cnetered primarily

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in eastern Europe, many reports were available only as abstracts obtained by a computerized search of a 1972-1977 Commonwealth Agricultural Bureau (CAB) information base.

Pioneering infestations of exotic weeds present a particular problem to weed scientists in that there is usually very limited information on the biology and control of such species. A rapid and inexpensive method of obtaining such information on species native to foreign-language agrea of Europe and Asia is provided through access to the CAB computerized information base. This base, included in most computerized library information retrieval systems, includes English abstracts or summaries for all listings, a feature not available in other information bases. In the case of *Nardus stricta* 131 listings of article summaries were obtained for approximately $30 and two man-hours in the library. Of these articles, 82 were in various Slavic languages, and access to information in the original articles through translation would be prohibitively expensive, but the CAB summaries provide much information on current research quickly with limited cost. This base could similarly provide information on other newly-found weeds.

Biology

Matgrass is described as a wiry, tufted perennial 10-40 cm in height. The leaves are rolled, very tough, sharp-pointed and erect when young, and at senescence the leaves spread at right angles to the sheaths. Within the family Graminae, *N. stricta* is a monotypic species and genus being placed in its own tribe, Nardeae. The common name is shared by other species; *Hemarthria uncinata* and *Axonopus sompressus*, both Graminae, and *Cyperus tagetum*, Cyperaceae, are also commonly referred to an matgrass.

There are numerous ecological descriptions of *N stricta*-dominated pastures. Dispersed, viable seeds are difficult to find in the field, which suggests the absence of dormancy mechanisms. Germination occurs both in the autumn and spring, and plants bloom in July and August. Biological productivity of matgrass is low relative to other associated species. Studies of the distribution of matgrass in a variety of plant communities in Britain suggest two natural clump or "vegetative unit" sizes, one of approximately 10 cm in diameter, comprised of individual clumps of *Nardus,* and another less well-defined size of 160 cm which is often visually apparent and for which there is no obvious explanation (3). Observations at matgrass infestations in both Canada (4), and Oregon (1) indicate this plant is a slow disperser. No obvious explanation regarding means of invasion to new areas is evident.

Matgrass is consistently reported as a calcifuge (does poorly on calcareous soils), and soil acidity appears a dominant factor influencing its distribution. Soils described as poor, sandy, oligotrophic or infertile are often mentioned in articles on matgrass, but fertility and drainage are probably less important factors in *Nardus* distribution than acidity. Most commonly this plant dominates high altitude montane pastures in Europe, but its altitudinal range is broad, occurring as low as 155 m in Rumania and as high as 2,355 m in Switzerland. The most often reported elevations are 700-1,600 m.

Soil moisture does not appear to be a factor governing distribution. Periodically flooded pastures and marshy and boggy meadows all provide a suitable habitat, while in many reports the plant is described as a xerophyte. Matgrass appears, then, to have a broad ecological amplitude with respect to soil moisture.

Several commonly-known species are associated with *N. stricta* in European plant communities. Among the most often mentioned are red fescue (*Festuca rubra*), sheep fescue (*F. ovina*), colonial bentgrass (*Agrostis tenuis*), redtop (*A. alba*), bermuda grass (*Cynodon dactylon*), perennial ryegrass (*Lolium perenne*), tufted hair-grass (*Deschampsia caepitosa*), meadow foxtail (*Alopecurus pratensis*), velvet grass (*Holcus lanatus*) and sweet vernal grass (*Anthozanthum odoratum*). The Oregon infestation was apparently well established by 1950 around cultivated fields of *Alopecurus* (1).

Control

Various methods are suggested in the literature for reducing if not eradicating matgrass populations. The methods most often recommended involve the application of fertilizers, but reports also include mention of other chemical and cultural control methods.

Numerous reports indicate that application of either manures, or of commercial fertilizers containing nitrogen, phosphorus, and potassium; cause a change in the vegetational composition of a *N stricta*-dominated meadow. It is often mentioned that before fertilization, *N. stricta* covered 25-90% of the pasture, while after application matgrass coverage was reduced to 0-10%. *N. stricta* is considered a poor utilizer of nitrogen. Other species increased their percent coverage, and since many of the newly dominant species (*Agrostis, Festuca*) grow more rapidly and are more palatable then *Nardus*, yield of useful hay increased in treated fields by 50-300%. Manure is most effective in causing both the compositional change and subsequent increase in yield. Ammonium nitrate and urea are equally effective. Average rates of application are in the ranges 400-800 kg of N, 200-400 kg P_2O_5, and 200 kg K_2O per hectare.

Reports also indicate that in soil with pH 3.9 or lower, the application of nitrogen had no effect on botanical composition. Perhaps this explains the one abstract which reported that compositional changes in the vegetation were not evident three years after a fertilizer treatment. Soils with pH of 4.7-5.2 responded to fertilization by supporting plants other than *N. stricta*.

Fertilization with micronutrients increased hay yield by approximately 25%, but as is the case with many of the abstracts, whether or not the particular methods (in this case, trace element application) used actually decreased absolute amounts of matgrass or decreased its relative abundance by favoring more productive species, is not indicated.

Liming has been found to be fairly to completely ineffectual in suppressing matgrass. Its ability to cause compositional changes is often dependent upon previous or simultaneous applications of nitrogenous fertilizers.

Other controls include plowing, tilling, and/or harrowing the matgrass-infested pasture. These practices alone are said to be effective in controlling matgrass. Along with an application of fertilizer, cultivation may also suppress *N. stricta* growth. Often the newly plowed area is resown with a grass-legume seed mixture (perennial ryegrass, fescue, and red clover). Application of fertilizer often follows reseeding. This combination of plowing, reseeding, and fertilizing may both reduce *N. stricta* coverage and increase the yield of hay by a factor of four.

The use of herbicides has been limited to attempts at reestablishing matgrass-infested pastures. Paraquat (1,1'-dimethyl-4,4'bipyridinium ion), dalapon (2,2-dichloropropionic acid) and TCA (trichloroacetic acid) sodium have been used in conjunction with cultivation, fertilization and reseeding to create a more productive sward with reduced *Nardus* cover. The reported clumping of growth might allow successful spot treatment where infestations were light and of limited extent.

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BIOLOGICAL CONTROL OF SKELETONWEED IN AUSTRALIA

Lambert C. Erickson[1]

A color photo by satellite of eastern Australia in November-December 1970 would have shown a very peculiar phenomenon. It was wheat harvest time but from a distance the fields still were green. The green was skeleton weed (*Chondrilla juncea* L.). This condition prevailed in varying intensities over an area comprising 500,000 square miles. It extended from southern Queensland to northern Victoria and from the South Pacific Ocean on the east to the Victorian Desert on the west. Pasture and range were likewise infested, the skeletonweed growing more than belly high on beef cattle.

Skeletonweed has a "vast past", extending from its introduction in southern New South Wales in 1914, to its identification via Harvard University Herbarium in 1918, to its recognition as the most aggressive competitor in 1920. It prevailed in disasterous proportions from 1920 to 1970, reducing wheat yields from 30 to 10 bushels per acre. In 1971 Dr. J. M. Cullen, entomologist of the Commonwealth Science Industry Research Organization of Australia, made the first successful inoculations with the parasitic fungus *Puccinia chondrilliana*. That event made biological control headlines in newspapers in Australia. It also brought larger appropriations from the legislature and larger financial grants from the wheat industry to the Department of Entomology of CSIRO.

A review of this problem in Australia shows that there have been four distinct eras in control effort of this weed. They are given hereafter.

Stage 1. Eradication. This era prevailed throughout the early stages of infestation, especially from 1920-1930. It, however, persists to this day as a measure of protection and prevention in stopping invasions into new areas. Soil sterilents were used extensively in this stage. Geographically this practice has moved northward and westward from its first focal point in southern New South Wales. Today this practice is more dominant in the state of Western Australia which is still relatively free of the weed. West Australia still maintains total eradication.

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Stage 2. Cultural Control. This era dominated the scene from 1920 to 1945. It was a rather erratic effort containing numerous cultural practices alone, then in conjunction with various legume crops utilized for their cash or forage value. The latter proved to be a substantial and lasting supplement. This 'forage' introduction served several purposes. It reduced the competitiveness of the weed. It increased the soil nitrogen content and thereby increased wheat yields. It changed a wheat monoculture by a biculture of wheat-forage, and livestock. The sheep did well foraging on the skeletonweed-legume mixture, especially in fattening lambs for market.

Stage 3. Cultural-Chemical. From 1946-1971 2,4-D and many other selective herbicides came into widespread use. Research verified their usefulness in a planned attack for skeletonweed control. This intensified investigations in bringing ecological, physiological, herbicidal, taxonomic and agronomic phases into closer coordination and much progress resulted in the discipline of weed science.

Stage 4. Cultural-Chemical-Biological. In 1971 the new entity was added to the arsenal of tools for skeletonweed control. It was biological control. It was the fruition of many years of effort by Australia's biological scientists. The prime discovery was a fungus "rust", *Puccinia chondrillina,* introduced from Europe. By 1973 the rust was widespread and served to weaken the weed. Thereby it became less competitive in field crops. Since 1971 three insects have been introduced from the homeland of skeletonweed (i.e. Eurasia) which have also successfully parasitized the weed. Some recent results show that this weed species can be simultaneously attacked by both the rust and an insect. Thus, biological control has seen synergism added as another agent in the fight against skeletonweed in Australia, and international weed science has benefited by a possible fourth dimension.

You will recall that the world's first spectacular success in biological weed control was with the moth *Cactoblastis cactorum* also in Australia.

The Puccinia is said to have spread at 14 miles per day from spring until autumn in 1971. This suggests that there was no shortage of host material for spore reproduction.

Unfortunately, three forms of *Chondrilla juncea* prevail and the rust biotype affects only Form A. That releases Forms B and C from the severe competition previously given by Form A which comprised approximately 95 percent of the total of the species. Thus, new rust biotypes must be found for B and C. So, biology and evolution proceed.

Form A is very much present and will remain so, but it is possible to again grow small grains. Data gathered from pastures in four different areas show that the weed was reduced as follows over a four-year period: 233 to 59, 172 to 51, 225 to 87, and from 40 to 1 rosettes per m^2. In another study over a 125 day period, roots from uninfected plants increased 13 fold in weight, whereas roots from infected plants increased only 8 times. More significantly, wheat infested with 1 to 10 rosettes/m^2 yielded 1385 kg/ha, 11 to 100 rosettes/m^2 the yield was 754 kg/ha, and at over 100 rosettes/m^2 the yield was 310 kg/ha.

Successful as biological control has been in Australia, it is a last not a first resort. Prevention is first. Eradication is second. Control by any means is third!

TOXICOLOGICAL INVESTIGATIONS ON GOATSRUE

M. Coburn Williams[1]

Goatsrue (*Galega officinalis*) is a tall, coarse, perennial legume that was introduced from the Middle East into Cache County, Utah. The species is known locally as professor weed since a university professor was believed responsible for its introduction.

The evolution of goatsrue from an innocuous introduction to a costly pest began in 1891 when the plant was seeded at the Utah Agricultural Experiment Station. Goatsrue was tested against numerous forage species for nutritive value, palatability, and its ability to grow under arid conditions. The tests soon revealed that the yield and protein content of goatsrue were only half that of alfalfa. The plant was unpalatable to horses and cattle. Although interest in the plant ended, existing stands were not destroyed.

Goatsrue was largely confined to the experimental farm until the late 1920's when it was found one mile from the original planting. Since the 1930's goatsrue has spread north and west through the county, generally following the flow of the valley's irrigation systems. Goatsrue often occurs in dense stands on canal banks, along roadsides, and in irrigated pastures. Some cases of sheep poisoning from goatsrue have been reported in recent years. Goatsrue now infests 60 square miles in Cache County and threatens to invade southern Idaho.

Cache County has now assigned one man and a sprayer full-time on goatsrue control each summer. Costs exceed $16,000 per year. Considering the observed results and the longevity of goatsrue seed in the soil, hundreds of thousands of dollars will be spent before this species is brought under control.

Goatsrue seed is found in the inventories of several plant introduction stations. Another species, *Galega orientalis,* was being evaluated in field plots at the plant introduction station at Ames, Iowa. This species, however has been tested for toxicity. It does not contain the toxic alkaloid found in goatsrue nor has it been found to be poisonous.

Goatsrue contains a toxic alkaloid, galegin, that is moderately toxic to livestock. Losses are not common since the plant has a bitter taste and is therefore avoided by all classes of livestock. An occasional sheep, cow, or horse is lost if scarcity of forage forces them to eat a considerable amount of plant.

Goatsrue was collected near Logan, Utah and analyzed for alkaloids throughout the growing season. The plant was tested for toxicity to one-week-old chicks, sheep and cattle.

The alkaloid content varied from 0.3% in the vegetative stage just before flowering to 0.1% after seed had matured. Most of the alkaloids were in the green leaf.

Goatsrue extracts were fed to chicks at 2 to 7 percent (as dried plant) of body weight. Dosages of 4 to 5 percent of body weight were necessary to kill chicks. These dosages are considered moderately high and indicated that the plant was not highly toxic.

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A 116# wether was fed 400 g of goatsrue at 9 a.m. No toxic signs were observed during the day, but the animal died during the night. Froth was observed in the nostrils indicating lung involvement. An accumulation of fluid was found in the thoracic cavity. In other experimental findings, a ewe showed no toxic signs when fed 400 g of goatsrue but died in less than one hour when dosed with the same amount on the second day. Another ewe was fed 400 g of goatsrue daily for 6 days without showing toxic signs. A 170 kg pound calf was fed 600 g of goatsrue for one week and 800 g daily for an additional week without exhibiting toxic signs.

Goatsrue can be classed as moderately toxic. A large amount of plant would need to be consumed at one time to kill a cow or sheep. Moderate amounts of the plant could be eaten for several days without producing toxic signs.

Fortunately, goatsrue is unpalatable and is avoided by livestock if more palatable vegetation is available. The plant is almost never touched, even in pastures where grasses have been grazed virtually to the ground. The major problem with goatsrue in Utah has been its infestations of pastures, particularly pastures that are irrigated. The species is not a problem in cultivated fields.

Goatsrue is highly susceptible to a combination of 2,4-D and dicamba. A major effort is underway to eradicate the species in Cache County. One man and one sprayer have been committed solely to goatsrue control each summer. Goatsrue should be sprayed by June before the plant is more than 1 1/2 feet high. Because of the large acreage to be treated, spraying in some areas is not accomplished until the plants are 5 feet high and producing seeds. Consequently, not all plants are killed and uniform coverage is difficult. The longevity of seed in the soil further complicates control.

Goatsrue is just one example of a plant that was introduced for a worthwhile purpose that has become a serious weed. Introductions that prove unsuitable during small plot or nursery evaluations should be eradicated so that they will not become future problems.

DIRECT SEEDING OF CROPS INTO BLUEGRASS SOD

Roland Schirman[1]

ABSTRACT: Plow-out of bluegrass seed fields in eastern Washington and northern Idaho is presently accomplished by numerous mechanical tillages of the existing sod prior to seeding the following crop. The high power requirement and the soil pulverization resulting from the multiple tillages make this approach undesirable.

Glyphosate [*N*-(*phosphonomethyl*)*glycine*] was tested as a pre-planting herbicide to suppress the bluegrass sufficiently to allow direct planting of wheat, peas, or lentils into the undisturbed sod. Application of rates greater than 1 lb/A at seasons when the bluegrass was actively gorwing resulted in satisfactory suppression of bluegrass and allowed normal crop

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production. Post-harvest burning of crop residue reduced the level of control from subsequent fall application of glyphosate but enhanced spring treatments. Vigor of fall-seeded crops was also improved by burning. Bluegrass varietal response to glyphosate was directly related to the relative growth rate at the time of treatment. Under dryland conditions, spring application was superior to fall application of glyphosate.

INFLUENCE OF NO-TILL CROPPING ON SOIL MOISTURE, TEMPERATURE, AND YIELD OF WINTER WHEAT

S. A. Dewey and L. O. Baker[1]

ABSTRACT: Temperature and moisture conditions created by no-till methods can result in considerable deviation from the 'normal' plant growth environment of conventionally cropped systems. Significant changes can influence crop yields and weed populations.

Tilled and no-till plots of Cheyenne winter wheat were planted in the fall of 1976 and grown under dryland conditions. Measurements of soil temperature, air temperature, and soil moisture were recorded periodically over the one year period. Less extreme soil and air temperatures were recorded during the winter in no-till plots. Summer temperatures in no-till plots were generally lower in the soil and warmer above the soil surface. Temperature differences at both 2 cm above and 2 cm below the soil surface were as great as 5.5 C on a summer afternoon. Winter soil moisture accumulation data indicated that as much as 5 cm more water was retained in the top 2 m of soil in no-till plots. Readings following harvest showed no significant soil moisture differences between the two systems.

Grain yield, crop height, and weed count data were also collected. No-till winter wheat plots produced 662.59 kg/ha more grain than did tilled plots, and the average no-till crop height was 20.38 cm greater. Differences in weed populations were not evident in this first year of study. However, significant differences in volunteer grain were observed. No-till plots averaged 14.29 volunteer heads per .84 m^2 while tilled plots averaged 100.29 volunteer heads.

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

INTERACTIONS BETWEEN GALLONAGE AND TIMING OF METRIBUZIN APPLICATIONS TO POTATOES

A. C. Scoggan[1]

Application timing and gallonage interactions were studied in two locations in Idaho during the 1977 growing season. Large scale (5 acre)

[1]Chemagro Division, Mobay Chemical Corporation, Boise, ID

plots in commercial fields were used. Aircraft included a Coll-Air A-9 and a Grumann Ag-Cat. Results demonstrated a need for increasing gallonage of spray solution per acre as the potato canopy increases.

Early applications showed no real differences between 3.5 and 10 gallons/A, while later applications (25% canopy) showed differences in control of barnyardgrass (*Echinochloa crusgalli* [L.] Beauv.) between 2.5, 5.0, and 10.0 gal/A, and pigweed (*Amaranthus retroflexus* L.) between 2.5 and 5.0 gal/A. Rates of metribuzin [4-amino-6-*tert*-butyl-3-(methylthio)*as*-triazin-5(4*H*)-one] remained constant.

POTATO HERBICIDE APPLICATION THROUGH SPRINKLERS

R. H. Callihan, G. M. McMaster, P. W. Leino, H. Slawinska and D. Corsini[1]

ABSTRACT: Applications of metribuzin [4-amino-6-*tert*-butyl-3-(methylthio)*as*-triazin-5(4*H*)-one] via sprinklers was more effective when done during the first hour of an 8-hour irrigation than when applied during the middle or last hour. Metribuzin recovery (gc analysis and bioassay) and depth of leaching were directly correlated with herbicidal effectiveness. Subsequent irrigations improved effectiveness and soil penetration, but apparent loss and weed development precluded regaining herbicidal effectiveness. Sprinkler application was superior to sprayer application of soil herbicides when applied to well developed plant canopies.

[1]University of Idaho, Aberdeen Research & Extension Center, P. O. Box AA, Aberdeen, ID 83210

POSSIBLE PROCEDURES AND DIFFICULTIES IN THE EVALUATION OF FIELD PLOTS

K. C. Hamilton[1]

Three general types of evaluations are used as a basis for weed control ratings. Weed counts are usually made early in the season. Estimates of weed control or groundcover can be made at any time during the season. Measurements of weed weight are less common because of the work and are usually made at harvest.

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

Weed control ratings are on many different scales; 0-100, 100-0, 0-10, and 1-5. Some companies say ratings should be on the basis of 1-10 or 1-100 because their computers will not handle 0's. It might be more correct to say they are not programmed for 0's. If you explain your rating system to the reader any system can be used; any system can be handled by machines.

When rating weed control, species can be grouped into grass vs. broadleaf weeds, or each species be rated separately, or the major species rated separately and the rest lumped together as "others".

In the 1977 Research Progress Report, most reports (26) listed weed control by species, 9 reports listed control of the main species with the rest as others, and a minority of 5 reports lumped weed control by grass or broadleaf weeds.

If control of all species are rated and many are present you can get data on 8 to 10 species in many tests. If all the weeds are planted in rows I can see how this data can be valid. However when I start rating more than three or four species that have natural distributions I become confused. What did the fifth and sixth species look like in the check? Is this 98% rating control or the fact the species was not found in this treatment?

Another problem in rating weed control is illustrated in this cotton data. When all control is 100% or 50%, we can understand the rating. However, is treatment C really giving no broadleaf control and complete grass control? Or like the untreated check, is the growth of broadleaf weeds controlling the grass? The rate of 2.24 illustrates thinking English and publishing Metric.

When should weed control be rated? Some Weed Scientists rate control each week. This has advantages. At the end of the year you have a very thick report. When writing papers you can select only the data which supports your beliefs and ignore the rest. A better system is to make weed control ratings at two or three logical times such as, at harvest, at thinning, or at the last cultivation. Perennial weeds and soil residues are usually rated 1 and 2 years after herbicide applications.

Plot size depends on the crop, the land and equipment available, and the purpose of the test. One California weed research technique that I have failed to understand and master is how to evaluate residues in the soil when herbicides are applied to 10 by 10 foot plots and incorporated with a double disk.

Counting weeds is an ancient Wyoming art which improves one's point of view and gets you in condition for "tepee creeping" later in the evening. Weed counting is a slow method that produces nice data. Counts do not vary too much from person to person.

Estimating weed control produces good data faster and easier than counting. Weed control can vary greatly from person to person.

Many people use the Kodak system to supplement weed control and crop injury ratings. A complete set of slides of each plot or treatment can be used to illustrate talks. This is most effective if only slides that are in focus are used. The trends of weed control are evident in these slides from a pecan test. The Kodak system is most useful in illustrating crop injury.

Where in the plot should weed and crop ratings be made? Stand ratings are often on permanent plots. Weed rating can be on random samples or whole plots. Yields are usually from center rows or beds.

Most Weed Scientists include a check in weed experiments. In the beginning this was a cultivated, or hoed, or cultivated and handweeded control. Today a standard herbicide treatment (s) is included in most tests. In 1971, ARS administrators would not allow Fred Arle to do research in cotton unless cultivated checks were included in all tests. No amount of discussion could alter their views that cultivated checks were still essential to weed research. At harvest, weeds were removed so machine pickers could get through these cultivated checks.

Some California weed researchers use what is termed a "blind check" when making weed ratings. Weed control on every plot is rated without first observing the control plots. This allows one to get 30 to 40% weed control on the untreated plots when weed infestations are not uniform. It also produces data that looks like it was created by a visual handicapped person from Central Europe. Unless one has divine guidance the untreated or control plots should be observed first to make valid ratings on the other treatments.

Crop injury or response is usually rated soon after crop emergence or herbicide application. Crop stand and height are simple to measure and easy to understand. Crop injury ratings are more subjective.

The type of data you collect depends on many things; your time and the number of tests, the type of crop, and who is paying for the research. Good yield data is vital for product registration and essential for testifying in subsequent lawsuits.

Most weed workers having completed an experiment retire from the field or lab for a ritual called "Manipulating the Data". The data can be combined into an average unless like with certain plant physiologists the experiment consists of a single plant. Today, most field tests have several treatments and replications so various multiple ranges can be determined for separating treatments means. In dealing with data two terms should be defined. "Transformations" and "conversions". Certain types of data are transformed by various means to make it more suitable for statistical analyses. If the data sent to companies is not in a form suitable to send to the EPA they have experts at "converting" it to a form the EPA will accept.

What name do you use when presenting weed data? There is no standardization. Yellow foxtail is identified by 8 notations in recent reports. Two and four letter combinations are often used when presenting data on six to ten species in a single table.

At some time the data collected should be transferred to the users. The most prestigious fate of data is publication in a referred journal. However, the data can be sent gratis to companies providing chemicals, sold to interested buyers or traded for whiskey. Alas much of our data, and some of it is good, remains stored in our files until retirement or death, when it is destroyed.

What is the best system? Despite pressure from industry and government for a uniform system for all, I believe it is the one that works best for you, your crops, your weeds, your time, and your ability.

In planning a life of rating weed plots you can look to certain sources of inspiration and guidance. The Old and New Testaments, the Book of Mormon, and EPA Regulations.

To conclude there has been found an additional Commandment, carved in stone, deep in a catacombe, in a far-off, foreign Capitol called Washington. And this eleventh commandment is "Thou shall keep all raw field data forever for validation by the EPA".

COMPLETE AND UNIFORM REPORTING OF FIELD TEST DATA

A. D. Kern[1]

My purpose is to discuss the need for complete and uniform reporting of field test data. In this discussion, some major problems and recommendations for reporting field data will be presented. Although the following discussion may be from my viewpoint, the points and concepts pertain to all of us as weed scientists.

All of us generate and review data for similar reasons. Each year we review data from hundreds of experiments for 1) decision making, 2) determining use patterns for the best possible recommendations to the grower and 3) registration requests. However, in our reviews, many experiments cannot be used because they lack essential or required information. Whether it is good or bad performance results, lack of complete information precludes the use of these data.

Complete and uniform data are required for several reasons. First, technological advances in chemistry and the discipline of weed science have created more sophisticated chemicals and herbicide programs that weave into our various cropping systems. Responses to soil type, interaction with other chemicals, narrow ranges of selectivity, tank mix combinations and timeliness of treatments are a few criteria that are becoming more important considerations as we make technological advances. We must ensure to record as many parameters that affect performance as possible.

Second, EPA guidelines for registration require specific information, background of plot area, treatment parameters, and observations on each experiment. Although I have grouped the requirements into eighteen items, the required information ranges from application equipment, variety of crop, date and stage of growth at evaluation, to yield. All the items shown must be detailed in the data submitted to EPA for review.

Third, we must ensure completeness and uniformity of reporting of current experimental work for future reference. We must be able to utilize the reported data from the past. As our level of knowledge increases with time, we wish to investigate previous data for the influence of a certain new parameter on performance or response.

Finally, the experimental data must be understood by other weed science personnel. Uniformity in weed abbreviations, rating scales, as well as completeness of data are essential.

We have discussed the need and reasons for complete and uniform data, now let us examine some key problems that exist. Often, we fail to report all observations. A subtle observation which is not documented may become important as time passes. Another deficient observation is the lack of a positive statement of crop response following herbicide treatment. Often we do not expect or observe any phytotoxicity from a herbicide application. As a result, a comment or rating of injury is not included in the data. To another reviewer, especially EPA, it would be assumed that the investigator did not look for injury rather than no injury was present.

Another common problem is the lack of complete data or experimental information. Some common omissions include plot size, soil type/organic matter, and density or stage of growth at treatment or evaluation. In a

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recent review of data assembled in 1977, astonishing numbers of experimental reports did not contain information on essential parameters that may affect performance.

Another problem in data reporting is the numerous rating scales for weed control and crop response. Weed weights, weed densities, and various scales result in confusion. Rating scales, such as 0-5, 1-9 and 0-10 often have levels of percentage control or commercial acceptance built into the scale. For crop observations on a 0-5 scale, in one case zero may indicate no injury and in another case five indicates no effect of treatment.

The last common problem is the inappropriate identification of weed species. In many cases weeds may be listed as foxtails, thistle, annuals, grasses, or annual broadleaves. These groupings tell us little in most cases. We do not use general groupings for our information and certainly cannot use groupings for our registration efforts. In some situations groupings may be used if detailed information and percentage of individual species are listed.

Recommendations and solutions to the problems of discussion are five-fold. First, consider one's reporting procedures. Often our standard way of reporting data for past experiments or chemicals does not ask all the information pertinent to a new chemical under investigation. Consider the recipients of one's data. Does it include all information required by another researcher, reviewer, industry, government, or EPA?

Secondly, anticipate future needs. Ensure completeness so the information will be of value as uses for the chemical, environmental conditions, or technology changes in the future.

Third, record all observations. Record the subtle observations. Sometimes we take certain observations for granted. Document all observations. Fourth, identify and specify target pests, rating scales, and parameters of experiment for reasons previously discussed.

Finally, standardize a comprehensive outline of recording techniques and parameters. This may be accomplished on an individual, a group, or discipline basis. A comprehensive outline will ensure that one considers the majority of parameters and observations in an experiment. Although each experiment may bring on a new dimension, basic information is common to all.

In Monsanto, we utilized a standard comprehensive field form to record our field experiments. All of our data is computerized by our Information Storage and Retrieval System. Our field forms request the significant questions that follow good experimental technique and observations. In addition, all information complies with the guidelines of EPA. This system has been of tremendous value in recording, retrieving and utilizing experimental data.

Although completeness is most important, standardization of several basic techniques and parameters is a key to universal reporting and understanding of field data. We in the weed science societies should strive to standardize some of the basic reporting parameters, techniques, weed abbreviations, and rating scales.

ECONOMIC OUTLOOK ON RANGE IMPROVEMENT

Mike Kilpatrick[1]

Rancher Limitations: Ranchers realize the importance of range improvements. During the past ten years Nevada ranchers invested almost 2 1/2 million dollars, for an average of $250,000 a year, on private range improvements.

One limitation in Nevada is the balance of private and public range. With federal government agencies controlling 87 percent of the State, present day ranchers have difficulty establishing seasonal feed needs, and ideal management systems.

Dependence on public range is greater in Nevada than any other western state. The report from the Secretary of the Interior and the Secretary of Agriculture on Study of Fees for Grazing Livestock on Federal Lands dated October 21, 1977 states "that about 68 percent of the total cattle in Nevada graze at least part of the time on public lands". The cattle in Nevada that graze public ranges walk over millions of acres of sparsely vegetated, poorly watered range to browse up to 3 million Animal Unit Months of feed. That is not an easy living for the cattle or their owners.

Nevada ranchers have been discouraged, in fact have often been prohibited from making private investments on federal ranges allotted to them to graze their cattle. Fences and watering facilities built by government agencies are, however, maintained by ranchers, and maintenance costs that occur annually can become another economic liability.

Another limitation faced by Nevada ranchers is the nutritional quality of grasses, forbs and shrubs on dry ranges. This is especially so during July and August when calves are learning to graze. It takes an exceptional year for calves to average 400 pounds at weaning. Most years the average weight of calves is 25 to 50 pounds lighter. The dry period also extends into the breeding season, a factor contributing to a 70 percent weaned calf crop. When 30 out of every 100 cows come home in the fall without a calf the pounds of beef produced per cow drops quickly to the point where profits are zero.

Money for future range improvement is becoming more difficult to borrow. Interest rates are rising and inflation on everything purchased is coming close to 10 percent a year. As money becomes more difficult to borrow, enterprise stability reflected by 10-year grazing permits becomes a real issue. These permits look promising and soon may become a reality.

Ranchers organize livestock associations to pass resolutions for legislative purposes. Many ranchers are also members of the Society for Range Management, an organization composed of ranchers, range conservationists, educators, scientists, public land managers and others interested in use, management and development of the rangelands. The SRM Section in Arizona of 350 members recently prepared a statement for Herbicide Registration. The statement reads "The State of Arizona has approximately 60 million acres of rangeland. It is estimated that 30 percent of this rangeland has undesirable woody and herbaceous plants where some selective control measures would increase rangeland productivity for wildlife, water yields, livestock, recreation and other uses.

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[1]Extension Range Specialist, College of Agriculture, University of Nevada, Reno NV

"Effective, safe herbicides are desperately needed as a tool to control these plants. Tebuthiuron and picloram have been proven through research and field trials to be such herbicides. Therefore, the Arizona Section, SRM, strongly recommends that tebuthiuron and picloram be registered for rangeland use in Arizona." This statement was sent to the Arizona State Chemist, the Environmental Protection Agency and all chemical companies engaged in herbicide manufacturing.

U.S. Government Treatment Programs: In a recent news release dated March 11, 1978 in the Nevada State Journal, it was stated that BLM Director Frank Gregg told western Congressmen, "The Western ranges are far below their productive potential. A 20-year program which would provide approximately $2.2 billion (to rebuild damaged grasslands) is responsive to the magnitude of need". This implies range improvements, but plant manipulation over large areas appears to be impossible for another 10 to 15 years because of court constraints. Unless Congress can exempt many range improvements from Environmental Impact Statements, federal funds once provided cannot be put in the bank. They are to be spent within a specified period. What will happen to the $2.2 billion?

Forest Service and BLM budgets have allocations for specific activities. Neither agency has allocated large sums for vegetation manipulation. There are very small amounts of money funded for spot treatments of noxious and poisonous plants, for example - treatment of small areas of tall larkspur found in aspen groves or on snowbank sites high in the mountains. Some District Rangers may be permitted to use their funds through cooperative agreements with County Weed Control Districts.

The use of fire handled through controlled burns will likely increase on National Forest and BLM lands. Site selection will be critical on many range areas in northern and western Nevada because cheatgrass blankets the range when big sagebrush is burned. We know of herbicides that can eliminate the cheatgrass plants before they set seed. On thousands of acres, billions of seeds are already present on range soils waiting to germinate when conditions are suitable, especially following a fire. From a practical viewpoint, controlled fire, chemical fallow and seeding to adapted grasses would all be required if the fire failed to generate sufficient heat to kill the cheatgrass seed embryos.

U.S. Government Aid Programs: There are no aid programs offered to farmers and ranchers as we understand AID. All of the programs in Nevada are cost-sharing for agricultural stabilization and conservation. On private ranges a rancher can cost-share and receive 60% of the costs for brush control, mostly plowing and seeding, up to a maximum of $2,500 per year. These programs are offered on a county by county basis depending upon the priority and needs set by the County ASC Committees.

Areas in the State declared drought diaster counties by the Governor qualified for emergency relief developments. During the past fiscal year ranchers in northeastern and eastern Nevada spent about three quarters of a million dollars for improving and extending range watering sites. The ASCS, through special funding from Congress, was able to provide 80 percent of the funds and ranchers had to raise 20 percent for those range improvements.

There are limitations, stalemates, court actions and countless other problems; yet ways will be found to improve our range resources. Lets hope these ways can be found soon.

MINUTES OF THE WSWS BUSINESS MEETING
Reno, Nevada March 16, 1978

President Lowell S. Jordan presided at the meeting with approximately 80 members in attendance.

Report of the Nomination Committee presented by E. E. Schweizer: 150 members cast ballots with the following results:

President-Elect	Larry C. Burrill
Secretary	Robert L. Zimdahl
Chairman-Elect, Research Section	Robert Callihan
Chairman-Elect, Education Section	Jack Evans

Report accepted.

Report of Committee on Honorary Members and Fellows presented by L. Jordan for W. Anliker:

Honorary member for 1978	Dr. Dale W. Bohmont
Fellows for 1978	Kenneth W. Dunster
	David Bayer

Report accepted.

TREASURER'S REPORT

The following financial statement was presented by J. L. Anderson and covers the period from March 1, 1977 to March 1, 1978.

Income	
Registration, Sacramento Meeting (298)	$4,270.04
Dues, members not attending Sacramento Meeting (87)	174.00
1977 Research Progress Report Sales	2,025.64
1977 Proceedings sale	2,618.38
Sale of back issue of publication	111.00
Payment of past due accounts	76.00
Advance order payments	126.00
Interest on savings	457.32
Total fiscal year income	$9,858.38
Assets, March 1, 1977	5,303.37
	$15,161.75
Expenditures	
Annual meeting expenses	$2,358.09
Luncheon ($1,422.66)	
Placques ($77.08)	
Coffee break ($82.58)	
Guest Speaker ($312.00)	
1977 Research Progress Report	1,326.45
1977 Proceedings	1,148.43
Business Manager Honorarium	250.00
Postage	465.12
Office Supplies	212.21
Total expenditures	$5,760.30

Assets

Savings certificates	$5,000.00
Checking account	4,351.45
Cash on hand	50.00
Total liquid assets	$9,401.45

Finance Committee is working toward having a two year operating budget on hand in savings and other liquid assets. The goal may be attained in one more year.

Approximately 362 registrants for this conference which is the highest total ever.

FINANCE COMMITTEE REPORT

Finance Committee report presented by L. Whitendale. They audited the society's books and found them in order. They recommended an increase of $250 in the Treasurer-Business Manager's honorarium to $500/year. Passed by the Executive Committee.

Treasurer's and Finance Committee reports accepted unanimously on motion by R. Norris.

SITE SELECTION COMMITTEE REPORT

Site Selection Committee Report presented by K. W. Dunster. The Site Selection Committee has reviewed the WSWS meeting sites from 1970 through 1980 and found that during this time the meetings will have been held in the Pacific region six times and the Mountain area five times. However, with the 1978 meetings in Reno, 1979 in Boise, and 1980 in Salt Lake City, the Site Selection Committee would recommend San Diego for the 1981 meetings.

A meeting site in New Mexico, Montana, Colorado or Wyoming was considered but with little or no enthusiasm.

PLACEMENT COMMITTEE REPORT

D. Colbert reported that the Placement Service should always be in a highly visible location. The placement service listed 113 positions desired and 74 positions available during this meeting. They obtained listings from WSSA, and the California Weed Conference.

WSSA REPORT

G. Lee presented the WSSA report. The 1978 meeting of the Weed Science Society of America (WSSA) was February 7-10, at the Dallas Hilton Hotel, Dallas, Texas. Attendance at the WSSA was diminished because of inclement weather in the Northeast. There were, however, 790 people registered for the meetings which represented a slight drop in attendance compared to the 1977 meetings.

The Board of Directors of WSSA met with incumbent President C. L. Foy on February 7, 8 and 9. A final Board meeting was held with the new President P. W. Santlemann on February 10.

New Officers and Board members of WSSA are:

President-Elect	J. R. Hay
Vice President	W. D. Carpenter
Secretary	D. E. Bayer
Treasurer	George Bayer
Member-at-Large	Chester McWhorter
Past President	C. L. Foy
SWSS Representative	H. R. Hurst

Because Will D. Carpenter was elected Vice-President of WSSA, George Bayer was appointed by the Board of Directors to complete the term as Treasurer and Chairman of the Finance Committee of WSSA. After many years of distinguished service, Dr. T. J. Sheets requested to be replaced as Editor-in-Chief of WSSA. Dr. James Hilton accepted the responsibility of the Chairmanship.

The Society is enjoying a steady financial growth. At present, the net worth of WSSA is $289,223.76. In light of the financial status of the Society, the page charge for publication will remain unchanged and dues will continue at $15.00 per year.

WEEDS TODAY has been unable to solicit adequate advertisement necessary to cover publication costs. WSSA will provide financial support for the next 4 issues at which time, the magazine may be discontinued. A survey of the WSSA membership and non-member readers of WEED TODAY will be conducted to determine the magazine's value.

A fourth edition of the Herbicide Handbook will be printed and available by mid-summer. Cost per copy will be approximately $7.50. The Extension Committee of WSSA is preparing a publication on weed seedling identification. The publication will contain colored photographs of the common weed seedlings of the U.S. and Canada.

The Constitution and Operating Procedures Committee has extensively revised the manual during the past year. The revised edition will be published in Weed Science during 1978.

Drs. O. Hale Fletchall, James L. Hilton, Homer M. LeBaron and David W. Staniforth were distinguished as Fellows of the Society in 1978. Mr. John D. Fryer was selected as Honorary Member of WSSA. Awards for outstanding contributions to the weed science discipline were as follows:

Extension	Lawrence W. Mitich
Research	Ellis W. Hauser
Teaching	Donald E. Davis
Publication	C. G. McWhorter
Graduate Student	David N. Duncan (Michigan State Univ.)

The Weed Science Society of America will meet in San Francisco, California on February 7-9, 1979. Information about the Meeting will be forthcoming in the near future.

EDITORIAL RULES COMMITTEE

L. Burrill reported that the Editorial Rules Committee made only a few changes in rules for the Research Progress Report for 1978. Camera ready copy for 1979 was moved by R. Zimdahl and passed after a brief discussion.

EDUCATION AND REGULATORY SECTION

H. Kempen reported on activities of the Education and Regulatory Section. The program was developed by resource people who led discussion on three subject areas. Three volunteer papers were included at the request of Program Chairman, R. D. Comes. Attendance varied from 50 to 100 people during the session.

Dr. Jim Hill, University of California at Davis, was elected Chairman for 1978-79. The Executive Committee suggested that future programs might include subject matter of interest to regulatory agency personnel, who could benefit from and contribute to the conference.

Dr. James Hill recommended an attempt to include more regulatory workers in future meetings.

RESEARCH SECTION REPORT

A. Ogg reported on the Research Progress Report. 134 reports submitted and printed in 1978 which was the highest total ever.

Cost of report preparation continues to go up - $1,300 - 1977; but, $2,000 - 1978.

R. Norris, University of California at Davis is Chairman for 1979.

The Project Chairmen briefly summarized their projects at the business meeting at the close of the 1978 meeting. Written summaries are given below.

PROJECT 1 REPORT: Perennial Herbaceous Weeds, Steven L. Kimball, Chairman

There were 74 in attendance at the Perennial Herbaceous Weeds project session. The program included two business items and discussions about four major weeds.

Wayne Belles is Project Chairman for 1979, and George Hittle is Chairman-elect. A proposal was made that the Project be reorganized into "Weed Control in Rights-of-Way and Non-Crop Areas", with perennial herbaceous weed control to be considered in other project sessions. Following discussion about the proposal, those in attendance voted not to recommend any change at this time.

L. O. Baker described leafy spurge and then moderated a group discussion. Leafy spurge is considered to be a more serious weed than Canada thistle in Wyoming. Grazing is one means of control. It spreads rapidly, and can become vegetatively reproductive within a week after emergence. Major research is planned to combat leafy spurge in Wyoming.

E. S. Heathman described Johnsongrass and moderated discussions about it. Grazing and mechanical fallow help to reduce Johnsongrass, while dinitroaniline herbicides work to control seedlings. There is potential for control using glyphosate if it is used as part of a comprehensive weed control program. The use of glyphosate in recirculating sprayers can greatly reduce Johnsongrass competition in row crops.

A. P. Appleby described yellow nutsedge, noting varietal differences and encouraging researchers to state the variety of yellow nutsedge examined in future research reports. Maintaining competitive pressure with crops such as alfalfa combined with selective herbicide treatment may constitute the best method of control presently available. Organic arsenicals, napropamide, metribuzin, bentazon, metolachlor, and terbacil have potential for selective control of yellow nutsedge.

J. O. Evans described field bindweed problems and possible control methods. Fall treatments of glyphosate repeated for several years gave good control. 2,4-D + dicamba is also effective for field bindweed control. The use of 2,4-D gives seasonal control but does not eradicate existing stands. Summer fallow treatments are necessary for good control in dryland cropping areas of the Pacific Northwest.

PROJECT 2 REPORT: Herbaceous Weeds on Range and Forest, T. R. Plumb, Chairman

Chairman Roger Rohrbough transferred out of the region and was replaced by T. R. Plumb, Chairman-elect for the proposed combined Projects 2 and 3. Approximately 40 people attended the Project session. The proposal to combine Projects 2 and 3 was reconsidered and it was moved and unanimously passed to keep the Projects separate. There was some discussion about changing Project names; however, time did not permit any final recommendations. Both a chairman and chairman-elect were nominated and unanimously approved as follows: Chairman - Walter L. Gould, Agronomy Department, New Mexico State University; and Chairman-elect - W. B. McHenry, Department of Botany, University of California, Davis.

Two general topics discussed were "Fire as a Tool in Vegetation Management" and the "Effects of Low Moisture Conditions" (on plant control).

L. R. Green introduced the subject of fire for fire hazard reduction on fuelbreaks. To a limited extent fire has been used to eliminate herbaceous fuelbreaks. To a limited extent fire has been used to eliminate herbaceous plants, brush seedlings, and shrubs on both timber and chaparral fuelbreaks. More of this work is expected in the future. S. R. Radosevich described the use of fire to clear and maintain brush conversion sites. Some of this work was done years ago by O. A. Leonard. Current work involves time of burning and shrub physiology. L. E. Warren briefly described the use of fire in forest site preparation in the Pacific Northwest. Shrub competition and logging slash must be removed prior to tree planting. Al Bruner reported on the use of prescribed burning to convert pinyon-juniper woodlands to brush-grass communities to benefit wildlife and livestock. Success of a burn can be predicted by adding together windspeed in miles per hour, temperature in degrees Farenheit, and percentage of vegetation cover. If the score is less than 110, the fire will not burn; if greated than 130, it is too hazardous. Scores between 126-130 produce self-propagating, clean burns.

Although fire is a valuable tool in vegetation management, herbicides or other means usually must be used to prepare a site for safe burning. Fire also only has a temporary plant control effect; where conversion is desired, herbicides are needed to eliminate resprouting plants and seedlings.

R. A. Evans reviewed work in Nevada on the effect of drought on plant management. He described three plant forms and how their different rooting pattern affects their response to drought. Drought is a perennial factor in Nevada, California, and other parts of the Southwest. H. M. Hull reviewed the literature on the action of herbicides under moisture stress conditions. Most work refers to plants under short-term stress conditions and doesn't consider long-term physiological drought effects. Water stress can affect both the physiological and anatomical state of a plant which, in turn, can significantly affect herbicide performance.

PROJECT 3 REPORT: Undesirable Woody Plants, L. E. Warren, Chairman

Secondary Weedy Plants on Range and Forest Sites. Jim Young described the emerging greasewood problem that is mostly on private lands in more salty ground. Basin wild rye could thrive on these sites if the greasewood is controlled. Infestation totals about 12 million acres. It re-sprouts after defoliation by phenoxy herbicides.

Wild (desert) peach was described as a local problem in areas and that 2,4-D + picloram would give reasonably good control if timed properly.

Howard Morton described a toxicity problem from *Astragalus* that is more pronounced with the higher rainfall.

Biological Control of Undesirable Plants. Dr. Paul Dunn reported on the status of controlling leafy spurge, diffuse knapweed and musk thistle with insects. The problem of differential response of biotypes was explained.

Dr. R. Hawkes reported some impending success with insects on Russian thistle and tansy ragwort.

Dr. Lisle Green reported some mild success in containing chaparral on a cut-over or burned forest site or fuel break using goats. By concentrating them on re-sprouting areas, brush can be kept down but they are selective and do require herding.

Range Economics. Mike Kilpatrick explained that ranchers could and should improve their range, but federal lands are tied up in preparing EIS (BLM) or in spraying restrictions. Some funds to assist control programs may be available through ASCS. The reduced availability of federal range because of little efforts to improve them emphasized the need for private ranchers to improve their own forage production.

There were very short discussions of all subjects because of time limitations. Thirty-eight to 45 persons were present.

A chairman had to be elected for 1979-80; Walter Gould (Univ. of New Mexico) was elected to this post. Chairman-elect for 1980-81 is W. B. (Jim) McHenry (University of California, Davis).

PROJECT 4 REPORT: Weeds in Horticultural Crops, Larry K. Hiller, Chairman

Subject 1. Plug Mix Planting, Floyd M. Ashton. Various approaches have been studied in the concept of plug mix planting. These have included the injection of carbon under pressure into the soil at planting, a solid-plug technique using a molded clay, peat, vermiculite, and activated carbon mixture containing the tomato seed, and most recently a flowable mix. Advantages of this concept include, among several, the increased crop selectivity to herbicides, reduced crusting, reduction in the amount of seed required and thus seed costs, and more uniform emergence. Some disadvantages are: slower planting speeds and a more complex operation, handling problems of the mix, and approximately 20 percent more expensive than direct seeding. Nevertheless, research has shown this to be a promising technique for processing tomatoes and several growers are utilizing the conception in their programs.

Subject 2. Effect of Initial Irrigation on the Activity of Preemergence Herbicides, J. T. Schlesselman and A. H. Lange. (This was substituted for the planned topic, "Herbicide Application through Drip Irrigation Systems".) The paper, as presented, is included with this report for inclusion in the proceedings.

Subject 3. Soil Fumigation for Weed Control, Harold M. Kempen. Various fumigation materials and other techniques have been studied for control of annual weeds in processing tomatoes. The major objective has been for nightshade control.

Subject 4. Status of IR-4 Registrations for Horticultural Crops, Alex Ogg. An update on submitted registration applications through the IR-4 program and current status within the EPA review process. Discussion of various projects on different crops, with emphasis that this is for minor crops and minor uses of existing registrations.

PROJECT 5 REPORT: Weeds in Agronomic Crops, Paul E. Keeley, Chairman

J. Wayne Whitworth is Chairman and Neil E. Humberg is Chairman-Elect for 1979. Approximately 80 were in attendance for the 1978 Project Meeting. Cost and benefits of herbicides in agronomic crops was chosen as the subject matter. Discussion leaders and crops considered were as follows: (1) H.P. Cords, alfalfa; (2) N. E. Humberg and G. A. Lee, barley and wheat; (3) D. Hyzak and P. E. Heikes, corn; (4) J. W. Whitworth and P. E. Keeley, cotton; (5) R. L. Zimdahl, potatoes; and (6) J. H. Dawson, sugarbeets.

Data were presented showing that it is economical to use herbicides for the control of weeds in the above crops. Benefits are realized in terms of increased yields and/or improved crop quality. Especially in crops such as alfalfa, where the entire herbage is harvested, yield increases may not be obtained from weed control practices. However, the increased feeding value of the weed-free alfalfa (greater % crude protein and TDN) makes weed control profitable. In terms of the anticipated returns from the investment in herbicides a dollar invested in herbicides may result in a return of two to four dollars to small grain growers; six to nine dollars to corn growers; and five to twenty dollars to cotton growers. Those desiring detailed information on specific crops should contact the above speakers.

PROJECT 6 REPORT: Aquatic and Ditchbank Weeds, Lars W. Anderson, Chairman

Fifty-five attended. Speakers and topics: Dr. Dick Comes: Discussed his studies on irrigation ditchbank revegetation with various grass species after removal of undesirable perennial weeds.

Dr. Richard Yeo: Discussed his studies on dwarf spikerush which included taxonomy, morphology, biology, and preliminary studies in the establishment of this species for competition with submersed aquatic weeds.

Dr. Lars Anderson: Discussed a proposed aquatic weed survey which is being developed by a federal working group to survey aquatic weed problems and herbicide use.

Mr. Gene Otto: Discussed the status of USBR studies on controlled released formulations of various aquatic herbicides. He also included a discussion of new aquatic site weed control methods including the recirculating sprayer and the Lasco electrical discharge system on salt cedar.

Dr. Richard Schumacher: Discussed new low residue methods of applying herbicides to aquatic site vegetation. These methods included the recirculating sprayer, the weed roller, and the Micron-Herbi.

Mr. Gary Hansen: Reviewed the registration status of herbicides used on western irrigation systems. This presentation was aimed primarily at herbicides used by the USBR.

The 1979 chairman is: Dr. Don Seaman, University of California, Rice Experiment Station, P. O. Box 306, Biggs, California 95917 and the 1978 chairman is: Dr. Lars Anderson, USDA_ARS, P. O. Box 25007, Denver Federal Center, Denver, Colorado 80225.

PROJECT 7 REPORT: Chemical and Physiological Studies, M. C. Williams, Chairman.

Project 7, Chemical and Physiological Studies, met March 14, 1978 with 80 in attendance. M. C. William, H. L. Morton, and R. D. Schirman, USDA-SEA, gave talks on poisonous plants with emphasis on foreign species that have been or might be introduced into the United States. Several aspects of the introduced species problem were discussed including a more rapid implementation of current seed laws, and more publicity to increase public awareness of the problem. A paper was presented on the penetration of two herbicides into tanoak leaf discs by M. G. King, Botany Department, University of California, Davis.

Howard Morton, USDA-SEA, Tucson, Arizona is Chairman of Project 7 for 1979. J. Wayne Whitworth, New Mexico State University, Las Cruces, New Mexico is chairman-elect for 1980.

Three resolutions presented by R. Zimdahl for J. Aldridge and D. L. Shaner (Resolutions Committee). Numbers 1 and 2 passed as amended.

Proposed Resolution - 1. Whereas, the facilities and arrangements for the 1978 annual meeting of the Western Society of Weed Science are of satisfactory quality and well organized, and

Whereas, the organization and content of the program have been of good quality,

Therefore be it resolved that the membership of the Western Society of Weed Science, in conference assembled, expresses its appreciation to Chairman P. C. Martinelli and members of the 1978 Local Arrangements Committee, and to Mr. Walter Ott and the entire staff of the Nugget hotel and convention center and Chairman R. D. Comes and members of the program committee.

Passed.

Proposed Resolution - 2. Whereas CAST has prepared factual reports on several matters of importance to agriculture and weed science, and

Whereas CAST has sent these reports to members of Congress, other decision makers, the news media and general public, and

Whereas CAST has enlisted the aid of knowledgeable leaders in agricultural science to present agricultures opinion in a forthright and factual manner,

Now, therefore, be it resolved by the Western Society of Weed Science, in conference assembled, that Dr. Charles A. Black and the members of the executive board of CAST be complemented for their efforts in obtaining and disseminating accurate and timely information about Agriculture and Food Production to the people and leaders of the country.

Passed.

Proposed Resolution - 3. Whereas, the Environmental Protection Agency has proposed in the Federal Register that data for individual replications may be requested from Agricultural Experiment Station and other researchers,&

Whereas, the EPA has indicated that the lack of such replicated data for any study may result in invalidation of the study as support data, and

Whereas, this proposal will inevitably lead to such invalidation,

The Western Society of Weed Science, in conference assembled, resolves that it is opposed to the retroactive requirements for raw data from individual replications as required by the EPA proposal.

Be it further resolved that the Western Society of Weed Science urges the EPA to reconsider the adoption of the retroactive requirements of the proposal.

Moved by J. Evans that the word "retroactive" be stricken from the resolution, Seconded. Passed by voice vote. Resolution Passed.

Phillip Rolston, Graduate Student, Oregon State University, thanked WSWS for the graduate student housing program.

J. Dawson requested news of Weed Science activity in the western U.S. for the WSSA Newsletter.

The meeting was turned over to R. Comes who thanked L. Jordan for his service to the society. He also expressed his appreciation to A. Ogg, H. Kempen (members of the program committee) and P. C. Martinelli, local arrangements chairman.

The 1979 meeting will be March 20, 21, 22 at the Rodeway Inn, Boise, Idaho. Meeting adjourned by President Comes at 12:15.

HONORARY MEMBER - 1978

Dale W. Bohmont was born June 7, 1922. He received a teaching certificate from Wheatland Normal School in 1941. After serving in the Army Air Force for 3 years, he returned to college and received his B. S. (with honors) in Agronomy in 1948 and an M. S. in Plant Physiology in 1950 from the University of Wyoming. Two years later he completed his Ph.D. in Agronomy from the University of Nebraska and returned to the Agronomy Department of the University of Wyoming where he taught weed science and conducted a research program in Weed Control. Dr. Bohmont later became head of the Agronomy Department and after reorganization, head of the Plant Science Division at the University of Wyoming. He obtained his Master of Public Administration degree from Harvard in 1959. From 1961-1963 Dr. Bohmont was the Associate Director of the Colorado Agricultural Experiment Station at Colorado State University. In 1963 he was appointed Dean and Director of the College of Agriculture at the University of Nevada.

Dr. Bohmont has served as a consultant on numerous national and international agricultural programs. He has participated in State, Regional and National organizations of the Land Grant Association including key responsibilities in policy making and planning positions. He is a fellow of the American Association for the Advancement of Science and the American Society of Agronomists.

Dr. Bohmont has maintained his interest and support of the weed science discipline. He has participated on several symposia of WSWS at the annual meetings.

1978 FELLOWS

Kenneth W. Dunster served as staff research associate in the Botany Department (Vegetable Crops/Weed Control) from 1958 to 1960 while completing his formal education at U. C. Davis. He joined Amchem Products, Inc. in 1960 serving as field research and development representative for herbicides and growth regulators in the Rocky Mountain region.

Ken returned to Amchem's California headquarters in 1971 and now serves as Field Development Coordinator for California, Hawaii and Nevada. His primary responsibility since returning to California has been the continued development and refinement of Amchem programs in California and Hawaii.

Ken served as President of the WSWS for the 1970-71 term. He has been active and served on several committees of this Conference. He has also given of his time to serve on committees of the Weed Science Society of America and several State Weed Conferences.

David E. Bayer was born on a wheat farm near Grass Valley, Oregon, on August 1, 1926. He received his B.S. and M.S. degrees from Oregon State University before going to the University of Wisconsin for his Ph.D. in agronomy in 1958. In 1958 he joined the Agricultural Extension Service with the University of California at Davis as an extension weed control specialist. In 1962 he transferred into the Botany Department to work on the physiology and herbicidal control of herbaceous perennial weeds. He has continued in this area of research as well as research on rice weeds.

Dave has been a member of the Western Society of Weed Science and served on many committees and offices. In 1973 he was president-elect and program chairman and in 1974 president of our society. He has also served as the society's representative to the Weed Science Society of America.

He has been active in WSSA as well. He has served on the executive committee; chairman of the Parent Awards Committee, served on the Editorial Committee, and is an Associate Editor of "Weed Science"; and is currently secretary of this organization.

Dave has been active in the Pest Control Advisory Committee for the California State Department of Agriculture and has been on other state advisory committees. He also has taught courses on all aspects of weed science. Many of the graduate students he has worked with are currently working -n the field of weed science. One of his students received the Outstanding Graduate Student Award in WSSA in 1975.

He has been elected to membership in the following honorary societies: Alpha Zeta, Phi Sigma, and Sigma Xi.

FELLOWS AND HONORARY MEMBERS OF THE WESTERN SOCIETY OF WEED SCIENCE

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. Hodgsen, 1969
Lee Burge, 1970
Bruce Thornton, 1970
Virgil M. Freed, 1971
W. A. Harvey, 1971
*H. Fred Arle, 1972
Boysie B. Day, 1972
Harold P. Alley, 1973
K. C. Hamilton, 1973
Dick Beeler, 1976
Dale H. Bohmont, 1978

FELLOWS

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

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*Deceased: H. Fred Arle passed away shortly after our 1978 meetings.

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