



PROCEEDINGS

**WESTERN SOCIETY
OF WEED SCIENCE**



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1995 - 1996

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1995
PROCEEDINGS
OF
THE WESTERN SOCIETY OF WEED SCIENCE

VOLUME 48

PAPERS PRESENTED AT THE ANNUAL MEETING

MARCH 13 TO 16, 1995

THE RED LION HOTEL

SACRAMENTO, CALIFORNIA

PREFACE

The Proceedings contain the written summary of the papers presented at the 1995 Western Society of Weed Science Annual meeting plus summaries of the research discussion groups and of the business transacted by the Executive Board. Authors submitted either abstracts or full papers of their presentations.

In these Proceedings, herbicide application rates are given as acid equivalent or active ingredient unless otherwise specified. Chemical names of the herbicides mentioned in the text are given in the herbicide index. Botanical names of crops and weeds are given in the appropriate index and are not repeated in the text unless their omission may cause confusion. Common and botanical names follow those adopted by the Weed Science Society of America as nearly as possible and Hortus third.

Copies of this volume are available at \$15.00 per copy from Wanda Graves, WSWS Business Manager, P.O. Box 963, Newark, CA 94560.

Cover: Flodman thistle [*Cirsium flodmanii* (Rydb.) Arthur] also known as prairie thistle. Cover photograph by Rodney G. Lym. All other photographs are courtesy of Jack Schlesselman.

Proceedings Editor: Rodney G. Lym

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INVOCATION

Wayne Belles
Sandoz Agro
Moscow, Idaho

Dear Heavenly Father, Almighty God, Maker of heaven and earth, help us this day, during this meeting and throughout the coming year to seek your guidance in our endeavors.

May we rejoice in your creation, your workings, the beauty of nature that surrounds us. Help us to be good stewards of the land you have entrusted us with.

Father may we also be good stewards of our time. In this age of technology, voice mail, E-mail and automatic tellers may we not be too busy, God, for the individual touch, the personal touch. We pray for harmony, for cooperation within our society. May we remember that we are all not the same; we are unique individuals, made so intentionally by You; different but with unique capabilities. Help us to respect those differences.

Again O God we pray, as a society, for your guidance in the days ahead to be good stewards of our time and resources that you have entrusted us with, may we be good caretakers worthy of our hire. We are reminded Lord, in Your word you have promised that if we trust in You with all our heart and lean not on our own understanding and in all our ways acknowledge You, You will direct our paths.

Be with us Lord.

In the name of Jesus Christ we pray. Amen.

Each year the Western Society of Weed Science begins the General Session with an Invocation by one of the members.

GENERAL SESSION

PRESIDENTIAL ADDRESS

Tom Whitson
University of Wyoming
Laramie, Wyoming

As the Western Society of Weed Science completes its 48th year, we have many accomplishments to be proud of and many challenges to face as we rapidly approach the 21st century.

Weed Science professionals have truly helped American Agriculture to become one of the most efficient of all American enterprises. We can be proud of the fact that 2% rather than 40 or 50% of the American population are required to produce food. This fact alone has released our American work force to do other important work. With the development of the herbicide industry in the 1940's and 1950's much of the hard labor required for weed control is no longer necessary. Our unofficial slogan "The hoe must go" has become a reality. One major concern that we all have is that we are becoming so dependent on herbicides for weed management that we have failed to develop additional strategies even though currently many of you are working on combined management strategies. As systems become an ever important part of weed management, we must use a planned approach to develop an effective system.

First, we must educate producers further in areas of preventative weed management. It is a sad day when we have to establish a complex process for a producer to follow to control jointed goatgrass or dodder that were planted through their own drill. **Second**, we must become skilled at predicting weed spectrums from seed banks or from past weed infestations which will allow us to select proper herbicides or use rotations as a part of a system. **Third**, long-term crop rotation planning will be critical to enable producers to properly prevent weed resistance or weed species shifts from occurring. **Fourth**, as weeds invade our grazing lands and eliminate wildlife habitats within our National Parks and public lands, we must be very aware that a single approach such as one spray application or one biological insect release will not eliminate a weed problem. We should think about a system for weed management as an important part of a perennial ecosystem. For example, the use of a herbicide or a multiple insect release coupled with goat or sheep grazing then the establishment of perennial grasses to replace invading weed species would be an example of a management system. This then should be followed with grazing livestock at the time grasses develop seed to allow perennial grasses to effectively compete in the early spring with weeds.

As professionals, we also need to be better equipped mentally to enter the 21st century. I will never forget a day in my early career in extension when I met Guy Shuck, a Kansas wheat farmer. I stopped him one day while he was plowing his field to ask him for a research/demonstration area in his field. After he understood what I wanted he said "I am 83 years old but you never get to old to learn, put the demonstration wherever you want, along the road". We should all be so eager to continue our lifelong learning as Mr. Shuck. As a group of weed management professionals, we have become very specialized. Some weed scientists study seed biology and germination, while, others study weed ecology and population dynamics. Applied research is divided into areas such as individual crops, or weed control in rangeland and wildlife habitat. Areas such as aquatic or non-cropland weed management also require special skills. In many cases information allowing us to develop a systems approach to weed management is yet to be discovered in many areas. In the near future our membership will be ask to become further involved with weed management on federal and state lands. The public awareness of invading non-indigenous species on public lands is becoming a major national concern. Are we ready for such a challenge? We will likely have increased job opportunities and be greatly challenged as wildlife and environmental groups ask us for help to control the biological wildfire that has been discovered on federal lands. Much of the knowledge we have in cropland weed control will have to be expanded when rangeland and perennial ecosystem management opportunities arise.

The Western Society of Weed Science is a wonderful organization and can provide a key to our future success. In addition to providing an opportunity for us to exchange information with each other it can also provide an opportunity for us to publish books, like our "Weeds of the West", CD ROM programs and bulletins for the people we serve. Our prospective can be broadened with programs like in our student enhancement program started by Paul Ogg. The future will allow us many opportunities to conduct training programs for governmental employees as well as enlarging our own student educational programs. A good example is the Weed Management Short-Course headed by Barbara Mullin in Montana. Members of our society continue to contribute greatly to make our society healthy. I really appreciate all of the extra efforts many of our members have given this past year and would like to recognize them as a group.

Gus Foster - Our Program Chair and President-Elect.

Don Morishita - Our Secretary.

Wanda Graves - Our Business Manager.

Rick Boydston - WSWs Chair of the Research Section.

Stott Howard - WSWs Chair, Education and Regulatory Section.

Doug Ryerson - Host of the Member Welcome and retiree reception, and our past-president.

Paul Ogg - Our Weed Science Society of America Representative.

Jack Evans - Our Cast Representative.

Vanelle Carrithers - Member at large with this years emphasis on building stronger coalitions.

Ed Schweizer - Chair Awards Committee.

Bart Brinkman - Chair of our Fellows and Honorary Members Committee.

Roland Schirman - Chair, Finance Committee.

Mick Canevari - Coordinator of our special wine country tour and also chair of local arrangements.

Barbara Mullin - Chair, Necrology Committee.

Paul Ogg - Chair of our Nominating Committee to select new officers.

Bob Stougaard - Chair of our Placement Committee.

Joan Campbell - Chair of our Poster Committee. She selected and purchased our new posterboards and easels.

Jack Schlesselman - Chair of our Public Relations Committee.

Steve Dewey - Chair of our Publications Committee.

Carol Mallory-Smith - Chair of the Resolutions Committee.

Jack Orr - Chair of the Site Section Committee.

Kai Umeda - Chair of our Student Paper Judging Committee, a very difficult but rewarding job.

Charles Hicks - Coordinator of the Sustaining Membership Committee.

Our Ad Hoc Committees Include:

Rod Lym - Editor of our WSWs Proceedings.

Steve Miller - Editor of our Research Progress Reports. He saved our society hundreds of dollars in printing.

Steven Seefeldt - Chair of our Committee on Herbicide Resistant Weeds.

George Beck - Our Legislative Representative.

Paul Ogg - Our Student Educational Enhancement Committee Chair.

Barbara Mullin - Chair and coordinator of our Weed Management Short Course in Montana.

The Western Society of Weed Science is also very fortunate to have industry support for many of our functions and as sustaining members of our society. Would you good people in industry please stand. Your support is sincerely appreciated. Let's give them a round of applause.

It has been an extraordinary honor and pleasure to work with all of you. You are certainly a cooperative and sincere group of people. Our hard driving WSWs committees are like most of our members, they realize that the only place that success comes before work is in the dictionary.

AGRICULTURAL TRENDS IN THE 21st CENTURY. Larry Nuffer, Vice President, Nuffer, Smith, Tucker, Inc., San Diego, CA 92101.

The external climate within which agriculture operates is changing at an accelerated pace. Future threats and opportunities are emerging on a continuous basis. With each issue that impacts agriculture, increasing numbers of stakeholders, those who care about the outcome of an issue, are demanding that their voices be heard.

To anticipate the direction agriculture and food issues will be heading in the future, a system for tracking critical trends has been established. *Food Forecast* is a collaboration between Nuffer, Smith, Tucker, Inc. (NST) and the California Institute of Food and Agricultural Research (CIFAR), University of California at Davis. Its charge is to identify emerging issues likely to impact government and consumer acceptance of agricultural practices and food products in the marketplace.

When an organization, company, agency or industry is able to anticipate new issues likely to affect them, as well as new developments in existing issues, they have sufficient time to lay plans to side step possible catastrophes and speed up opportunities as they surface. There are many more management strategies available when an issue is first emerging rather than when it is already in the middle of regulatory discussion or confronting consumers on the front page of the newspaper.

Organizations and industries that get involved in issues early in their development can:

- 1) redirect likely threats to government and consumer acceptance.
- 2) accelerate potential opportunities to enhance government and consumer acceptance.
- 3) make internal adjustments to adapt to a changing environment.

The *Food Forecast* System tracks 19 on-line data bases, 10,000 plus publications/sources which generate some 1,800 abstracts across 30 categories of issues. This search is compiled three times a year and subjected to in-depth analysis by a blue-ribbon panel of experts from many disciplines representing key aspects of the national food and agricultural environment. The debate is intense as the panel drives toward reaching a consensus on the direction key issues are headed and which are most likely to affect agricultural practices and consumer food choices.

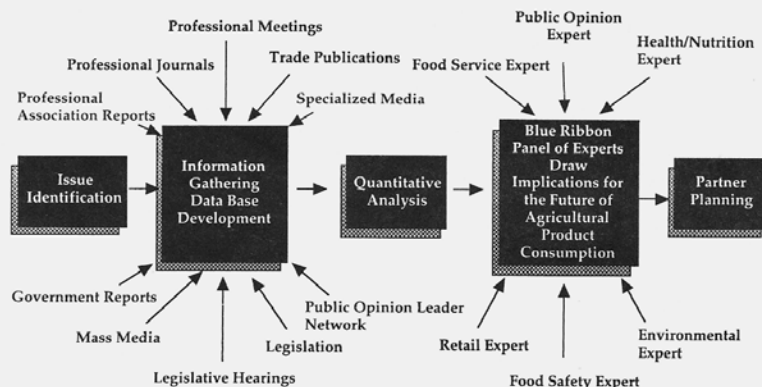
The following are some trends that are likely to impact agriculture well into the 21st century:

- 1) Reformulation of the American diet is underway, molded by a trinity of health, environmental and animal welfare concerns. This may shift food concerns driven by nutrition/health issues to the environmental and health implications of producing food.
- 2) Consumers will increasingly hold producers and distributors accountable for providing safe products and will make food-purchase decisions based on safety, availability of choice and perceived benefit.
- 3) Biotechnology will continue to grow because of its strategic importance to the U.S. economy, but products that don't clearly demonstrate consumer benefit and the perception of choice will meet public resistance.
- 4) It will be increasingly difficult to separate discussion of resource utilization and quality (e.g. water, land, air) as environmental issues continue to cross pollinate and affect each other. With this discussion the use of pesticides will be of public concern and regulatory pressure will continue.

These trends will likely lead to the development of alternative strategies of weed management. Weed scientists will be involved in new technologies and collaborative integrated approaches to agriculture.

For more information about *Food Forecast*, contact Larry Nuffer or Bill Trumpfheller at Nuffer, Smith, Tucker, Inc., at 619-296-0605.

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TODAY: SAFEGUARDING THE PUBLIC FROM PESTICIDES, TOMORROW: SAFEGUARDING PESTICIDES FROM THE PUBLIC. David Whitacre, Ph.D., Vice President of Development, Sandoz Agro, Inc., Des Plaines, IL 60025.

It's a rare pleasure for me to be able to spend the day among a group of scientists. Science writer Arthur C. Clarke said that any scientist over 50 years old is good for nothing except board meetings and should at all costs be kept out of the laboratory -- and I think my company has taken that message to heart! So I consider it a real treat to be asked to participate in your meeting. Thank you!

Recently I had the occasion to learn what a very select group we scientists are: According to the National Science Foundation, there are fewer than 500,000 Ph.D. scientists and engineers in the US, counting people in medicine, in academia, government and business.

That's about 0.2 of 1% of the population -- or 2000 parts per million. If we were to try to isolate agricultural scientists out of that number, the ratio would be infinitesimal: all the ag scientists in this great agricultural nation probably wouldn't fill up a good-sized football stadium.

On the one hand, I'm proud and honored to be part of such an elite group; on the other, our limited numbers probably have caused problems for us all. And that's part of what I want to discuss with you today.

Gus asked me to talk with you about the long-term future of the crop protection industry, and I will do that. First, however, I want to speak briefly about the present. I will begin by talking about pesticide safety, and what we have -- and have not done -- to protect the public from pesticides. Then, after that, I will give my views for the long term, along with what I believe we must do to safeguard the future of pesticides for tomorrow's farmers.

Since prognostication always has risks, I want to let you know up front that I share the sentiments of Mark Twain. He said, "the art of prophecy is very difficult, especially with respect to the future." And so, with that disclaimer, I will begin by talking about an agricultural prognosticator of 30 years ago. I'm talking, of course, about Rachel Carson and her 1962 book. Her prophecy was of a *Silent Spring* and songbirds destroyed by widespread use of chemical pesticides.

I don't believe that Carson used good science -- *Silent Spring* was one of the first volumes of what has become known as political toxicology -- but her book pulled the alarm on some very real problems. Rachel Carson's warning was widely heeded, and it galvanized this country into a full-court environmental press. The Environmental Protection Agency was organized. Laws and regulations were passed. Scientists in agrochemical companies began looking for lower-dose, more environmentally sound materials to help farmers cope with weed, disease, and insect pests. And the result was that we avoided a "silent spring." *Newsweek* recently reported that of 40 bird species Carson predicted would disappear, most have stayed the same or actually gained in population.

Only seven of the 40 species have decreased in number, and the North American Breeding Bird Survey - the bird population experts -- chalk that up to natural fluctuation. A person looking back over the years since 1962, when early questions were being raised about pesticides, would see that the agricultural scientists have done great work.

By the mid-1970's, the US had the most-monitored and safest food supply in the world, with new, even safer products regularly being brought to market to serve the American growers. Yet at the same time, we live in a society where the work of agricultural scientists is neither readily understood nor appreciated. A study recently published by CAST, the Council of Agricultural Science and Technology, reports that about 75% of the American public believe that they face risks from pesticides.

Interestingly, they do recognize that crops need to be protected from insects, disease and weeds -- they see the benefits of pesticides and the need for them. They just don't necessarily believe that chemical solutions are the only answer. They distrust chemicals because, for the past 30 years, they have been told that chemicals are bad.

Rachel Carson's warnings were heard. Our course corrections -- and the heroic science that went with them -- barely registered in the public consciousness. They blame us because our industry failed to ask the hard questions, failed to speak up when we should have. The pesticide industry never admitted that we should have done things differently, or that we were running fast to catch up.

Today we are paying for that reticence. It's all a matter of trust. And there are those who lay the blame for that at the feet of the same scientists who created the new generations of crop protection. A couple of months ago, *Chemical & Engineering News* editor Mike Heylin wrote an editorial on this very subject. He urged scientists to shed our bunker mentality in dealing with the public. He criticized the much-overused posture that "only scientists know about science, that it is just too difficult for the lay public to ever understand, and that the public's role is to remain in awe of the bounty that science bestows and to keep sending the money, no questions asked."

Just trust us -- we know. Doesn't that sound familiar? Let's see, how does it go in the ag industry? "Pesticides give us the best, most economical, most abundant food supply in the world, and the public is foolish to worry about the relatively tiny handful of synthetic chemicals in the environment." The fact that those statements are true does not eliminate fears raised by environmental activists.

As Mike Heylin wrote, "This bunker mentality does not help. It is arrogant, irrelevant, and unscientific." What we need to do -- ourselves -- is to talk to the rest of the world about agriculture and science. We need to talk to our neighbors, our children's schools, the local Rotary, even the Sierra Club if that's possible -- all the other 99.98% of the American population who are not scientists and the 98% of the population who are not farmers.

Apparently, this same subject came up in a rather surprising way at the Southern Weed Science meeting last month in Memphis. A couple of my colleagues were there, and they attended a session on Weed Science Research Needs, expecting to hear calls for more basic investigative work on a variety of subjects. Instead, the entire meeting became a call for more and better communication between weed scientists and the rest of the country.

We need to go out and talk like people, not scientists. We need to say that things may not have been so good before, but now they are much better. We need to admit to problems, and talk about what we are doing to alleviate them. We need to be concerned about misuse and misapplication of products, and condemn those who knowingly and willfully misuse synthetic pest control products.

Actually, I believe that if the industry had been more vocal in the past about condemning misuse, we might not have the problems that we do today. When people could see mistakes that the industry was ignoring or denying, it hurt our credibility for the long term. Especially so, since advocacy groups were not only vocal, but tenacious about broadcasting their concerns.

Given the CAST report, it's clear that we have a long way to go to gain public confidence for high tech crop management, and that gaining an audience will not be easy. However, my mission is to tell you that we really have no choice. As scientists, our next assignment is to become communicators.

If we can't make our successes known and our message heard in the near term, there may not be much opportunity for crop management technology -- or agricultural scientists -- in the 21st century. That, sadly is not just David Whitacre's forecast. It is a warning put forth years ago by one of our best and brightest: Nobel Laureate Norman Borlaug.

Dr. Borlaug won the Nobel Prize for his role in bringing about the Green Revolution. Where Rachel Carson predicted doom from high technology crop protection, Dr. Borlaug promised just the opposite. Dr. Borlaug's prophecy is that only with continued technical advances will we be able to feed our growing world population. Over the years, even as Indian and Chinese farmers have learned to feed their nations, Dr. Borlaug continued to preach and push for more technical advances, and he still does today.

As a crop scientist, I have more faith in Dr. Borlaug's predictions than in Rachel Carson's. Our ingenuity and know-how have caused Rachel Carson's prediction to fail, but it is going to take communication skills, and not science, if we are to prove Dr. Borlaug to be correct. About 6 months ago, he warned against the proponents of low input agriculture in Africa. "Some people say that Africa's food problems can be solved without the application of chemicals," he said. "They're dreaming. It's just not possible to raise crop productivity without improving soil fertility."

The irony is that as agricultural scientists, we listened to both of the prophets, and through our science we answered them both. On the road to the future we have reinvented modern agriculture. Some of us here today are no doubt involved in the pursuit of better biological or integrated controls. Others are in the midst of introducing the new *B.t.* seeds with herbicide resistance into the marketplace. Others, the next low dose chemicals. Whatever the specific, all of us are helping build a approach to pest control: a model whereby growers will be able to tap the most appropriate combination of tools and technologies available to control the pests in question. The western US has been the crucible for the development of this integrated approach to pest management.

If I were to bet my house and my collection of tractors on the future of pest management, I would say that an environmentally-focused systems approach will drive pest management in all parts of the world well into the next century. I would say that biological controls, biorational chemicals and biochemicals will play an increasingly important role in providing options to growers, but that chemical products will continue to be needed to deal with specific problems.

I predict that the California system of PCAs and prescription-oriented crop protection will be the model for the rest of the nation, and ultimately the rest of the world. However, my crystal ball has a dark side. There are those who continue to preach and lobby against chemical pesticides, genetic engineering, and technology in general despite the changes that have been made, the understanding that has been achieved and the value that modern crop protection provides to our society, where fewer than 2% of us choose to be farmers. There are those who fear that the Green Revolution, which saved tens of millions of people from starvation, may only have put off the inevitable, forestalling even greater famines as the population increases. They disregard evidence that population increases drop off in developing countries, and that high input agriculture employs less land than low input. The late Robert Kennedy, who was US Attorney General during the height of the 1960s activism said, "What is objectionable, what is dangerous about extremists is not that they are extreme, but that they are intolerant. The evil," he said, "is not what they say about their cause, but what they say about their opponents."

A few weeks ago, a meeting was held in Switzerland to discuss the very issue of feeding the two billion more people who will join the world in the next 20 years. At that meeting, the World Bank's vice president for Environmentally Sustainable Development registered concern about the proponents of low input agriculture for the Third World, and the fact that there has been a drop in funding available for research.

"Environmentalists," he said, "traditionally thought of agriculture as 'the enemy' because farmers chopped down forests and added pesticides and fertilizers to earth and water -- and they were right." But, he said, there is no way to protect the environment unless great strides are made in agriculture, and farmers are able to grow more on the land they have or can reclaim.

Do you get the feeling that with the best of intentions, we may all be working at cross-purposes? I do. Part of the problem is that as a whole, our well-fed modern society has lost sight of what farming is really

all about. I grew up on a farm, as I'm sure many of you also did. When I was a kid, I knew that a crop failure affected the farmer's ability to feed their families and live through the winters. People who have never been hungry, and who have never faced food shortages, are quick to believe that if we can control crop pests today with chemicals, then modern technology ought to be able to devise biological or cultural controls that work just as well. Read that NO CHEMICALS. I believe that we can, too, but just not so easily. And I have this nagging concern about our food situation. We can see it and hear it among people who deal with the farmers of the Third World.

Dr. Borlaug, and World Bank executives who are in the business of supplying development technology to those nations, are worried that the environmental activism of the developed world will produce hunger and may cost lives in the lesser developed areas. I fear that our environment has cushioned our society so much, with our abundance of food and fiber, and the ability -- thus far -- of the agricultural industry to meet regulatory demands, that our leaders are beginning to believe we're exempt from the laws of nature. No one really believes that our food supply could be in jeopardy.

To borrow a phrase from Generation X, I fear that much of our society lives in a "Virtual Reality," not even intellectually connected to those in our world who go to sleep hungry. By the same token, I also fear that our lawmakers in Washington -- and here in Sacramento -- inhabit a still more far-removed Virtual Reality where almost nothing is as it seems.

When I think about the fragility of our food supply in the face of the utopians in our society, I am reminded of the time, a number of years ago, when the Mona Lisa was stolen from the Louvre in Paris. According to the museum staff, during the time it was gone more people came to stare at the space where the famous painting had been, than came before or since to look at the painting itself.

It would be a nightmare if high technology agriculture were to suffer the same fate. The fact is, we've done a lot of work -- very good work -- to make sure that the public is protected from pesticides. What we haven't been able to do nearly so well, is to protect pesticides from the public.

Despite our excellent and exciting science, it is communication and not technical expertise, that will be the predictor for what kind of pest control technology is available to farmers in the year 2050. We've got the science right now to do what is required. I am confident of that. But if we can't figure out a way to assure public support, there may not be any synthetic crop protection available in a half-century.

Our future is caught between questions of science, public priorities and values. Between the warnings of Rachel Carson, and those of Dr. Borlaug. Where do we stand today? Where will we be tomorrow? And if the priorities and values of the public do change, will technology and thoughtful scientists be there to help move us forward again? Contrary to what we learned in school, contrary to the rules under which modern American industry has grown up, we no longer have the luxury of simply being able to build a better mousetrap. It's hard to do good science. But it's getting even harder to get people to see that what we're doing has value to them. That's our challenge. And that, depending on what we do and how successful we are, will be the key to pest control in the 21st century.

LAND-GRANT UNIVERSITY PARTNERSHIPS: OUR LINKAGE TO THE FUTURE. Charles W. Laughlin, Director Colorado Agricultural Experiment Station, Colorado State University, Fort Collins, CO 80523.

I appreciate the opportunity to share my thoughts along with other members of this panel at the 48th annual meeting of the Western Society of Weed Science. As I reviewed my comments, I decided that this presentation has the potential of offending everyone in the audience at one point or another. As the last member of the panel, I cannot help thinking about the minister who gave the invocation at a conference

when he said "Lord, give the first speaker the power to provide inspiration here today. Lord, help the second speaker to convey the seriousness of the message to all assembled, and Lord, have mercy on the last speaker."

On the way in I noticed an announcement on the bulletin board that some of you may have missed. It said that the meeting of the local clairvoyant society had been cancelled-- due to unforeseen circumstances. I do not consider myself a clairvoyant but having accepted your challenge to discuss our linkage to the future--land-grant university partnerships, being a clairvoyant would be very helpful.

The future of land-grant universities is of significant interest. Recently, the Council for Agricultural Science and Technology released a paper entitled "Challenges Confronting Agricultural Research in Land-grant Universities"; ...The National Research Council's Board on Agriculture of the National Academy of Sciences announced that it is undertaking a comprehensive 3-year study of Colleges of Agriculture..... and the W.K. Kellogg Foundation has identified twelve "Food Systems Professions Education" projects in 22 states. As Bob Dylan often sang, "Times, they are a changing."

General Motors is not the biggest auto manufacturer; Toyota is. Of the 10 largest banks in the world, only one is based in the United States. But United States agriculture has and continues to be number one in the world. The United States has not moved away from an agricultural economy. We have merely moved the work force away from agriculture. Yes, technologies based upon sound science and disseminated through educational programs have built and maintained an agriculture which is the envy of the world. But we can't rest on our laurels. We can't be the institutions we are today in 25 years. We've got to change. There is a book on the market entitled "If It Ain't Broke, Break It!" I would prefer entitling it "If it ain't working as well as it might, change it". I think that's the situation in which we find agriculture and its partners today.

When I talk about change, I am talking about change through flexible stability. That means that change is faster than evolution but slower than revolution. But with the rapidity of change around us, we've got to favor on the side of revolution. One of the difficulties with change is that there are associated risks that people automatically equate to danger. What we must do within our land-grant universities, and particularly those of us in the agricultural sciences, is to remember that we were created as risk-reduction agents. We must go back and recapture our pioneer spirit, which is more important than counting publication numbers. Let me elaborate for a moment with a story that illustrates the difference between risk and danger.

Imagine that you are a little further west in California. It's a beautiful sunny day. You drive to the beach; you walk across the beach where all of those bodies are catching rays. You wade out into the surf, turn around and you yell "shark!" Immediately, all the bodies levitate off the sand, run to their cars, and many of them light up cigarettes. Now, where is the risk and where is the danger? This year there will be over 15,000 deaths associated with sun induced skin cancers in the United States. There will be 50,000 fatalities associated with car accidents, and at least 150,000 people will die from smoking-related illnesses. Worldwide there will be less than 10 people who will be harmed by sharks. Where is the danger and where is the risk?

What we need to ask ourselves is "what is the worst thing that will happen if we don't change", and additionally, "what is the worst thing that will happen if we do change?"

The introduction of the land-grant university was a radical innovation, born at a time of turmoil, transition and stress. The federal-state partnership was established through the Morrill Act of 1862, the Hatch Act of 1887, the second Morrill Act of 1890 and the Smith-Lever Act of 1914. Through this federal-state partnership developed our teaching, research and education programs, which have been the mainstay of the land-grant university. Unfortunately, this triad has been, for the most part, relegated to colleges of agricultural science, and has not been a university wide commitment. However, there are signs that institutions are recapturing the land-grant mission.

There is very little understanding that agriculture, like other biological systems, is in a constant state of development. Few legislators or staffers have a grasp of how funding is provided for agricultural research and extension. Many seem to have a vague notion that a lot of money is provided by the agricultural chemical industry to justify the use of products. By and large, although researchers aren't suspected of collusion or falsifying their research, the general suspicion among the public is that the "goodwill" of many researchers has been bought, and the objectivity of research and extension is in doubt. However, the greatest problem I feel facing agricultural research, education and extension is not antagonism or opposition, but simply ignorance of the fact we exist.

If land-grant universities ignore public concern for new issues and listen only to their traditional clientele groups, or worse, just ourselves, we will find ourselves increasingly at odds with the people we are supposed to serve. Changing societal structures and values and changing economics are critical to the role of the land-grant universities if we are to continue as the "people's universities." Never has the need for the land-grant model been greater for our country than now. To quote Roger Wyse, the Dean from the University of Wisconsin, "...The times now call for us to focus on developing the best students, improving farm profitability, protecting the environment, and contributing more to human health and nutrition, all in a socially acceptable, community development model with budget reductions of 10 to 30%." What is happening today is that the expectations of what we can deliver within the realities of the resources are out of balance.

The challenge today is to develop a research/education agenda that will produce the technical knowledge and institutional structure that society demands, staying neutral on the issues but understanding all sides of the issues.

How might our land-grant universities address these challenges? According to Peter McGrath, President of NASULGC, they will need:

- to develop a continual quality improvement system, which creates a new way to relate to its constituents.
- to foster multidisciplinary, integrated system approaches that will improve our abilities to respond to the needs of traditional clientele and of society as a whole.
- to learn to live with and work in ways compatible with changing societal expectations in environmental and human resources.
- to help policy makers set a balance between voluntary programs and regulatory approaches.
- to develop programming strategies that will be customized to meet the needs of specific constituents.
- to make the necessary organizational changes to address the needs of a contemporary society.
- to build educational programs and research priorities based upon commonalities between the rural and urban members of society.
- to develop a wide-range of alternatives to the traditional model; and
- to build coalitions that will serve as the keystone in the development and implementation of new programs.

To accomplish these challenges, new partnerships must be developed and traditional partnerships strengthened. The simple monodimensional problem no longer exists. We need to look for working relationships with colleagues from broadened disciplinary backgrounds. We must be willing to meet with, listen to and learn from peers outside our usual comfort zones, if we are to identify and address the complex issues confronting agriculture rather than focusing on isolated symptoms of the real problems. While a strong relationship has existed between the state agricultural experiment stations and cooperative extension, these linkages need to be enhanced. We view ourselves as teachers, research and extension specialists. We have developed boundaries about what our responsibilities are. A question we need to ask is, "who cares about these boundaries?" Our clientele don't care who has the responsibility to address their needs---just meet them.

Our relationships need to be strengthened with our traditional industry and commodity contacts. We in the land-grant university need to develop coalitions with industry and commodity groups, arriving at the

table without out-stretched hands. Conversely, when industry or commodity groups request land-grant scientists to conduct research, they must pay real costs, not provide token payments. We've got to take time to think, to think about potential alternatives to address the needs of society.

Perhaps we need to reevaluate our state-federal partnership, particularly as it relates to regional research. Perhaps we need to develop a portfolio of regional research, which reflects the highest priorities based upon strategic planning and not a continuation of what has always been. Perhaps we need to pool our regional dollars and distribute them on a competitive basis between regions within a similar ecosystem, crossing over state lines so resources are shared to better meet the needs of our clientele. Perhaps our regional research dollars should be only "seed" money, funding projects for a limited time period, then redirecting money toward emerging issues.

We need to look at our relationship with community colleges, which in many ways are the land-grant universities of the 21st century. Perhaps they should become the future research and education centers for the traditional land-grant universities. We also need to develop linkages with those representing environmental issues and link these non-traditional clientele with the needs of our commodity-based clientele. The interface between production agriculture and environmental concerns is an area where we must focus. The time for defensiveness as it relates to our production activities is long past.

Industrial and manufacturing extension will be a new thrust in which we do not look at commodity production, but how to add value to our commodities. We need to involve our urban constituents, because our traditional constituents represent less than 2% of the population and approximately 1% of the votes in state and federal governments. We must reach out from our colleges of agriculture to the other colleges on campus; we must be willing to put together multi-disciplinary and interdisciplinary teams that cross over department and college lines, approaching issues from a systems perspective. We must get out of our comfort zones. We must also become active participants in the public policy arena, so that when decisions are made, decisions are made upon science, logic and knowledge and not on the emotion of the moment.

All of these come down to the simple premise that we must reach out, forming coalitions with those with whom we are comfortable and those with whom we are challenged to find the areas of commonality. I believe that these changes and these new partnerships can be accomplished if each of us has a philosophy that:

- concentrates on the new or better rather than the old or same
- is responsive rather than reluctant
- is externally focused rather than internally focused
- is flexible rather than inflexible
- is innovative rather than bureaucratic
- is action oriented rather than procrastinating
- is participatory rather than passive
- achieves rather than offers excuses
- looks to the future rather than to the past

This philosophy can be achieved and agriculture research and education programs can be recognized for their excellence, if each of us cares more than others think is wise, risks more than others think is safe, dreams more than others think is practical, and expects more than others think is possible.

POSTER SESSION

YIELD AND QUALITY OF TRANSGENIC POTATOES EXPRESSING THE *BXN* GENE. Charlotte V. Eberlein, Mary J. Guttieri, and William R. Belknap, Professor and Support Scientist, University of Idaho, Aberdeen Research and Extension Center, PO Box AA, Aberdeen, ID 83210 and Molecular Biologist, USDA/ARS/WRRRC, 800 Buchanan, Albany, CA 94706.

Abstract. To broaden the spectrum of herbicides useful in potato production, a chimeric gene (*bxn*) for bromoxynil resistance was introduced into 'Lemhi Russet' potato. The *bxn* gene, which encodes a nitrilase specific for bromoxynil, was derived from *Klebsiella ozaenae* and was introduced into potatoes by *Agrobacterium tumefaciens* mediated transformation. Fourteen transgenic clones were tested initially in the greenhouse and four clones, LH 20D, LH 67, LH 71, and LH 81, were selected for additional greenhouse and field trials. In greenhouse studies, the four transformed clones were more than 70 times more resistant to bromoxynil than the untransformed control. In field trials, these transformed clones also displayed excellent resistance to bromoxynil at rates up to 4.48 kg/ha. Laboratory studies confirmed that resistance was due to rapid metabolism of bromoxynil in transgenic plants.

In yield trials, total and U.S. No. 1 yields of a given bromoxynil-treated transgenic clone were not reduced compared to the untreated control for that clone. However, transformed clones varied in yield compared to the untreated, untransformed control. Total yields of LH 67 and LH 81 were equal to the untransformed control, but yields of LH 20D and LH 71 were 76 and 71%, respectively, of the untreated, untransformed control. All transgenic clones produced U.S. No. 1 tubers but none of these clones produced U.S. No. 1 yields equal to the untreated, untransformed control. The best performing clones were LH 81 and LH 67, which had U.S. No. 1 yields that were 85 and 70%, respectively, of the untreated, untransformed control. U.S. No. 1 yields of LH 20D and LH 71 were 53% and 35%, respectively, of the untreated, untransformed control.

Several aspects of tuber quality were evaluated, including specific gravity, percent solids, and french fry color. For a given transgenic clone, internal quality was similar for tubers from bromoxynil-treated and untreated plants. Percent solids and specific gravity of all clones except LH 71 were greater than or equal to the untransformed control. Average fry color of all four transgenic clones was equal to or lighter than the untransformed control. However, fries from LH 71 had a higher percent mottling than fries from other clones, suggesting an uneven distribution of sugars in LH 71 tubers.

USING A COMPUTER AIDED DRAFTING GEOGRAPHICAL INFORMATION SYSTEM (CAD/GIS) TO ENHANCE A NOXIOUS WEED MANAGEMENT PROGRAM. John L. Baker and Kim K. Johnson, Fremont County Weed and Pest, Lander, WY 82520.

Abstract. Fremont County Weed and Pest Control District has been developing a geographical information system to manage an integrated control program for leafy spurge. The GIS is used to generate maps which show land surfaces infested with leafy spurge, treatment activity on those lands, land ownership, topography, soil types, and irrigation practices. Release sites for biocontrol agents can be buffered on the map to show areas of potential impact. Areas of the map without an integrated effort can then be targeted for future work.

TRACER STUDIES INVOLVING BARLEY UPTAKE OF FLUOROBENZOATES. R. J. Heightman, J. Schroeder, M. D. Remmenga, B. Rao, and R. S. Bowman, Graduate Assistant and Associate Professor, Department of Entomology, Plant Pathology, and Weed Science, and Department of Experimental Statistics, New Mexico State University, Las Cruces, NM 88003; and Graduate Assistant and Associate Professor, Department of GeoScience, New Mexico Tech, Socorro, NM 87801.

Abstract. Water quality research investigating movement of herbicides through soil must compare herbicide movement to water movement. Chemicals currently used to trace water movement through soil are not always appropriate due to background interference and analytical difficulties. Fluorinated benzoic acid derivatives, also known as fluorobenzoates, have many properties required of nonreactive soil and groundwater tracers, and have been used successfully under bare ground conditions. However, since the effect of fluorobenzoates on growing plants is unknown, the use of these compounds in water quality research has been minimal. The goal of the research project was to determine the advantages and limitations of fluorobenzoate tracers in solute transport experiments involving growing plants. The objective of this greenhouse experiment was to determine the response of barley to increasing concentrations of fluorobenzoate tracers in soil.

Three fluorobenzoates (2,6-difluorobenzoate [2,6-DFBA], 3,4-difluorobenzoate [3,4-DFBA], and pentafluorobenzoate [PFBA]) were compared to bromide. The tracer concentrations used were 0, 125, 250, 500, and 1000 mg/L. Ten barley seeds were planted in sealed pots containing 600 g of soil. The tracers at each concentration were added in 80 ml of water to appropriate pots. The pots were watered to weight daily to maintain tracer concentration. Plants were fertilized as needed and visual injury symptoms were recorded weekly. Plants were harvested 12 days after treatment. The number of plants in each pot were counted, roots and shoots were washed from the soil, oven dried at 75 C, then weighed. Barley top weights were significantly reduced by all fluorobenzoate tracers at all concentrations, compared to bromide and the control. Bromide did not adversely affect top dry weight at any concentration. Quadratic models provided the best fit describing top weight response to fluorobenzoate concentrations. The model for 2,6-DFBA was $y = 0.1414 + [-0.0002(x)] + [9.0 \text{ E-}8(x^2)]$, adjusted $R^2 = 0.87$; 3,4-DFBA was $y = 0.1412 + [-0.0001(x)] + [8.3 \text{ E-}8(x^2)]$, adj. $R^2 = 0.64$; PFBA was $y = 0.1405 + [-0.0003(x)] + [1.5 \text{ E-}7(x^2)]$, adj. $R^2 = 0.89$. The models for the three tracers had a p-value of 0.0001 or smaller. The bromide data for top dry weights did not fit a quadratic nor a linear model.

TILLAGE AND HERBICIDE EFFECTS ON JOINTED GOATGRASS POPULATIONS AND WINTER WHEAT YIELDS. T. M. Price and J. O. Evans, Research Assistant and Professor, Department of Plants, Soils and Biometeorology, Utah State University, Logan, UT 84321.

Abstract. Wheat and jointed goatgrass are similar genetically as well as in growth habit. It is often difficult to distinguish jointed goatgrass and winter wheat in the early stages. An experiment was initiated using a split-split plot design to determine the effectiveness of tillage and herbicides in an integrated management approach against jointed goatgrass in winter wheat. Tillage treatments were applied in strips allowing common tillage equipment to be operated at normal speeds with herbicide treatments in strips perpendicular to tillage. Three tillage regimes and three herbicides were evaluated. The tillage regimes consisted of no-till, conservation tillage, and conventional tillage. Throughout the fallow season the conventional tillage plots were subjected to single rodweeding at 3 week intervals. The herbicides consisted of a preemergence herbicide, clomazone, and two postemergence herbicides, 2,4-D and glyphosate at different rates.

Herbicides alone were not capable of controlling jointed goatgrass during the fallow season. Postemergence herbicides were effective if complemented with conventional tillage. However, there was no difference among herbicides in the percentage of jointed goatgrass in the wheat harvests. A dramatic difference existed among the tillage regimes regarding wheat yields. In some cases, jointed goatgrass percentages in the harvests were five times more in the no-till and conservation tillage than in the conventional tillage plots. Wheat yields also exhibited a five-fold difference among tillages where the conventional tillage yields were greater than the no-till or conservation tillage yields. No difference existed between the no-till and conservation tillage regimes.

TILLAGE ALTERS WEED SPECIES MIX IN WINTER WHEAT-FALLOW SYSTEMS. Drew J. Lyon and Robert G. Wilson, Assistant Professor Agronomy and Professor Agronomy, University of Nebraska, Panhandle Research and Extension Center, 4502 Avenue I, Scottsbluff, NE 69361.

Abstract. Long-term tillage plots established at the High Plains Agricultural Laboratory near Sidney, Nebraska were monitored monthly in 1993 and 1994 for weed emergence during the year of winter wheat grain harvest and sampled for weed seed bank composition in March of the same year. The plots were established in 1970 when, with the exception of the sod treatments, native short-grass sod was moldboard plowed and winter wheat-fallow cropping systems were established. The site is divided into two major blocks; one block is seeded to winter wheat and the other left fallow each year. The winter wheat-fallow systems consisted of no-tillage, stubble-mulch, and plow or black fallow. The stubble-mulch treatment was not sampled in this study. Winter wheat was treated with 2,4-D ester at 0.25 lb/A on May 3, 1994. After wheat harvest, the no-tillage system was treated with glyphosate at 0.75 lb/A in late August, and with atrazine and clomazone at 0.5 lb/A each in early September of both years. Downy brome was the most numerous weed to emerge in both years. Mean downy brome emergence was 7.8, 0.1, and 0 plants/m² for the no-tillage, plow and sod systems, respectively. Downy brome seed bank levels were not different between the sod and no-tillage systems, but were reduced in the plow system. Downy brome seed was not detected in the soil weed seed bank below a depth of one inch. Other commonly observed weeds included kochia, slimleaf lambsquarters, redroot pigweed, and Russian thistle. Slimleaf lambsquarters emergence was greatest in the no-tillage system and redroot pigweed emergence was greatest in the plow system.

ROOT-KNOT NEMATODE INTERACTION WITH CHILE PEPPERS AND FOUR WEEDY SPECIES.

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Abstract. The ultimate success of Integrated Pest Management efforts depends largely upon our understanding of the interactions among pest species and agricultural commodities. Limited information exists concerning the interaction of multiple types of pests in disturbed agricultural systems due to the complexity of such research. The goal of current research in New Mexico is to determine interactions among selected pest species. Specific objectives of this three year research project are to determine the influence of Southern root-knot nematode (*Meloidogyne incognita*) (RKN) on spurred anoda (SA), London rocket (LR), yellow nutsedge (YNS), and purple nutsedge (PNS) growth and development; to identify the interactions among SA, LR, YNS, PNS, and chile peppers in the absence and presence of RKN; and to determine the influence of SA, LR, YNS, and PNS on overwintering populations and virulence of RKN. These pests were selected because of their concomitant worldwide distribution and severity of their effect on plants.

Thirteen combinations of chile peppers and the above weedy species are under continuous study in a field microplot experiment at the Leyendecker Farm near Las Cruces, New Mexico. The experiment was established in 1994 on an Anthony-Vinton fine sandy loam soil (76% sand, 11% silt, 13% clay, pH 7.0, 0.8% O.M.). Plant combinations (chile, annual weed(s), perennial weed(s), chile plus annual weed(s), and chile plus perennial weed(s)) were grown in paired plots with absent or present root-knot nematode infection for one summer. Plants were sampled monthly and leaf area, stem length, plant dry weight, and root-knot nematode egg counts from root extractions per volume of soil were determined. Preliminary results of the first year of work indicate that SA, YNS, and PNS host RKN and that chile root, shoot, and reproductive biomass are not significantly reduced by weeds when the crop is grown with RKN infestation. This experiment will continue through 1996.

THE RELATIONSHIP BETWEEN THREE YELLOW NUTSEDGE BIOTYPES WITH CHILE PEPPERS AND THEIR INTERACTION WITH SOUTHERN ROOT-KNOT NEMATODE. A. Covarrubias and J. Schroeder, McNair Scholar and Associate Professor, Department of Entomology, Plant Pathology and Weed Science, New Mexico State University, Las Cruces, NM 88003.

Abstract. Sustainability of New Mexico crop production depends on understanding the interactions among pests species. Many common New Mexico weeds, including the perennial weed yellow nutsedge, are alternate hosts to the southern root-knot nematode. Greenhouse research was conducted to evaluate the effect of RKN infected and non-infected YNS biotypes on chile growth and their interaction with RKN, and to determine if YNS from RKN infected fields infect chile with RKN.

Experiments showed that all three YNS biotype similarly reduced chile root, height, top and root dry weights. RKN populations became established on YNS and chile root systems when YNS was established from Dona Ana County +RKN tubers. The results support the hypothesis that YNS maintains RKN populations between crops and the RKN associated with YNS can infect chile. The YNS biotype from the Covarrubias Farms did not show any RKN infection. RKN reproduction occurred on YNS and chile after surface sterilization of +RKN tubers. Under nonsterile conditions, YNS produced from +RKN tuber had smaller root weight, tuber number and weight compared to YNS produced from -RKN tubers. However, under sterile conditions YNS root weight, tuber number and weight was similar whether produced from either - or + RKN. Surface sterilization may have reduced the competition of other organisms allowing greater RKN infection and reproduction as well as YNS growth and reproduction. Research is needed to verify whether the surface sterilization procedure was adequate to remove all RKN eggs from the surface to the tubers.

PROMETRYN UPTAKE AND TRANSLOCATION BY PIMA AND UPLAND-TYPE VARIETIES OF COTTON SEEDLINGS. M. P. Waldrop, L. A. Gibbs, and T. M. Sterling, Undergraduate Student, Research Assistant, and Assistant Professor, Department of Entomology, Plant Pathology, and Weed Science, New Mexico State University, Las Cruces, NM 88003.

Abstract. The use of herbicides on weeds that invade cotton crops is an essential part of agricultural production in the southwestern United States. Prometryn, a major herbicide used in cotton, is a photosynthetic inhibitor and can cause cotton injury. Thus, herbicide interactions with cotton must be understood. In this study, uptake by the root or hypocotyl, translocation, and metabolism of prometryn was examined in Pima S-7, Acala 1517-75 and Delta Pine 5415 varieties of cotton. Acala and Pima are Pima-type cotton and are tolerant varieties while Delta Pine is an Upland-type cotton and is sensitive to prometryn. Our objective was to determine the extent to which these varieties would absorb prometryn from either root or hypocotyl tissues, then translocate, and metabolize it. This experiment would give us a greater understanding as to how tolerant varieties react to prometryn compared to susceptible varieties.

We examined uptake of prometryn by excised root and hypocotyl for each cultivar of 6-day-old cotton seedlings. Tissues were treated with $7.41 \mu\text{Ci/L}$ ^{14}C -prometryn ($30.7 \mu\text{Ci/mg}$ specific activity) supplemented with ^{12}C -prometryn to reach a final concentration of $1.0 \mu\text{M}$ prometryn. Aliquots of uptake solution were removed over time and counted using liquid scintillation spectrometry to determine prometryn uptake by tissue. The experiment was a random complete block design arranged as a factorial with root and hypocotyl treatments, 3 cultivars, 7 time points, 4 replications, and the experiment was repeated.

Metabolism of prometryn was determined by HPLC analysis. Prometryn and possible metabolites were eluted through a C_{18} HPLC column with an acetonitrile:water of 3:2 as the mobile phase at a rate of 1.5 mL/min. Whole plant uptake and translocation of prometryn was then examined for each cultivar. Our planting strategy used two seeds per pot in 45 g of soil, above or below an activated charcoal layer. Also above or below this charcoal layer was added 2 of spiked soil treated with 1×10^6 dpm ^{14}C -prometryn supplemented with formulated prometryn at a net prometryn application rate of 1.3 kg/ha. The charcoal barrier allowed differential uptake of

prometryn by the roots or hypocotyl to be determined. The experiment was a randomized complete block design arranged as a factorial with a hypocotyl and root treatment, three cultivars, four harvests and five replications. Cotton plants were harvested 14, 21, 28, and 35 days after emergence and separated into root, hypocotyl, cotyledon, and leaf sections. Soil was separated into above carbon layer, carbon layer, and below carbon layer. Plant and soil material was dried, oxidized, and dpm content quantified using scintillation spectrometry.

For excised tissue study, root tissue absorbed more prometryn than hypocotyl tissue for all cultivars, Pima root and hypocotyl tissue absorbed more prometryn than Acala or Delta Pine at many of the time points, and no metabolism was found in any of the tissues. In the intact seedling study, prometryn uptake and translocation did not differ between cultivars. Therefore, differential prometryn tolerance among these varieties cannot be explained by uptake or translocation. However, uptake and translocation was greater in root-treated compared to hypocotyl-treated seedlings over time, averaged across cultivars. Thus, depth of prometryn infiltration may be an important factor affecting prometryn damage.

NITROGEN APPLICATION TIMING EFFECTS ON DOWNY BROME AND WINTER WHEAT GROWTH AND YIELD. D. A. Ball, D. J. Wysocki, and T. G. Chastin, Assistant and Associate Professors, Columbia Basin Agricultural Research Center, Oregon State University, Pendleton, OR 97801.

INTRODUCTION

Control of annual grass weeds such as downy brome in winter wheat presents a major constraint to the adoption of conservation tillage systems in the Pacific Northwest. Changing nitrogen management practices can produce changes in weed populations and their competitive relationship with wheat (1, 3) and could facilitate the integrated management of downy brome in conservation tillage systems. In addition, a change in nitrogen management practices from conventional application in summer fallow prior to winter wheat planting to later application timings has been proposed as a method to protect water resources from excess nitrate nitrogen (4). To integrate weed control and fertilization practices for water quality protection, an understanding of weed responses to different nitrogen management practices is necessary.

MATERIALS AND METHODS

Field experiments were conducted in 1993 and 1994 near Pendleton and Moro, OR on a Walla Walla silt loam soil (mixed mesic Typic Haploxerolls) to determine downy brome and winter wheat response to nitrogen management regimes under the low annual precipitation (300 to 460 mm) areas of the inland Pacific Northwest which are typically cropped in a winter wheat/summer fallow rotation. Experiments at both locations were arranged as a split-plot design with main treatments consisting of N-fertilizer rates and application timings using a point injection fertilizer application unit (2). Main plot treatments consist of the following N management strategies: an untreated control, 45 kg ha⁻¹ N at planting as a 32% aqua ammonia N solution, 45 kg ha⁻¹ N in fallow as anhydrous NH₃, 90 kg ha⁻¹ N at planting as a 32% N solution, 90 kg ha⁻¹ N in fallow as anhydrous NH₃, 90 kg ha⁻¹ N in growing crop as a 32% N solution using point injection, 45 kg ha⁻¹ N in fallow as anhydrous NH₃ plus 45 kg ha⁻¹ N in growing crop as a 32% N solution using point injection, 45 kg ha⁻¹ N at planting as 32% N solution plus 45 kg ha⁻¹ N in growing crop as a 32% N solution using point injection, and 22 kg ha⁻¹ N at planting as 32% N solution plus 45 kg ha⁻¹ N in growing crop as a 32% N solution using point injection. Fallow treatments were applied approximately two to three months prior to planting wheat, and in-crop applications were made in April. Treatments were the same at Moro with N rates cut in half. Main treatments were split into two subplots, one of which was seeded with downy brome prior to wheat planting (infested) and the other not seeded (uninfested) with downy brome. Plots were 7 m by 3 m with four replications. Wheat was seeded each year with a deep furrow drill at the Moro location and a hoe-type drill at Pendleton. Winter wheat var. 'Madsen' was used in this study. Measurements were made of wheat grain yield, and downy brome dry matter production.

RESULTS AND DISCUSSION

Results are from plots that were subjected to the same fertilizer treatments for two consecutive cropping cycles. For example, the 1993 experiments were overlaid on plots treated in the 1990 to 1991 crop season. In 1994, experiments were overlaid on plots treated in the 1991 to 1992 crop season. At Pendleton in 1993 when cropping season precipitation was 95 mm above average (Table 1), split application of N and full rates at later application timings resulted in greater grain yield compared to full anhydrous N application rates applied in fallow and the untreated control in the absence of downy brome (Table 2). When downy brome was present at levels interfering with wheat growth, weed biomass was increased by these same split applications and later application timings (Table 3). The increased interference from downy brome from these fertilizer treatments diminished the crop yield benefit from in-crop and split application timings.

At Pendleton in 1994 and Moro in 1993 when growing season precipitation was similar (Table 1), there was no added crop yield benefit compared to conventional anhydrous N application during summer fallow (Table 2), but downy brome dry matter was increased by full rate split applications and later timing of N, particularly when applied to the growing crop (Table 3). At Moro in 1994, there was no clear crop response to any added N treatments over the untreated control because of the extremely dry growing season precipitation that year (Table 1). Similarly, there were unclear trends on downy brome growth response to fertilizer treatment due to the dry conditions in 1994 at Moro.

Results indicate that there was no definite crop yield benefit from split application of N or from N application with point injection at planting or as a spring time application in the growing crop, except during the one year of greater than average growing season precipitation in 1993 at Pendleton. However, these application timings increased downy brome dry matter production, and presumably weed seed production under most of the sites each year.

Table 1. Crop year precipitation at the Pendleton and Moro sites during 1993 and 1994 growing seasons.

Crop Yr	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total
inches													
Pendleton, Oregon													
1992-93	0.58	1.70	2.61	1.30	2.43	1.04	2.32	2.67	1.58	2.01	0.47	2.60	21.31
1993-94	0	0.30	0.49	1.91	2.38	1.67	.52	1.18	2.88	0.75	0.33	0.07	12.48
20 Year Average	0.82	1.21	2.42	1.94	1.88	1.57	1.95	1.70	1.61	1.06	0.45	0.95	17.57
Moro, Oregon													
1992-93	0.68	0.85	1.50	1.68	1.42	1.47	1.68	1.22	1.42	0.87	0.39	0.30	13.48
1993-94	0.02	0.09	0.41	0.68	1.40	0.90	0.55	0.40	0.62	0.61	0.11	0.07	5.86
20 Year Average	0.54	0.80	1.67	1.65	1.41	1.17	1.18	0.93	0.86	0.60	0.37	0.48	11.65

Table 2. Influence of nitrogen application method and downy brome (BROTE) infestation on grain yield of winter wheat.

Treatment ^a	Pendleton				Moro			
	1993		1994		1993		1994	
	BROTE	No Weeds	BROTE	No Weeds	BROTE	No Weeds	BROTE	No Weeds
(Rate ha ⁻¹)	(kg ha ⁻¹)							
Control	2890	3490	2220	2420	3430	3430	2490	2820
22 kg at planting + 45 kg in crop	3830	5110	3900	4370	4430	3960	2750	3160
45 kg in fallow	4030	4770	4100	4030	4370	4430	2490	2960
45 kg at planting	3560	4570	3830	4030	4300	4370	2620	3090
45 kg in fallow + 45 kg in crop	4230	5310	3360	4100	3960	4170	2890	3020
45 kg at planting + 45 kg in crop	5000	5910	4300	4640	4430	4700	2820	3090
90 kg in fallow	4370	4840	3700	4370	4430	4700	3020	3290
90 kg at planting	4430	5110	4230	4370	4640	4770	2890	2960
90 kg in crop	3760	5310	3830	4300	4300	4300	2750	3020
LSD (0.05)								
Fert	400		670		470		NS	
Herb	200		600		NS		130	
Fert x Herb	0.0775 ^b		NS		NS		NS	

^aFertilizer rates at the Moro site were one half of the rates shown for Pendleton.

^bLevel of significance for Fert x Herb interaction.

Table 3. Influence of nitrogen application method and downy brome (BROTE) infestation on late season dry weight of downy brome.

Treatment ^a	Pendleton				Moro			
	1993		1994		1993		1994	
	BROTE	No Weeds	BROTE	No Weeds	BROTE	No Weeds	BROTE	No Weeds
(Rate ha ⁻¹)	(kg ha ⁻¹)							
Control	1270	120	380	10	240	50	330	50
22 kg at planting + 45 kg in crop	2800	230	910	10	330	70	350	20
45 kg in fallow	1540	160	390	10	370	10	490	40
45 kg at planting	1380	120	430	10	205	40	670	230
45 kg in fallow + 45 kg in crop	1760	160	950	30	430	10	360	190
45 kg at planting + 45 kg in crop	2240	80	1170	30	500	30	580	120
90 kg in fallow	1210	200	410	10	150	10	210	80
90 kg at planting	2060	460	650	10	380	10	560	90
90 kg in crop	2170	220	1070	10	410	40	280	260
LSD (0.05)								
Fert	560		340		NS		NS	
Herb	280		180		50		NS	
Fert x Herb	NS		NS		0.042 ^b		NS	

^aFertilizer rates at the Moro site were one half of the rates shown for Pendleton.

^bLevel of significance for Fert x Herb interaction.

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LONGEVITY OF DICLOFOP-RESISTANT ITALIAN RYEGRASS SEED IN SOIL. Bill D. Brewster, William S. Donaldson, and Carol A. Mallory-Smith, Senior Instructor, Research Assistant, and Assistant Professor, Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002.

Abstract. Widespread resistance of Italian ryegrass to diclofop-methyl in the Willamette Valley of Oregon has resulted in large numbers of Italian ryegrass seeds entering the seedbank. Because diclofop-resistant Italian ryegrass is often cross-resistant to related herbicides, a study was initiated to determine how long the seeds would remain viable and, therefore, limit the weed control options in infested fields. Diclofop-resistant Italian ryegrass seed was sown at rates of 0, 15, and 1500 lb/A and rototilled into the soil to a depth of 6 inches at the

Hyslop Agronomy Farm, near Corvallis, Oregon in September, 1990. The grass was killed with glyphosate each year to prevent seed production following stand density observations, and each fall the soil was rototilled prior to ryegrass germination. The 15 lb/A ($\sim 3 \times 10^6$ seeds) rate was considered the lowest seeding rate that would likely result in extremely severe competition with a wheat crop, and the 1500 lb/A ($\sim 3 \times 10^8$ seeds) rate was estimated to be the amount of seed being produced in some badly infested fields. The trial design was a randomized complete block with three replications. The Italian ryegrass stand densities were about the same during the first two years of the study, but there was a large decline beginning in the third year. Wheat fields would not be greatly affected by the ryegrass stand that developed from the 15 lb/A seeding rate in the fourth year or from the 1500 lb/A seeding rate in the fifth year, but if not controlled, each plant could produce many additional seeds.

Table. Diclofop-resistant Italian ryegrass stand densities during 5 years following seeding at two rates near Corvallis, Oregon.

Year	Italian ryegrass stand density		
	15 lb/A rate	1500 lb/A rate	LSD _(0.05)
	Thousands/A		
1990-91	1,133	50,268	29,534
1991-92	990	43,464	6,382
1992-93	470	4,199	1,172
1993-94	15	425	243
1994-95	18	102	43

ISOZYME VARIATION OF BROOM AND THREADLEAF SNAKEWEED FROM FOUR WESTERN STATES.

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Abstract. Broom and threadleaf snakeweed are distributed widely in the western United States. They reduce rangeland productivity and are toxic to livestock. Both species are highly variable in morphology and phenology and grow under a variety of environmental conditions. The objective of this study was to evaluate and quantify genetic variation using isozyme analysis among snakeweed populations from Arizona, New Mexico, Texas, and Wyoming and compare to results determined previously for populations within New Mexico.

Twenty to thirty plants of broom and threadleaf snakeweed were transplanted from sites in Arizona, New Mexico, Texas, and Wyoming and were maintained in a greenhouse for six months prior to isozyme analysis. Enzymes were extracted from young leaf tissue with buffer containing 0.1 M Tris (pH 8.5) plus 1.0% (w/v) reduced glutathione. Enzymes evaluated using starch gel electrophoresis included aconitase, aspartate aminotransferase, α -esterase, β -esterase, malate dehydrogenase, malic enzyme, phosphoglucoisomerase, phosphoglucomutase, 6-phosphogluconate dehydrogenase, and shikimate dehydrogenase. Three gel and electrode buffer systems were used for isozyme separation. Appropriate substrates and staining buffers were provided for isozyme detection.

Genetic variation was assessed based on expressed isozyme patterns on the gel using the computer program BIOSYS. Of 10 enzymes tested, 16 loci were identified. For broom snakeweed, mean number of alleles per locus ranged from 1.1 ± 0.1 to 1.5 ± 0.2 , polymorphic loci from 12.5 to 43.8%, and mean heterozygosity from

0.062 ± 0.043 to 0.199 ± 0.060. For threadleaf snakeweed, mean number of alleles ranged from 1.1 ± 0.1 to 1.4 ± 0.4, polymorphic loci from 12.5 to 31.3%, and heterozygosity from 0.062 ± 0.043 to 0.132 ± 0.051. Genetic variation between species, variation among populations within species, and variation among individuals within populations were 0.569, 0.374 and 0.312, respectively for all loci. Phylogenetic analysis using Nei's genetic similarity and distance defined two major groups, one group contained three broom snakeweed populations and other contained two threadleaf snakeweed populations, Arizona and New Mexico. Broom snakeweed populations from New Mexico and Texas were more similar to one another compared to broom snakeweed populations from Wyoming and Texas, and from Wyoming and New Mexico. These results indicate that these species can be distinguished using isozyme analysis. There were great genetic differences between species and among broom and threadleaf snakeweed populations within each species. Variation between species was larger than within species. Compared to genetic differences within New Mexico populations, more differences existed among states, which may be related to larger geographic separation and environmental differences at collection sites.

HYBRID NECROTIC WHEAT, A POTENTIAL COVER CROP. Edward J. Souza, Charlotte V. Eberlein, Mary J. Guttieri, and Katherine L. O'Brien, Associate Professor, Professor, Support Scientist, and Scientific Aide, University of Idaho, Aberdeen Research and Extension Center, Aberdeen, ID 83210.

Abstract. Cover crops are a potentially powerful tool for weed and erosion control. Successful application of cover crops requires optimization of cover crop interference with weeds and minimization of cover crop interference with the production crop. In practice, this optimization has necessitated chemical control of the cover crop. Winter wheat is a potentially useful cover crop because it is strongly competitive with weeds and provides ground cover over the fall and winter. Hybrid necrosis of wheat, a physiological disorder elicited by complementary alleles, results in untimely senescence. Deployment of hybrid wheats carrying complementary necrotic alleles could eliminate the need for chemical control of the wheat cover crop. To evaluate the potential of specific combinations of necrotic alleles, 55 winter wheat hybrids, involving 5 *Ne1* carriers and 11 *Ne2* carriers, were manually synthesized and characterized in replicated, irrigated, field trials at Aberdeen, ID in both 1992 to 1993 and 1993 to 1994. Timing of onset of necrosis, the severity of necrosis, and the architecture of the hybrid varied widely with the parental combination. In the extreme case, crosses involving 'Ponca' (*Ne1*) had necrotic responses evident shortly after emergence, and the necrotic hybrids senesced during the winter. At the other extreme, the necrotic response was limited to a mild chlorosis, and the hybrids developed similarly to the inbred parents. Within these two extremes, a number of successful combinations of alleles were identified that produced hybrids which survived winter, developed into competitive plants, and subsequently completed senescence prior to heading (Feekes stage 10). Ponca may be a viable parent in combination with carriers of mild *Ne2* alleles such as 'Heine VII'. Therefore, hybrid necrosis of wheat could potentially be manipulated to optimize the onset and severity of necrosis for specific cropping systems.

HERBICIDE INFLUENCE ON YIELD AND QUALITY OF CHILE PEPPERS. G. Hoxworth, J. Schroeder, and J. Libbin, Research Assistant, Associate Professor, Department of Entomology, Plant Pathology, and Weed Science, and Professor, Dept. of Agricultural Economics and Agricultural Business, New Mexico State University, Las Cruces, NM 88003.

Abstract. Chile pepper, representative of *Capsicum* cultivars, is a minor use crop currently grown with a heavy dependence on cultivation and hand labor for weed management. Hand labor for weed management is expensive and inconsistent and entails a substantial amount of record-keeping, personal liability and supervision; therefore, producers are using herbicides in greater amounts. Research was conducted in 1994 on a Belen clay loam soil (pH 7.7, 1.2% OM) near Las Cruces, NM to determine the efficacy of registered, soil applied herbicides for use in chile peppers, determine if herbicide treatment reduces the need for hand-weeding chile peppers, and

determine the influence of weed management systems on yield and quality of chile peppers. The experiment was established with a split plot treatment arrangement in a randomized complete block design and four replications. The main plots were herbicide treatments and subplots were either hand-weeded or remained unweeded. The eight herbicide treatments included a nontreated control, napropamide, clomazone, or napropamide plus clomazone applied preplant incorporated (PPI), each PPI treatment followed by metolachlor plus trifluralin applied postemergence directed and incorporated (PODEI), and metolachlor plus trifluralin applied PODEI. All herbicide treatments were applied at labeled rates. Chile peppers were seeded on March 23 and thinned on May 31, 1994. PODEI treatments were applied on June 1. The entire experiment was cultivated three times during the growing season. Each hand-weeded plot was weeded every two weeks beginning two weeks after planting. Data included time required to hand weed plots, visual evaluation of crop injury and weed control by species, and red pepper yield and quality.

Overall control of all species at thinning was superior with the napropamide plus clomazone tank mix. Clomazone alone did not provide acceptable control of Palmer amaranth and only good control of barnyardgrass. Napropamide alone did not control oakleaf thornapple well. Control of oakleaf thornapple and tall morningglory 45 days after thinning and PODEI treatment was excellent with all treatments. Overall weed control (of all species) was best with clomazone, napropamide, or napropamide plus clomazone followed by trifluralin plus metolachlor. The weed control at the end of the season was again best with the napropamide plus clomazone followed by trifluralin plus metolachlor treatment. The weed control information is supported by the amount of time required to maintain weed-free conditions and by the weed-free yield. All herbicide treatments required significantly less time for maintenance than the nontreated control. However, the additional PODEI treatment of trifluralin plus metolachlor following any PPI treatment significantly reduced the hand labor requirement compared to PPI treatment alone. The napropamide plus clomazone followed by trifluralin plus metolachlor with hand weeding treatment yielded 4138 kg red chile/ha compared to 2937 kg/ha for the hand-weeded control. In addition the same treatment without hand-weeding yielded 1388 kg/ha chile and the weedy control yielded 62 kg/ha indicating that herbicide treatments were beneficial to maximum production. None of the herbicide treatments in the weed-free plots had any effect on the extractable red color (ASTA) of the chile powder. However, in the weedy plots, the quality of the chile powder color was reduced compared to the nontreated control in five treatments (napropamide (PPI), napropamide plus clomazone (PPI), napropamide (PPI) plus trifluralin plus metolachlor (PODEI), napropamide plus clomazone (PPI) plus trifluralin plus metolachlor (PODEI), and trifluralin plus metolachlor (PODEI).

FALL VERSUS SPRING HERBICIDE APPLICATIONS FOR PERENNIAL RYEGRASS CONTROL IN ALFALFA. Larry S. Jeffery and Bryan C. Leavitt, Professor and Former Graduate Student, Department of Agronomy and Horticulture, Brigham Young University, Provo, UT 84602.

Abstract. Alfalfa is grown as a high protein forage crop throughout the western United States. It is a major cash crop for many farmers. Its value often depends on its protein content and overall feed value. Perennial ryegrass is also a forage and at times is grown with alfalfa to prevent bloating in grazing animals. When alfalfa is grown as a cash crop, perennial ryegrass is considered to be a weed because it lowers forage quality. Field experiments were conducted in 1988-89 and 1992-93 at the Brigham Young University Agricultural Research Station to evaluate five herbicides applied in the fall and spring for the control of perennial ryegrass in established alfalfa. Diuron (2.2 and 2.7 kg ha⁻¹), hexazinone (1.1 and 1.7 kg ha⁻¹), metribuzin (0.8 and 1.1 kg ha⁻¹, pronamide 1.2 and 1.6 kg ha⁻¹), and terbacil (1.1 and 1.3 kg ha⁻¹) were applied in the fall after several killing frosts and in the spring at or slightly before new alfalfa leaves appeared. In general fall herbicide applications controlled more perennial ryegrass than did spring applications. Hexazinone (1.7 kg ha⁻¹) and terbacil (1.1 and 1.3 kg ha⁻¹) gave the highest and most uniform control of perennial ryegrass. Diuron, metribuzin and pronamide (1.2 kg ha⁻¹) control of perennial ryegrass was not consistent between years or alfalfa cuttings. Herbicide treatments reduced total forage yield from 0 to 20% depending on cutting and treatment primarily because of reduced perennial ryegrass portion. Most herbicide treatments increased the pure alfalfa yield per acre.

EFFECT OF TILLAGE AND FERTILIZER SYSTEM ON CORN AND WEED RESPONSE. Patrick G. Renner, Stephen D. Miller and K. James Fornstrom, Research Assistant, Professor and Professor, Dept. of Plant Soil and Insect Science and Civil Engineering, University of Wyoming, Laramie, WY 82071.

Abstract. Field studies were conducted, at the University of Wyoming Research and Extension Center, Torrington, WY in 1992, 1993, and 1994 to determine the effects of timing and placement of nitrogen fertilizer on weed and corn response under three tillage systems (conventional, minimum and no-till). Fertilizer treatments consisted of both dry surface broadcast and liquid spoke wheel injection. Except for the late season count in 1994, no-till plots consistently had the highest weed populations. Weed population response as related to fertilizer placement method were variable. There was a trend for surface broadcast methods to have increased grass weed pressure during early but not late season observations. Conventional tillage consistently had the highest yields for both corn silage and grain. Corn grain and silage yield differences between tillage treatments were most pronounced in 1992. A cool summer and an early freeze in 1993 and limited irrigation in 1994 minimized yield differences between treatments. There was no difference in corn silage yields between fertilizer treatments, however, there was a trend for the liquid injection applied 50% at planting, 25% at cultivation and 25% at ditching to have slightly higher grain yields.

EFFECT OF FLY ASH ON THE EFFICACY OF SOIL-ACTIVE HERBICIDES. Bill D. Brewster, William S. Donaldson, Carol A. Mallory-Smith, and Susan Aldrich-Markham, Senior Instructor, Research Assistant, Assistant Professor, and Associate Professor, Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002.

Abstract. Industrial fly ash has been applied to agricultural soils in the Willamette Valley of Oregon as an economical means of disposing of this waste. However, growers have complained of poor weed control with certain herbicides following this practice. Fly ash was applied at rates of 0, 25, and 50 T/A in a trial at the Hyslop Agronomy Farm near Corvallis, Oregon to investigate the influence of fly ash on herbicide performance. The experimental design was a split block with four replications. The soil was a Woodburn silt loam with a pH of 6.1, organic matter of 3.0%, and CEC of 20. The fly ash was rototilled into the soil to a depth of 6 inches in September, 1992, and Italian ryegrass seed was broadcast over the trial site and harrowed into the soil. Triallate, EPTC, and diclofop-methyl were applied preplant incorporated, while pronamide, diuron, metribuzin, and chlorsulfuron plus metsulfuron were applied at the 1-leaf stage of ryegrass development. Herbicides were applied in a broadcast spray of 20 gpa at 15 psi with a single-wheel, compressed-air sprayer. The trial area was re-rototilled in the fall of 1993 and again in 1994. Each year ryegrass seed was broadcast across the trial and the herbicides were reapplied. All of the herbicides were less effective in the fly-ash-treated areas than in the non-treated areas each year. The higher rate of fly ash often reduced ryegrass control from a particular herbicide more than did the lower rate.

Table. Italian ryegrass control with herbicides following applications of fly ash to the soil at rates of 0, 25, and 50 T/A near Corvallis, Oregon, 1992-1994.

Treatment	Rate	Italian ryegrass control								
		1992			1993			1994		
		Fly ash (T/A)								
		0	25	50	0	25	50	0	25	50
	(lb/A)	(%)								
Triallate	1.25	80	18	8	91	58	33	92	79	69
EPTC	3	83	13	8	93	60	40	93	69	48
Diclofop-methyl	1	95	38	20	94	65	35	94	75	60
Pronamide	0.75	86	40	30	94	50	23	68	50	40
Diuron	1.6	91	68	63	80	45	33	83	63	45
Metribuzin ^a	0.14	93	60	55	38	5	0	74	38	18
Clr-met ^b	0.023	96	63	50	73	15	5	86	71	71
Check	0	0	0	0	0	0	0	0	0	0
LSD _{0.05} for a herbicide treatment within a year		11			13			14		

^anon-ionic surfactant added at 0.25% v/v

^bclr-met = chlorsulfuron + metsulfuron

DETECTION OF YELLOW HAWKWEED WITH HIGH RESOLUTION MULTISPECTRAL DIGITAL IMAGERY. Larry W. Lass, Hubert W. Carson, and Robert H. Callihan, Postdoctoral Fellow, Graduate Student, and Extension Specialist, University of Idaho, Moscow, ID 83844-2339.

Abstract. Yellow hawkweed (*Hieracium pratense* Tausch, HIECA: Asteraceae) infests upland permanent pastures and forest meadows in northern Idaho. Open areas susceptible to infestation by yellow hawkweed are often disjunct while forests and rough terrain render infested areas hard to access for land-based surveys. A multispectral scanner mounted in an airplane produced digital images of flowering yellow hawkweed, with 1 m resolution. Spectral band 1 of the image measured blue-green light reflectance, with a light wavelength range of 480 to 520 nm. Band 2, for green reflectance, ranged from 505.5 to 598.5 nm. For measurement of near infrared light reflectance, band 3 ranged from 722.5 to 771.5 nm and band 4 from 791 to 901 nm. Supervised data classification resulted in finding 6.2 ha hawkweed while unsupervised classification could detect only 4.7 ha in the 38.4 ha test site. Where yellow hawkweed was the dominant ground cover species, infestations were detectable with high accuracy (97 to 98%) from multispectral scanner images. Detection of different densities was unreliable because moderate hawkweed infestation detection was unreliable (6% accuracy), and areas containing less than 20% hawkweed cover were not detected.

COMPARISON OF PICLORAM-RESISTANT AND -SUSCEPTIBLE YELLOW STARHISTLE IN A REPLACEMENT SERIES. L. A. Gibbs, M. W. Murray, T. M. Sterling, Research Assistant, Graduate Student, Assistant Professor, Department of Entomology, Plant Pathology, and Weed Science, and N. K. Lownds, Associate Professor, Department of Agronomy and Horticulture, New Mexico State University, Las Cruces, NM 88003.

Abstract. Yellow starthistle can decrease the carrying capacity of grazing land and seriously damage non-grazed ecosystems. Picloram, an auxin-like herbicide, is the primary herbicide used to combat this weed. Resistance to picloram has been detected in 1989 in a field near Dayton, WA. To determine if there is a competitive advantage between resistant (R) and susceptible (S) plants in the presence or absence of picloram, the two accessions were tested using a replacement series over a 1 year period. Greenhouse studies were conducted to evaluate plants grown in 5 ratios of S to R; 8:0, 6:2, 4:4, 2:6, and 0:8. Picloram (0.28 kg/ha) was applied at the rosette stage. Following treatment, plants were harvested at rosette, bolting, and past flowering. Plants that matured to flowering were cross-pollinated with all other flowering plants within the pot. If there were no other plants within the pot flowering, the flowering individual was crossed with its monoculture control plants. Pollination was conducted by hand using deceased bees. At each harvest date, plant fresh and dry weights were taken and seeds collected, counted and weighed at the final harvest. In the absence of picloram, both S and R plants contributed equally to pot biomass. In the presence of picloram, R contributed more dry weight to the total pot dry weight than S. R produced more seeds than S only in the presence of picloram. These results suggest that R has a competitive advantage over S only in the presence of picloram. Seedlings from seeds of plants not treated with picloram were screened for picloram resistance by spraying with picloram at 0.14 kg/ha 27 d after germination. Visual ratings of epinasty on a scale of 1-10 were recorded twice a week for 4 weeks. After 4 weeks fresh and dry weights were taken. Results indicate that resistance is inherited only when both the parents are R plants.

BROOM SNAKEWEED DISPERSAL AND GERMINATION. B. L. Wood and K. C. McDaniel, Research Assistant and Professor, Department of Animal and Range Sciences, New Mexico State University, Las Cruces, NM 88003.

Abstract. Undesirable stands of broom snakeweed of various intensities are ubiquitous throughout New Mexico's blue grama rangelands. To efficiently and economically control this half-shrub, a more comprehensive database concerning its reproduction strategies needs to be developed.

Broom snakeweed dispersal characteristics were monitored by placing four seed traps (1m by 10 by 3.2 cm) around ten plants at the cardinal directions and by collecting achenes weekly or bi-weekly from late October 1993 through July 1994. Over 50% of achenes dispersed between October and December 1993. Relatively large amounts of seed were recovered after periods of intense southwest winter winds and after heavy May rains. Of the seed recovered, 78% were in the east tray and 86% were within 50 cm of the parent plant. Examination of both ray and disc florets revealed that only ray achenes routinely produce fertile embryos. The highest average number of achenes produced over twelve plants harvested bi-weekly was estimated at 3900 per plant. Viability of seeds from harvested plants were tested using tetrazolium salts at harvest and after three, six, and nine months lab and field storage. Viability of seeds collected in January and stored in the field within nylon packets until April averaged 82%. After May 17, 1994, viability of all but lab stored seed declined to less than 4%; lab stored seed did not differ significantly from seed tested at harvest over time.

Greenhouse experiments were conducted 6 and 12 months after seed harvest to evaluate the influence of water application interval and water amount on germination and survival of broom snakeweed. Treatments consisted of five water intervals: daily, 5-d, 10-d, 15-d, and 20-d, and four water amounts: field capacity (fc), 3/4 fc, 1/2 fc, and 1/4 fc. Seed germination was 42% at daily:fc and no seed germinated at 1/4 fc. Average mean soil matric potential (Ψ_m) at germination ranged from -39 kPa at daily:fc to -1125 kPa at 20-d:1/2 fc. Data suggest that optimum germination occurs when soils are maintained at a minimum $\Psi_m > -300$ kPa for at least

three days. Optimum Ψ_m for seedling survival appears to range between -300 and -900 kPa while mortality would generally be expected near a Ψ_m of -1800 kPa.

BROADLEAF WEED CONTROL IN SPRING-SEEDED ALFALFA WITH POSTEMERGENCE APPLICATIONS OF AC 299-263 AND IMAZETHAPYR. E. J. Gregory, R. N. Arnold and D. Smeal, Professor, Pest Management Specialist, and Agriculture Specialist, New Mexico State University Agricultural Science Center at Farmington, Farmington, NM 87499.

Abstract. Alfalfa is New Mexico's leading cash crop, accounting for approximately 20% of the state's crop income. Weeds compete vigorously with spring-seeded alfalfa for light, nutrients, and moisture. Some weeds, when harvested with alfalfa, may reduce quality. Hay quality, particularly protein content, is an important consideration in feed rations in some markets, such as the dairy and horse racing industries. A field experiment was conducted in 1994 at Farmington, NM to evaluate the response of alfalfa (var. Champ) and annual broadleaf weeds to postemergence applications of AC 299-263 and imazethapyr. All treatments except EPTC, were applied postemergence with SUN-IT II at one qt/A when alfalfa was in the second trifoliolate leaf stage and weeds were small. AC 299-263 and imazethapyr applied at 0.12 and 0.094 lb/A caused significantly more injury (stunting only) than any other treatment. Black nightshade, redroot and prostrate pigweed control were excellent (>94%) with all treatments except the check. The check plot yielded significantly more T/A than any other treatment. All treatments had a significantly higher protein content than the check.

BROADLEAF WEED CONTROL IN PINTO BEANS WITH IMAZETHAPYR AND IMAZETHAPYR COMBINATIONS. R. N. Arnold, E. J. Gregory and D. Smeal, Pest Management Specialist, Professor, and Agriculture Specialist, New Mexico State University Agricultural Science Center at Farmington, Farmington, NM 87499.

Abstract. Approximately 97% of New Mexico's pinto bean production occurs in northwestern New Mexico. Most of this production occurs under sprinkler irrigation. Pinto bean growers usually preplant incorporate one or two herbicides in combination and then follow with one mechanical cultivation for annual weed control. Weeds compete vigorously with dry beans and yield reductions exceeding 70% have been recorded. A field experiment was conducted in 1994 at Farmington, NM to evaluate the response of Olathe pinto beans and annual broadleaf weeds to postemergence applications of imazethapyr alone or in combination. All treatments were applied with X-77 and 32% nitrogen solution at 0.25% v/v and one qt/A, except dimethenamid and bentazon applied at 1 and 0.5 lb/A. Bentazon was applied with a COC at one qt/A. Treatments were applied when pinto beans were in the second trifoliolate leaf stage and weeds were small. Imazethapyr at 0.047 lb/A caused significantly more injury (stunting and slight yellowing of leaves) than any other treatment. All treatments gave good to excellent control of redroot and prostrate pigweed except bentazon and dimethenamid at 0.5 and 1 lb/A. Dimethenamid at 1 lb/A with and without surfactants and bentazon at 0.5 lb/A gave poor control of black nightshade. Yields were 2767 to 154 lb/A higher in the treated plots as compared to the check.

ACCUMULATED GROWING DEGREE DAYS FOR PESTICIDE AND CROPPING SYSTEMS

MANAGEMENT. Ed H. Vasey, Armand Bauer, A. B. Frank and Galen L. Schroeder, Professor Emeritus, Soil Science Department, North Dakota State University, Fargo, ND 58102, Soil Scientist/Collaborator and Plant Physiologist, respectively, USDA-ARS, Northern Great Plains Research Laboratory, Mandan, ND 58554, and Weed Scientist, 25 36TH Ave. NE, Fargo, ND 58102.

Abstract. A growth and development staging guide has been developed for Hard Red Spring (HRS) and Durum wheats grown in the northern Great Plains based on accumulated Growing Degree Days (AGDD). The correlation of AGDD to the development stages of standard and early season HRS and Durum wheat varieties from planting to maturity to both the Haun and Feekes scale has been combined with photography, line drawings and other crop management data in a four-color wall poster.

The capability to precisely predict crop development stage has utility. It can improve the timeliness of postemergence herbicide and fungicide applications when their proper use is safe or effective in a relatively narrow crop growth stage. It allows assessment of potential yield reductions from environmental stresses at specific development stages. Water or fertilizer applications, to coincide with specific development stages, can be timed for maximum efficiency. Also, accurate determination of grain maturity allows for timely preharvest herbicide applications or swathing and combining operations.

A software program with weather station linkage developed by Sandoz Agro, Inc. for calculating AGDD in spring wheat as well as a Spring Wheat Management Calendar and a wheat staging video produced by the Spring Wheat Doctor (1-800-794-8302) can be combined with the staging guide in the education and training of wheat producers, students and agribusiness people.

WEEDS OF RANGE AND FOREST

SULFOMETURON USE IN PACIFIC NORTHWEST FOREST APPLICATIONS. Bruce R. Kelpsas and Vanelle F. Carrithers, Northwest Chemical Corporation, Salem, OR 97303, and DowElanco, Mulino, OR 97042.

Abstract. Forest plantations are often treated with herbicides to remove or reduce competition from herbaceous plants. Recently sulfometuron has been used effectively on forest sites. While this herbicide has presented many opportunities, much has yet to be known about conifer tolerance, timings of applications and tank mixes on vegetation control.

Several field trials were established in 1993 and 1994 to examine the impacts of seasonal timing, conifer tolerance to varying rates, and tank mixes with other herbicides. Replicated field trials were established using a randomized block design with three or four replications. Individual plots were sprayed with a gas operated backpack sprayer and six nozzle boom calibrated to deliver 10 gpa. Sulfometuron was sprayed alone over test seedlings planted in plots, or alone and with glyphosate, triclopyr, hexazinone, and atrazine in tank mixes to test timings and vegetation control. Sulfometuron rates varied between 1.5 and 6 oz/A.

The results of these trials indicate that sulfometuron can be used safely over newly planted bare root and container Douglas-fir seedlings at rates up to 3 oz/A without a reduction in shoot growth. Conifer seedlings sprayed after budbreak at 1.5 oz/A grew similarly to trees sprayed before budbreak at the same rate and the untreated seedlings. Fall and winter applications of sulfometuron were as effective for vegetation control as normal spring applications on moist Coast Range forest sites. In addition, triclopyr in mixture with sulfometuron resulted in improved vegetation control especially on *Galium* species where sulfometuron by itself performed poorly. Glyphosate, hexazinone, or atrazine tank mixed with sulfometuron resulted in variable improvement in vegetation control.

THE ESTABLISHMENT, INCREASE, AND IMPACT OF *Aphthona nigriscutis* FOUDRAS (CHRYSOMELIDAE) ON ITS HOST, LEAFY SPURGE (*Euphorbia esula*) (L.) IN FREMONT COUNTY, WYOMING. Stephen M. Van Vleet and Tom D. Whitson, Graduate Student and Associate Professor, Plant Science Division, University Station 3354, University of Wyoming, Laramie, WY 82071.

Abstract. *Aphthona nigriscutis* is an effective biological control agent of leafy spurge. In 1990, *A. nigriscutis* was established in twelve sites in Fremont County to determine its rate of spread and its effect on the survival of leafy spurge. In 1992 feeding damage was visible in five release sites. A significant, 70 to 95% decrease in leafy spurge coverage was recorded in the sites from 1993 to 1994. A significant increase (35 to 50%) in grass was found in two sites. Area of bare ground increased 40 to 90% in all five sites due to the reduction of leafy spurge. Leafy spurge on the perimeter of two of the sites was completely eliminated after 1 year. Approximately 0.25 A of leafy spurge was eliminated by *A. nigriscutis* in the study sites between 1993 and 1994.

A PRELIMINARY REPORT ON HOW MEDUSAHEAD, AN ANNUAL EXOTIC GRASS, ESTABLISHES, GROWS AND REPRODUCES ON CLAY AND LOAMY SOILS OF AN INTACT NATIVE SHRUB STEPPE COMMUNITY. Heather C. Miller and David A. Pyke, Graduate Student, Department of Rangeland Resources, Oregon State University, and Senior Rangeland Ecologist, National Biological Survey, Forest and Rangeland Ecosystem Science Center, Corvallis, OR 97331.

Abstract. Medusahead, an annual exotic grass species, is known to establish and reproduce on disturbed clayey soils. This study is investigating the possibilities of medusahead expansion onto both clayey and loamy soils within intact native shrub-steppe communities by observing the plants individually within a population. In addition, this study will also investigate the possibility of medusahead expanding in disturbed sites both on clayey and loamy soils with the emphasis being placed on the results of the possible expansion on disturbed loamy soils.

Seven thousand medusahead seeds were randomly assigned one of four treatments and individually planted in September 1993, within grids on clay and loamy soil sites in order to determine individual plant establishment, growth, and reproduction. Seeds were observed approximately every 2 weeks after the initial planting. It was determined that rodent predation of the seeds had occurred at both sites, therefore more plots were established and 7000 additional seeds were planted in March 1994. All plants were collected in June of 1994. Overall survival on both sites was low because of the extremely dry 1993 to 1994 growing season. Germination at the clay site from the spring planting was higher than germination at the loamy site, but survival at the loamy site was slightly higher (Table).

Table. Percent germination and survival of medusahead, by treatment, planted on clay and loamy sites in an intact native shrub-steppe community.

Treatment	Clay site			
	Fall planting		Spring planting	
	Germination	Survival	Germination	Survival
	%		%	
Control	11.4	4	80.2	1
Defoliation	13.8	4	64.8	0
Soil disturbance	9.4	2.2	70	0
Cattle grazing	6	1.8	47.2	0
	Loamy site			
Control	7.8	0.8	7.6	0.4
Defoliation	1.6	0.2	13.2	3.6
Soil disturbance	2.4	0.4	12	3.8

DAMAGE POTENTIAL OF A LONG-HORNED BEETLE ON BROOM AND THREADLEAF

SNAKEWEED. R. E. Parreira, T. M. Sterling, D. A. Thompson, L. W. Murray Undergraduate Student and Assistant Professors, Department of Entomology, Plant Pathology, and Weed Science, Assistant Professor, Department of Experimental Statistics, New Mexico State University, Las Cruces, NM 88003.

Abstract. Broom and threadleaf snakeweed are common half-shrubs widely distributed throughout the western United States. Snakeweed is highly competitive with perennial range grasses and toxic to livestock and wildlife. Snakeweed can be controlled by herbicides; however, chemical control is often not economical. Therefore, other methods of control are being investigated, one being biological control using a long-horned beetle, *Crossidius pulchellus* Le Conte. A study was conducted to observe the damage potential of the long-horned beetle on broom and threadleaf snakeweed, as well as determine feeding preferences among different species and populations of snakeweed. This was conducted because of a large, natural infestation of the long-horned beetle being observed in the snakeweed garden 1 year after it was established. The common garden of broom and threadleaf snakeweed was established in 1992, from cuttings of plants originally collected from eight locations in NM, one location in AZ, and one in TX. Clones were made from cuttings of the original plants by clipping off stems approximately 10 cm long, dipping excised ends in auxin, placing into flats containing moist, sandy soil, and transferring to a mist bench for three weeks or until roots formed. Rooted cuttings were grown in small pots until being transplanted to the common garden. The garden was designed as four replications of 20 genotypes from 11 different populations, arranged factorially, in a complete randomized block design. Two replications were treated with an insecticide (carbofuran at 1.6 kg/ha) by pouring 200 ml of solution into holes made by a soil corer at the base of each plant. Insecticide-treated plots served as control plots to compare healthy plants with plants damaged by the beetle. Evaluations of plants were taken weekly starting from the date symptoms of chlorosis and necrosis were first seen. Once plants were 100% necrotic, plants were dug up, crown diameters measured, and roots examined for beetle damage and/or presence. Chlorosis was less than 5% throughout the season and did not differ among populations or snakeweed species. Plant death due to beetles did not differ between insecticide-treated plots compared to noninsecticide-treated plots, suggesting insecticide treatment was ineffective in reducing insect infestation. Therefore, data from insecticide and noninsecticide-treated plots were pooled and a chi-square test of homogeneity was conducted among populations and among genotypes within populations. Categories were established because of the problems with normality, and 95% confidence interval were added to each percent. Less than 5% of either threadleaf snakeweed population was necrotic. Among broom snakeweed populations, Tatum and Corona NM, contained the highest percent necrosis throughout the season with over 25% of the population with some category of necrosis. No threadleaf snakeweed plants died due to the beetle. Deaths due to beetles occurred in all broom snakeweed populations except the TX population. Tatum, NM compared to other broom snakeweed populations had the highest percent mortality at 15%. Thus, beetles preferred broom snakeweed over threadleaf snakeweed plants and beetle preference for broom snakeweed was population dependent. Therefore, beetle preference should be considered in future evaluation of the long-horned beetle as a biological control agent of snakeweed species.

THE EFFECT OF HERBICIDE TIME OF APPLICATION ON SULFUR CINQUEFOIL (*Potentilla recta* L.) CONTROL. C. A. Duncan and M. B. Halstvedt, Weed Management Services, P.O. Box 9055, Helena, MT 59604, and DowElanco, 2155 Carriage Dr. LPR, Estes Park, CO 80517.

Abstract. Sulfur cinquefoil is an introduced perennial weed that is widespread on range and pasture lands in western Montana. Research data are limited concerning the efficacy of herbicides on sulfur cinquefoil and the optimum growth stage for application. The purpose of this research was to determine the optimum sulfur cinquefoil growth stage for applying picloram, metsulfuron, 2,4-D ester, and dicamba plus 2,4-D.

Field trials were established near Bozeman and Missoula, Montana in 1992. Herbicides were applied with a CO₂ backpack sprayer in 18 gpa solution. Herbicide treatments were made at the rosette, bud, flower, and fall regrowth plant stages. Plots were 10 by 25 feet and each treatment was replicated three times in a randomized

complete block design. Visual evaluations are based on percent stand reduction as compared to the control. Data were analyzed using analysis of variance and means were separated using Tukey's multiple range test (P=0.10). Data from Missoula and Bozeman are presented separately because there was a significant difference in treatment response between locations.

Picloram controlled greater than 94% of the sulfur cinquefoil 1 year after application and was the most consistent treatment across locations regardless of application timing (Table 1). Two years after application, control dropped slightly but not significantly at the Bozeman location to 89% at the rosette and bolt timings (Table 2). Control with dicamba plus 2,4-D was greatest at the rosette, bud, and flower stages and lowest at the fall regrowth stage at Bozeman. There was no difference in application timing with this herbicide combination at Missoula 1 or 2 years following treatment. Time of application was a factor with 2,4-D ester at both locations. Control was greater than 90% 1 year after treatment across locations at the rosette and bud stage. At the flower growth stage, control with 2,4-D ester ranged from 90% at Missoula to 35% at Bozeman, and averaged 67% at the fall regrowth stage 1 year after treatment. Metsulfuron did not control sulfur cinquefoil at any application timing at the Missoula location. At Bozeman, metsulfuron provided 53 and 79% control at the flower and fall regrowth stage respectively, 1 year after treatment. The best metsulfuron treatment was a fall application at Bozeman and control dropped to 40% at the 2 year evaluation.

Table 1. Sulfur cinquefoil control 1 year after treatment with various herbicides applied at four plant growth stages.

Treatment	Rate	Rosette		Bud		Flower		Fall	
		Msla ^a	Bzn ^b	Msla	Bzn	Msla	Bzn	Msla	Bzn
	oz/A	% control ^a							
Metsulfuron + surfactant	0.25 0.25%	3c	10fg	7c	8g	7c	53cde	0c	79abc
Picloram	4	100a	99a	99a	94a	96a	100a	100a	100a
Dicamba + 2,4-D amine	8 16	97a	93a	92a	83ab	83ab	94a	89a	45de
2,4-D ester	32	95a	99a	98a	93a	90a	35ef	69b	67bc

^aMeans within columns followed by different letters are significantly different based on Tukey's HSD at P=0.10.

^bLocation: Msla = Missoula, MT; Bzn = Bozeman, MT.

Table 2. Sulfur cinquefoil control 2 years after treatment with various herbicides applied at four plant growth stages.

Treatment	Rate	Rosette		Bud		Flower		Fall	
		Msla ^a	Bzn ^b	Msla	Bzn	Msla	Bzn	Msla	Bzn
	oz/A	% control ^a							
Metsulfuron + surfactant	0.25 0.25%	3c	7d	0c	3d	3c	38bc	0c	40b
Picloram	4	99a	89a	93a	89a	95a	98a	99a	93a
Dicamba + 2,4-D A	8 16	89a	76a	90a	72a	85a	86a	89a	12cd
2,4-D ester	32	88a	94a	92a	77a	88a	20bcd	68b	35bc

^aMeans within columns followed by different letters are significantly different based on Tukey's HSD at P=0.10.

^bLocation: Msla = Missoula, MT; Bzn = Bozeman, MT.

WEEDS OF HORTICULTURAL CROPS

BROCCOLI YIELD LOSS FROM ITALIAN RYEGRASS INTERFERENCE. Carl E. Bell, Weed Science Farm Advisor, University of California Cooperative Extension, 1050 E. Holton Rd., Holtville, CA 92250.

Abstract. Italian ryegrass interference in broccoli was measured in field experiments repeated 3 years at the University of California Desert Research and Extension Center in Holtville, CA. Broccoli yield loss was regressed against Italian ryegrass density counted shortly after crop and weed emergence and fit to a rectangular hyperbola competition model. The rectangular hyperbola model is $Y_L = Id/(1+Id/A)$, where Y_L is percent yield loss, I is percent yield loss per unit weed density as d approaches 0, d is density, and A is percent yield loss as d approaches infinity. Italian ryegrass density was compared to Italian ryegrass dry weight at broccoli harvest using a reciprocal linear regression model. The reciprocal linear regression model is $1/W = a + bd$, where W is the mean weight per plant, d is density, a and b are the intercept and the slope, respectively.

Percent broccoli yield loss predicted by the model was 76%, 49%, and 47% in 1988, 1989, and 1990 respectively, and 58% when data were pooled. Economic threshold values, the number of Italian ryegrass plants per meter of row that caused a yield loss equal to weed control costs, also varied by years. When pooled over the 3 years, 4.9 Italian ryegrass plants per meter of row was sufficient to achieve the economic threshold. This value ranged from 7.3 plants in 1988 to 1.7 plants per meter of row in 1990.

The reciprocal linear regression model predicted Italian ryegrass dry weight well, $R^2 = 0.93, 0.33, \text{ and } 0.74$ in 1988, 1989, and 1990, respectively, and 0.79 when pooled. The low value in 1989 reflected lower densities of Italian ryegrass during that year, which increased variability of mean weight per plant. Slope values (b) for the three years were equal ($P = 0.01$), indicating that the relationship of Italian ryegrass density to dry weight was constant.

EVALUATION OF DIMETHENAMID FOR TOLERANCE AND WEED CONTROL IN POTATOES.

Dennis J. Tonks, Charlotte V. Eberlein, Felix E. Fletcher, and Bart A. Brinkman, Postdoctoral Fellow, Professor, and Research Technician, University of Idaho Aberdeen Research and Extension Center, P.O. Box AA, Aberdeen, ID 83210 and Field Scientist, Sandoz Agro, 5130 2nd Ave. S.E. Salem, OR 97306.

Abstract. Weeds compete with potatoes and can interfere with harvest operations. Options for mechanical and chemical weed control in potatoes are limited. Field studies were conducted to evaluate potato tolerance to dimethenamid and weed control efficacy with dimethenamid alone or in combination with broadleaf herbicides. Tolerance experiments were established at Aberdeen, Burley, and Idaho Falls, Idaho. Studies consisted of dimethenamid at 0, 1.1, 1.4, 1.7, 2, and 3.4 kg/ha applied either after hilling and before potato emergence (PRE) or early postemergence (EPOST) to potatoes (5 to 10 cm). Visual injury ranged from 1 to 10% for PRE treatments and 0 to 38% for EPOST treatments when evaluated 7 days after treatment (DAT). Injury at 14 DAT ranged from 0 to 2% for PRE and 4 to 9% for EPOST treatments. None of the dimethenamid rates tested resulted in yield loss or reduction in tuber quality.

Dimethenamid also was evaluated for weed control alone and in tankmix combinations at Aberdeen. Dimethenamid controlled redroot pigweed, common lambsquarters, and hairy nightshade greater than 90% at 1.1, 1.4, and 1.7 kg/ha. The addition of metribuzin (0.56 kg/ha) or rimsulfuron (0.026 kg/ha) to dimethenamid enhanced control of green foxtail, especially at the 1.1 kg/ha rate. Weed control with dimethenamid was equal to or greater than standard herbicides alone. Dimethenamid tankmixes including metribuzin or rimsulfuron provided weed control equal to or greater than standard tankmixes. Yields of U.S. No. 1 tubers in herbicide treated plots ranged from 178 to 315% higher than the weedy check. Plots treated with dimethenamid alone or in tankmixes yielded similarly to standard treatments. None of the herbicide treatments decreased tuber quality.

VARYING-RATE BANDED APPLICATIONS OF TRIFLURALIN FOR LAYBY WEED CONTROL IN TOMATOES. B. R. Correiar and W. T. Lanini, Research Assistant and Extension Weed Ecologist, Weed Science Program, Department of Vegetable Crops, University of California, Davis, Davis, CA 95616.

Abstract. A Campbell Soup survey of 500 California tomato growers (Campbell Soup Co. 1990, unpublished) found that over 75% of the pesticides they used were herbicides. Over 90% of the growers used layby herbicide applications, with trifluralin being most commonly used. This study evaluated the effects of reducing trifluralin application rates at layby. Evaluation of treatment effectiveness was based on weed control, fruit yield, and fruit quality at harvest.

Trifluralin was applied at layby as a directed application to the furrows and sides of beds, then incorporated with knives. The varying rate applications were applied with a 5 nozzle boom. Nozzle 3 was centered on the furrow, nozzles 2 and 4 were directed at the bed shoulders on either side of the furrow, and nozzles 1 and 5 were directed at the bed tops adjacent to the crop. The rates used in the reduced rate treatments were based on standard layby applications of trifluralin, which ranged from 1 lb/A to 0.8 lb/A, depending on soil conditions at the location. A medium rate treatment consisted of a 1X herbicide rate for nozzle 3, a 0.67X rate for nozzles 2 and 4, and a 0.33X rate for nozzles 1 and 5. A low rate treatment consisted of a 0.5X herbicide rate for nozzle 3, a 0.33X rate for nozzles 2 and 4, with no herbicide applied by nozzles 1 and 5. Check plots were tilled by knives as in the other treatments, but did not receive a layby herbicide application.

The layby treatments were evaluated at four locations from the time of layby application through harvest. Plots were 100 ft long by three beds wide. Treatments were replicated three times at each location, and arranged in a randomized complete block design. Weed densities in the different treatments were evaluated at each location at regular intervals using visual estimates of percent weed cover and weed counts in a 25 cm by 125 cm quadrat. Fruit yield was measured as ton/A. Fruit quality was measured as soluble solids and color. Data was analyzed by an analysis of variance.

Two of the locations had significant differences between the checks and the other treatments in weed densities at harvest measured on a square foot basis. Location 3 had significantly higher weed densities at harvest in the check plots as compared to the other treatments at $p = 0.05$ (Table 1). Location 4 had significantly higher weed densities at harvest in the check plots as compared to the other treatments at $p = 0.1$. The same two locations had significant differences between the checks and the other treatments in visual estimates of percent weed density at harvest at $p = 0.05$. Fruit soluble solids were significantly lower in the check plots at location 2 at $p = 0.05$ (Table 2). There were no significant differences between treatments in fruit soluble solids at the other locations. There were no significant differences between treatments in fruit color at any location at $p = 0.05$. Three of the locations had no significant differences between treatments in yields at $p = 0.05$. Location 4 had a significantly lower yield for the untreated check at $p = 0.1$, with no significant difference in yields between the other treatments.

The results indicate that layby herbicide applications may not be necessary in fields with less than five weeds per square foot and less than 11% weed cover at harvest. Fields with greater than 24 weeds per square foot at harvest and greater than 16% weed cover at harvest may be able to reduce the rates of layby applications significantly without suffering losses in fruit quality or fruit yield.

Table 1. Weed densities per layby herbicide treatment at four locations.

Layby trifluralin rate	Weed densities							
	Location 1 ^a		Location 2 ^a		Location 3 ^c		Location 4 ^c	
	feet ²	% cover	feet ²	% cover	feet ²	% cover	feet ²	% cover
Untreated Check	0.552	b	0.054	b	5.06 ^c	11.667 ^c	24.311 ^d	16.667 ^c
Low	0.360	b	0.054	b	1.728	b	0.624	b
Medium	0.288	b	0.054	b	0.768	b	0.816	b
Standard	a	a	a	a	a	a	0.48	b
LSD _{0.05}	0.507	-	0.815	-	1.206	7.779	19.925	5.061
LSD _{0.1}	0.389	-	0.647	-	0.926	5.974	15.829	4.019

^aTreatment not included in original plot design.

^bLess than 5%.

^cSignificant at p = 0.05.

^dSignificant at p = 0.1.

^aPrimary weed species at location 1 was barnyardgrass. Primary weed species at location 2 was black nightshade. Primary weed species at location 3 were barnyardgrass and field bindweed. Primary weed species at location 4 was barnyardgrass.

Table 2. Tomato fruit yield (ton/A), color, and solids (brix) per layby herbicide treatment at four locations.

Trifluralin rate	Tomato Fruit Yield and Quality											
	Location 1			Location 2			Location 3			Location 4		
	Yield	Color	Solids	Yield	Color	Solids	Yield	Color	Solids	Yield	Color	Solids
	Ton/A		Brix	Ton/A		Brix	Ton/A		Brix	Ton/A		Brix
Check	54.0	b	b	26.8	21	4.8 ^c	19.5	20	5.23	12.4 ^d	23	5.27
Low	54.3	b	b	25.5	22	5.4	20.0	21	5.20	22.9	23	4.80
Medium	54.8	b	b	26.7	22	5.3	21.4	20	5.33	19.7	22	5.43
Standard	54.3 ^a	b	b	27.4 ^a	21 ^a	5.8 ^a	23.4 ^a	20 ^a	4.83 ^a	21.6	23	5.13
LSD _{0.05}	5.351	-	-	2.114	1.189	0.319	7.213	2.069	0.475	8.181	2.514	0.913
LSD _{0.05}	4.110	-	-	1.679	0.949	0.253	5.540	1.589	0.365	6.469	1.996	0.725

^aTreatments not included in original design or analysis. These plots are believed to have received an addition nitrogen side dressing not received by the experimental plots. Figures are provided for purposes of comparison of experimental treatments to standard treatments at locations 1, 2, and 3.

^bMeasurement not taken.

^cSignificant at p = 0.05.

^dSignificant at p = 0.1.

WEED MANAGEMENT IN LETTUCE USING REDUCED-RATE HERBICIDE TREATMENTS OR HAND-WEEDING. W. T. Lanini and M. LeStrange, Extension Specialist and Farm Advisor, Department of Vegetable Crops, Weed Science Program, University of California, Davis, CA 95616.

Abstract. Studies conducted at West Side Field Station and UC Davis have evaluated the influence of various weed-free periods on lettuce yields and on weed biomass. Additionally, pronamide and benefin at full rate and half rate with or without hand-weeding were also evaluated. Data was collected on the amount of time required to hand-weed plots for comparison of production costs. Yields of marketable heads were not affected by treatment, with the exception of the untreated plots, which yielded approximately 40% less heads than other treatments. Individual head size varied with the length of the weed-free period, with the larger heads found on plots where weeds were excluded for 4 weeks or longer. Pronamide, benefin, or the combination with either one or two cultivations provided good weed control and yields equivalent to full-season hand weeding. Individual head size was slightly smaller where the herbicides were used without hand-weeding. However, weed cover at harvest was greater than hand-weeded plots. The herbicides alone or in combination reduced weed density and reduced weeding time and cost by over 50 % at the 4-week hand-weeding. Hand-weeding at 2-week intervals was less cost-efficient than 4-week intervals. Unless there is a price premium paid for larger heads, weed control past 2 weeks is not profitable.

WEEDON: A COMPUTER PROGRAM FOR WEED MANAGEMENT DECISIONS IN ONIONS. Claudio Dunan, Philip Westra, Frank Moore III^{*}, and Adam Weinrich, Post Doctoral Researcher, Weed Scientist, Crop Modeler, and Programmer, Department of Plant Pathology and Weed Science and ^{*} Department of Horticulture, Colorado State University, Ft. Collins, CO 80523

Abstract. WEEDON is a computer bioeconomic program designed to help producers, crop consultants, extension agents, researchers, and students evaluate and make weed management decisions in onions. WEEDON is written in Visual Basic and consists of screens where input information is entered by the user. Output screens provide the results of model runs. WEEDON permits evaluation of preemergence and postemergence control strategies, including hand weeding. Preemergence decisions are based on a bivariate non-linear model that accounts for weed density (estimated from seed banks) and duration of competition and permits the evaluation of possible yield reductions that may occur between planting and the time at which a postemergence tactic can be used. Because onions do not develop a full canopy WEEDON was developed to permit the evaluation of multi-postemergence weed control decision during the crop season. The basis of the WEEDON postemergence model is the distribution and interception of solar radiation among the components of the canopy. Radiation interception is a function of the leaf area index of the species (LAI). Any weed control tactic reduces weed species LAI according with its efficacy of control. By comparing the yield reduction that weeds produce with and without control, WEEDON permits an economic evaluation of the weed control tactic. Presently, WEEDON has been calibrated and validated for five weed species and onions. Parameters for the model were obtained from growth analysis and competition experiments over a 4 year period.

WEEDS OF AGRONOMIC CROPS

WILD BUCKWHEAT CONTROL IN WINTER WHEAT WITH TRIASULFURON AND

PROSULFURON. R. N. Klein and D. J. Thraikill, Professor and Research Technologist, University of Nebraska West Central Research and Extension Center, North Platte, NE 69 01.

Abstract. For hard red winter wheat producers in southwestern and western Nebraska, wild buckwheat is an important weed that can reduce yields and cause problems at harvest. Past research has evaluated several herbicide and tillage operations for the control of wild buckwheat. The fact that wild buckwheat emerges later in the season than other common weeds has often put producers in a dilemma. Herbicide treatments timed to control early emerging weeds, often were not effective at controlling wild buckwheat. If herbicide treatment was delayed until later in the season, effective control of wild buckwheat could be obtained but the earlier emerging weeds had become too large to control. Crop damage, either mechanical damage from driving ground equipment through the wheat or herbicide damage as the wheat nears or surpasses the joint stage, has been a concern with the delayed herbicide treatments. In 1993 triasulfuron, with its relatively long residual activity, applied in April gave effective control of wild buckwheat. Another study in 1994 was designed to evaluate triasulfuron plus bromoxynil as well as prosulfuron alone and in combinations for the control of wild buckwheat. Treatments were applied on April 18, 1994 to well tillered wheat. Wild Buckwheat was just emerging at the time of application. The test was conducted in Logan county, NE approximately 25 miles north of North Platte. Soil at the site was a Hord silt loam with a pH of 5.6 and 2.3% organic matter. The following table list the treatments used and the percent wild buckwheat control.

Table. Treatments applied for the control of wild buckwheat in winter wheat.

Treatments	Rate —lb/A—	Control ^a		
		Wild buckwheat		Waterpod
		29 DAT	49 DAT	29 DAT
Triasulfuron ^b	0.0134	98 a	88 a	99 a
Triasulfuron + bromoxynil ^b	0.007+0.125	94 a	88 a	99 a
Triasulfuron + bromoxynil ^b	0.011+0.187	96 a	93 a	99 a
Bromoxynil	0.187	89 a	87 a	96 a
Prosulfuron ^b	0.009	90 a	90 a	97 a
Prosulfuron ^b	0.018	92 a	85 a	99 a
Prosulfuron + dicamba SGF ^b	0.009+0.063	90 a	84 a	95 a
Prosulfuron + dicamba SGF ^b	0.018+0.063	95 a	93 a	98 a
Prosulfuron + triasulfuron ^b	0.009+0.0067	94 a	93 a	98 a
Dicamba SGF	0.0625	48 b	70 b	40 b
Prosulfuron + bromoxynil ^b	0.009+0.125	98 a	93 a	99 a
Prosulfuron + 2,4-D LVE ^b	0.009+0.25	90 a	81 a	95 a
Untreated check	-----	0 c	0 c	0 c
Least significant difference (0.05)		9	12	7

^a Ratings followed by the same letter are not significantly different using a t-test at the 5% significance level.

^b X-77 was added to all treatments containing triasulfuron or prosulfuron at 0.25% v:v.

The early evaluation is based on a visual estimation of control while the 49 DAT evaluation is based on plant counts, although the buckwheat plants in the checks were up to 6 inches tall while those in the treated areas were only about 1 inch tall indicating younger plants. At both rating dates, the prosulfuron treatments gave control not significantly different than the triasulfuron treatments. Dicamba alone gave control significantly lower than the other herbicide treatments tested.

F-8426 FOR BROADLEAF WEED CONTROL IN SMALL GRAINS. Stephen D. Miller, Professor, Department of Plant, Soil, and Insect Sciences, University of Wyoming, Laramie, WY 82071.

Abstract. Weed resistance to herbicides is a serious concern in much of the small grain producing regions of the western United States. F-8426 (ethyl-2-chloro-3[2-chloro-4-fluoro-5-(4-difluoromethyl)-4,5-dihydro-3-methyl-5-oxo-1H-1,2,4-triazol-1-yl]phenyl-propanoate) is an experimental herbicide being developed by FMC Corporation for broadleaf weed control in small grains. The chemistry of this compound is unique and appears to offer opportunities for resistant weed management in small grains. Field experiments were conducted at Archer, Powell, Sheridan and Torrington, WY during the past 3 years to evaluate weed control and crop tolerance with F-8426 alone or in combination with other herbicides. Trials were conducted in winter wheat, spring wheat and barley. All treatments were applied in water with a 6-nozzle knapsack sprayer delivering 20 gpa at 40 psi. Winter wheat treatments were applied in mid to late April and spring wheat or barley treatments from mid May to early June all years. All plots were evaluated for injury 1 and 2 weeks following application and for weed control 2 weeks following application.

F-8426 caused slight to moderate small grain injury (2 to 20%) 7 days following application; however, recovery was excellent with little or no injury evident 14 days following application. Injury was primarily in the form of leaf speckling and burn and was influenced by additive. Injury was generally greater with aqueous nitrogen (28-0-0) than with the other additives tested. Kochia, tansymustard, common lambsquarters, redroot pigweed, and hairy nightshade control was excellent (95 to 100%) with 0.031 lb/A F-8426 alone or in combination with other herbicides. Further control of these weed species with F-8426 generally was not influenced by additive. Wild buckwheat control with F-8426 was good (85 to 90%) only when applied in combination with 2,4-D ester or dicamba. F-8426 has shown only very limited activity on Canada thistle or field bindweed.

INFLUENCE OF WEED MANAGEMENT STRATEGIES IN SPRING BARLEY AND SUGARBEETS. Robert W. Downard and Don W. Morishita, Support Scientist and Assistant Professor, Department of Plant, Soil, and Entomological Sciences, University of Idaho, Twin Falls, ID 83301.

Abstract. New emphasis being placed on reducing the amount of pesticides used may affect future weed management strategies in small grains and sugarbeets. Since spring barley often precedes sugarbeets in crop rotation, this experiment was designed to examine how weed management in spring barley affected weed management input in sugarbeets. Different herbicide and grain seeding rates were evaluated at two locations to determine their influence on weed control in spring barley in 1993 and their effect on weed control inputs in sugarbeets in 1994. Barley herbicides were thifensulfuron plus tribenuron plus bromoxynil plus MCPA applied as a tank mixture. The rates used were 0.165 oz/A plus 0.25 lb/A and 0.33 oz/A plus 0.5 lb/A. An untreated check was also included. Barley seeding rates were 0.6, 1 and 1.4 million seeds/A. Kochia, common lambsquarters, hairy nightshade, and redroot pigweed control were good (>87%) with both herbicide rates. Barley yield increased with increasing seeding rate at the location with a high weed density, but did not at the low weed density location.

Weed management strategies in sugarbeets involved three levels of weed control input. Low input was ethofumesate applied preemergence plus one handweeding; medium input was two postemergence phenmedipham and desmedipham applications plus one handweeding; and high input was ethofumesate applied preemergence followed by two postemergence phenmedipham and desmedipham applications plus one or two handweedings. Sugarbeet yields were influenced by the level of weed control input at the high weed density location, but not by weed management practices in barley. At the low weed density location sugarbeet yields were not influenced by the level of weed control input or by weed management practices in barley.

Grain yields were higher at high weed densities when seeding rate was increased. At high weed densities sugarbeet yields increased as the level of input for weed control increased. Future weed management studies should investigate weed control practices for more than 1 year to determine how these practices influence weed control in the following years crop.

VOLUNTEER RYE AND JOINTED GOATGRASS COMPETITION IN WINTER WHEAT.

S. D. Miller, Professor, Department of Plant, Soil, and Insect Sciences, University of Wyoming, Laramie, WY 82071.

Abstract. The winter annual grasses, jointed goatgrass and rye, are serious weed problems in dryland winter wheat producing areas of the central and western United States. These grass weeds reduce winter wheat production by competing for the same growth resources. Abundant information is available on downy brome, competition with winter wheat. However, information is limited on the competitiveness of jointed goatgrass and volunteer rye. Research was initiated in the fall of 1992 and 1993 at the Research and Extension Center, Archer, Wyoming to determine the effects of season-long competition from jointed goatgrass and volunteer rye on winter wheat. Four weed densities plus a weed-free check were established for each weed species both years. The experimental design was a randomized complete block with four replications. Actual weed densities were documented after winter wheat emergence and again before wheat harvest. Data collected included tillers/plant, seed/head, seed weight, height, biomass and yield for winter wheat as well as both weed species.

Neither weed species influenced winter wheat density or height; however, tillers/plant, seed/head, seed weight and yield reductions increased as jointed goatgrass or volunteer rye density increased. Winter wheat yield reductions increased from 9 to 35% or 5 to 32% as volunteer rye or jointed goatgrass densities increased from 2 to 12 plants/m²; respectively. Most of the volunteer rye seed was harvested with winter wheat and did not contribute significantly to the soil seed bank, while jointed goatgrass matured before wheat harvest and the spikelets disarticulated contributing significant seed to the soil seed bank.

ISSUES RELATED TO KOCHIA (*Kochia scoparia* L.) MANAGEMENT IN WESTERN AGRICULTURE.

Philip Westra and Tim D'Amato, Associate Professor and Research Associate, Department of Plant Pathology and Weed Science, Colorado State University, Ft. Collins, CO 80523.

Abstract. Widespread presence of herbicide resistant kochia in Colorado has forced farmers to adopt alternative control strategies for this important weed in both irrigated and dryland areas. Approximately 50% of Colorado kochia from irrigated sites tested in the late 1980's was shown to be resistant to triazine herbicides. This forced many producers to utilize non-triazine herbicides such as banvel, butрил, or pyridate to achieve effective control of triazine resistant kochia. Corn yield are frequently increased 15 to 25% where effective management of triazine resistant kochia is practiced. A Colorado statewide survey of ALS inhibitor resistance in kochia showed only 1% of 6000 plants were resistant in 1991, but that by 1992 and 1993 that level had risen to approximately 50%. Colorado research with ALS inhibitor resistant and susceptible kochia has shown nearly equal growth rates and seed production by both kochia types, suggesting that selection pressure will not drive the existing population back to a higher level of ALS susceptibility. In the late 1960's, North Dakota research showed that kochia accessions displayed differential tolerance to PGR herbicides.

Recent Colorado research, including use of a purported PGR resistant kochia source from western Nebraska has shown similar results. Although isolated sources of kochia may exhibit increased tolerance to PGR herbicides, Colorado testing of more than 20,000 kochia plants over the past 5 years has shown that virtually all kochia remains highly susceptible to PGR herbicides such as dicamba. A 1994 greenhouse screening of kochia

from 60 Colorado sites showed an average of a 9.9 response to 0.25 kg dicamba/ha when evaluated using a scale of 0 to 10 where 10 equaled total death. For western U.S. farmers, dicamba is still one of the most important tools available for kochia management in small grains and corn. While herbicide resistant weeds clearly have complicated chemical strategies for weed control, they have also opened up new opportunities for basic plant science research which may ultimately improve our understanding of the basic biology and ecology of key weeds in western North America.

INTERACTIONS OF WINTER ANNUAL GRASSES AND THE RUSSIAN WHEAT APHID IN WINTER WHEAT. Kirk A. Howatt and Philip Westra, Graduate Research Assistant and Associate Professor, Department of Plant Pathology and Weed Science, Colorado State University, Fort Collins, CO 80523.

Abstract. Yield loss and grain price deductions due to Russian wheat aphid (RWA) damage and winter annual grass competition are a major concern for winter wheat producers throughout the United States. This experiment examined the effects of the RWA as well as three winter annual grasses on the growth and yield of winter wheat. Experimental design was split-plot replicated six times. Whole plots were RWA level (presence or absence). These were then split into winter annual grass treatments (none, volunteer rye, downy brome, or jointed goatgrass). Treatment plots were 3 m wide and 3.5 m long. RWA's were released and weeds were broadcast seeded to achieve desired treatments. Wheat height and fresh weight, tiller damage, and RWA population were determined at three growth stages. Final grain yield was used to calculate economic impact from these pests. Yield results indicate that the RWA greatly reduced final wheat yield. In addition, volunteer rye and jointed goatgrass decreased yield while downy brome showed no detrimental yield effect. Volunteer rye suppressed wheat growth more than jointed goatgrass or downy brome. Plant fresh weights were also depressed by the presence of all pests except downy brome.

DRY EDIBLE BEAN RESPONSE TO CHLOROACETAMIDE HERBICIDES. Casey S. McDaniel, Jill Schroeder, Student and Associate Professor, Department of Entomology, Plant Pathology and Weed Science, New Mexico State University, Las Cruces, NM 88003, and J. Gus Foster Research Specialist, Sandoz Agro, Fort Collins, CO.

Abstract. Dimethenamid is a possible candidate for registration in dry edible beans for control of selective grasses. However, more information is needed concerning the tolerance of different classes of dry beans to dimethenamid treatments. Therefore, two greenhouse studies were conducted to evaluate dry bean tolerance to dimethenamid and other chloroacetamide herbicides when applied both preplant incorporated and preemergence. The experiments were each established with a factorial treatment arrangement in a randomized complete block design and four replications. Factors studied were the three bean classes, Great Northern, Pinto and Navy, three herbicides, dimethenamid, alachlor, and metolachlor, and five concentrations of each herbicide. Herbicides at concentrations equivalent to 0, 0.25X, 0.50X, X, and 2X application rates of each compound were used. The number of plants and plant growth and vigor were observed and recorded daily. Ten days after planting, experiments were harvested and dry shoot and root weights were recorded for each pot. Plants were dried at 75 C for 24 to 48 hours prior to weighing. Analysis of variance compared herbicides, rates, bean classes, and interactions between each. The preplant incorporated experiment required treating and mixing the soil before dividing it into four 355-ml styrofoam cups per rate. Eight beans were then planted and the cups were watered. No interactions between variables were present only main effects.

As rates of all herbicides increased bean root weights decreased. Plant root and shoot weights differed due to bean class; however, herbicides did not effect root and shoot weights or the percent emerged. The preemergence experiment was applied with a CO₂ backpack sprayer calibrated to deliver 25 gpa at 2 mph. Beans were planted and watered before the application and watered again after. No interactions between variables were noted only

main effects. Metolachlor significantly reduced both root and shoot weights regardless of rate or bean class compared to dimethenamid and alachlor. The percent emergence of the plants was also significantly reduced at the 2X rate for all herbicides regardless of bean class. The first days of plant growth are critical for beans. By comparing this study with past and future studies, one can determine the role dimethenamid and other chloroacetamides will have on dry bean production.

SCREENING FOR PROMETRYN TOLERANCE IN COTTON VARIETIES. Martina W. Murray and Tracy M. Sterling, Graduate Research Assistant and Assistant Professor, Entomology, Plant Pathology and Weed Science Department, New Mexico State University, Las Cruces, NM 88003, and William T. Molin, Assistant Professor, Department of Plant Sciences, University of Arizona, Tucson, AZ 85721.

Abstract. Prometryn is a triazine herbicide registered for use on cotton, but can cause considerable crop injury when used on coarse-textured soils common in the arid southwest. Previous research at the University of Arizona has shown that there is differential tolerance to prometryn among cotton varieties. Data suggested that Pima-type varieties (*Gossypium barbadense*) may be more tolerant than Upland-type varieties (*G. hirsutum*). Identification of varieties with enhanced tolerance would make it possible to increase tolerance in less tolerant varieties through breeding or genetic engineering programs. However, due to cross-breeding, common cotton varieties contain genes from both Pima and Upland cotton types, making the genetic source of the tolerance difficult to determine. The objectives of this study were to screen a collection of cotton varieties for prometryn tolerance and determine whether tolerance is a trait endowed by cotton species or the variety.

Seeds from ten cotton varieties were planted in potting mix, and covered with a 0.25 inch mixture of sand and potting mix treated with six rates of prometryn: 0, 0.7, 1.3, 2.7, 5.4, and 13.4 kg/ha. The cotton varieties included ancestral, "pure" varieties of Pima and Upland cottons (Pima 3-79 and TM-1), a known prometryn-susceptible Upland type (Delta Pine 90), two additional Pima types (Pima S-7 and Sea Island MSI 1368), and six additional Upland types, including two glandless varieties (Acala 1517-91, Acala 1517-95, Acala Maxxa, Acala g1287, and Acala g1340). Plant injury was rated visually every week and, after eight weeks, dry weights of shoots and roots were recorded. Additionally, thylakoid membranes from 4-week old plants from eight varieties were tested for oxygen evolution in the presence of eight rates of prometryn (1, 2, 5, 10, 20, 50, 100 and 200 nM) to determine whether tolerance is due to the ability to maintain photosynthetic activity. Oxygen production was assayed with an oxygen electrode. The varieties assayed were the same as before with the omission of Pima 3-79 and TM1, and the substitution of MS1 1310 for MS1 1368. The screening found no correlation between prometryn tolerance and cotton species. The glandless varieties were the most susceptible, having the lowest mean dry plant weight. DP 90 dry weight was not significantly different than the glandless varieties, but was significantly less than Pima S-7 and Acala Maxxa. The other varieties did not differ significantly in plant weight. A relationship between prometryn susceptibility and reduced oxygen evolution was not found. This suggests that prometryn tolerance in cotton is not due to a difference at the site of action in the chloroplast.

F-8426 IN COMBINATION WITH THE GRASS HERBICIDE DICLOFOP METHYL AND CROP OIL CONCENTRATE FOR THE CONTROL OF BROADLEAF WEEDS IN SMALL GRAINS. W. Dennis Scott and Terry W. Mize, Research Biologists, FMC Corporation, Agricultural Chemical Group, 27 Tremont Dr., College Place, WA 99324, 7502 Dreyfuss, Amarillo, TX 79121.

Abstract. F-8426 is a new postemergence herbicide for control of major broadleaf weeds in small grains, being developed by FMC Corporation. F-8426 was applied at 17, 25 and 35 g/ha, in factorial combination with diclofop-methyl at 1.12 kg/ha and crop oil concentrate (COC) at 1 and 2.5% by volume, to wheat. At 35 g/ha, F-8426 gave excellent control of several broadleaf species including *Lamium amplexicaule*, *Amaranthus*

retroflexus, *Lactuca serriola*, *Machia glomerata*, *Kochia scoparia*, *Salsola iberica*, *Solanum nigrum*, *Descurainia pinnata*, *Chorispora tenella*, and *Sisymbrium altissimum*. *Gallium aparine* was controlled at the 17 g/ha rate. Little benefit to broadleaf weed control was seen with the addition of COC, while these combinations increased the level of crop injury. The 2.5% COC treatments with Diclofop gave unacceptable wheat leaf necrosis regardless of the F-8426 rate. No antagonism between F-8426 and Diclofop's grass control was observed. Wheat yield was unaffected by any level of crop injury observed in this study.

THE INTERACTION AND EFFECTS OF THREE IRRIGATION REGIMES AND VARIOUS YELLOW NUTSEDGE DENSITIES ON COTTON GROWTH. Jody E. Moffett and William B. McCloskey, Graduate Research Assistant and Assistant Specialist, Department of Plant Sciences, University of Arizona, Tucson, AZ 85721.

Abstract. The goal of our research is to determine the effects of yellow nutsedge competition on cotton and to examine how the competitive relationship between these two species is modulated by soil moisture. In support of this goal, an additive competition experiment with various nutsedge densities and three irrigation regimes was conducted at the University of Arizona, Maricopa Agricultural Center. This experiment was arranged in a split-plot design with four (1993) or six (1994) blocks. Each block contained three main plots corresponding to the three irrigation regimes. Wet, standard and dry soil moisture regimes were maintained by irrigating when 35, 50 and 65% soil moisture depletion occurred, respectively. Initial irrigations were scheduled by using a pressure bomb to determine plant water potentials and later irrigations were scheduled by using crop evapotranspiration rates to track soil moisture depletion. Actual soil moisture depletion was measured using a neutron probe in order to check the estimated depletion levels calculated from soil moisture holding capacity and the evapotranspiration curves. Each main plot contained subplots of various yellow nutsedge densities. In 1993 densities of 33, 17, 8, 4, and 0 tubers/m of crop row were planted whereas in 1994 densities of 50, 33, 17, and 0 tubers/m of crop row were planted. Following standard field preparation and pre-irrigation, a medium maturity cotton variety, Delta and Pine Land (DPL) 5415, was planted to moisture and a dry soil mulch placed over the seed row to conserve moisture. Yellow nutsedge tubers were planted 1 to 3 days after cotton planting by removing the soil mulch, planting tubers 2 to 3 inches deep in the seed row and recovering the seed row with a dry soil mulch. The soil mulch was removed 3 days after the cotton was planted to facilitate cotton emergence. Cotton and yellow nutsedge plants emerged simultaneously 5 and 6 days after the cotton was planted.

Increasing nutsedge density caused a significant linear decrease in cotton seed yield in both 1993 ($p=0.03$) and 1994 ($p=0.002$) (Table 1). The cotton yield reductions caused by the highest nutsedge densities, 33 and 50 tubers/m of crop row in 1993 and 1994, respectively, were 13.5 and 15.5%, respectively. Stem biomass, an indicator of total above ground biomass, increased significantly with increasing soil moisture (Table 2). There was also a trend of increasing seed cotton yield with increasing soil moisture with the wet treatment (i.e., irrigation at 35% moisture soil moisture depletion) resulting in the highest biomass and yields (Table 2). In 1994 this trend was significant ($p=0.0001$) but in 1993 it was not ($p=0.098$) probably because fewer blocks were used in 1993 and problems in irrigation scheduling resulted in some over-irrigation of the dry treatment. In 1994 the standard and dry irrigation treatments were, at times, similarly water stressed compared to the wet treatment. The effects of soil moisture availability on stem biomass and seed cotton yield are interrelated because water stress affects the balance between vegetative and reproductive growth in cotton. Since cotton is a perennial plant, decreases in water availability may decrease biomass but not necessarily seed cotton yield if a greater proportion of growth is devoted to reproduction under dry conditions. An important goal of this research is to determine if cotton, with its deeper tap root type of root architecture, is more competitive against yellow nutsedge, which has a fibrous root system, when soil moisture levels are decreased. Analysis of variance showed that there was no significant interaction between soil moisture availability and nutsedge density in either 1993 ($p=0.44$) or 1994 ($p=0.62$). Thus, the effect of yellow nutsedge density on cotton biomass and seed cotton yield was not modulated by soil moisture levels indicating that the interference of yellow nutsedge with cotton can not be reduced through improved irrigation scheduling and more efficient use of water in cotton production.

Table 1. Effect of yellow nutsedge density on cotton stem biomass and seed cotton yield^a.

Nutsedge density (tubers/m crop row)	Stem biomass		Seed cotton yield ^b	
	1993 (g/m crop row)	1994 (g/m crop row)	1993 (kg/ha)	1994 (kg/ha)
0	213 ± 47	287 ± 66	2585 ± 550	3225 ± 431
4	-	-	2507 ± 384	-
8	201 ± 71	-	2338 ± 301	-
17	177 ± 60	291 ± 69	2339 ± 295	2939 ± 577
33	173 ± 55	269 ± 51	2243 ± 374	2838 ± 422
50	-	256 ± 73	-	2730 ± 481

^aData are means ± standard deviations.

^bSignificant linear trend between increasing nutsedge density and decreasing cotton yield in 1993 ($p=0.03$, $R^2=0.08$) and 1994 ($p=0.002$, $R^2=0.12$).

Table 2. Effect of irrigation treatment on cotton stem biomass and seed cotton yield^a.

Irrigation treatment	Stem biomass		Seed cotton yield	
	1993 (g/m crop row)	1994 (g/m crop row)	1993 (kg/ha)	1994 (kg/ha)
Dry	150 ± 38 c	259 ± 67 b	2541 ± 162 a	2255 ± 184 b
Standard	194 ± 56 b	242 ± 56 b	2500 ± 282 a	2376 ± 244 b
Wet	229 ± 55 a	327 ± 36 a	2904 ± 403 a	3192 ± 150 a

^aData are means ± standard deviations; means followed by same letter are not significantly ($p<0.05$) different using the Bonferroni (Dunn) T test.

INFLUENCE OF FLOOD DEPTH ON RICE AND WEED SENSITIVITY TO FENOXAPROP-P-ETHYL. M. H. Ehlhardt, AgrEvo USA, Chico, CA 95928.

Abstract. Trials were conducted in 1993 and 1994 to evaluate how differences in flood water depths in a rice field effected the growth of rice and grassy weeds and as a result how the use rates and application timing for fenoxaprop-p-ethyl was influenced. Rice was sown in individual checks where flood depths were set at 2, 5 and 8 inches. These water levels were maintained until the rice stand was established (4- to 5-leaf stage of growth). Water depths were then uniformly set at 4 to 5 inches and remained so throughout the season (except lowering for application). In both years there was a correlation between flood depth and weed population. As flood depth decreased the weed density increased with more tillers per plant and the weed population maturing faster. The population of rice and rice tiller numbers were uniform across the three water levels. Developing under shallow water, however, rice maturity was delayed. This had no effect on the activity of the herbicide.

Initial fenoxaprop-p-ethyl treatments were made when the rice had developed 1 to 2 tillers. In 1993, no sequential applications were made. In 1994, by design, single treatments as well as multiple treatments were made in the 2 and 5 inch flood plots. Applications in the 8 inch flood plots were made at 1 to 2 tiller rice in 1993 and also at 4 tiller rice in 1994. Results demonstrated that in a shallow flood (2 inches) with increased weed pressure higher rates (minimum of 0.059 lb/A) or multiple treatments of (0.042 to 0.05 followed by 0.059 lb/A) of fenoxaprop-p-ethyl were needed to obtained control of 90% or greater. In the 5 inch flood plots, bearded sprangletop control of 88% was obtained with rates as low as 0.042 lb/A.

Watergrass control was harder to achieve needing 0.067 lb/A alone or 0.05 lb followed by 0.059 lb/A. With less weed pressure in the 8 inch flood plots lower rates (0.042 lb/A) provided sufficient control of both watergrass and bearded sprangletop. Visual control was superior when the applications were made at the 4 tiller rice timing. However, yields were higher when treatments were made at the 1 to 2 tiller timing.

EXTENSION, EDUCATION, AND REGULATORY

INTEGRATED PEST MANAGEMENT SOFTWARE: THE UCIPM WAY. Joyce Strand, Computer System Manager, UC Statewide IPM Project, Davis, CA 95616.

Abstract. The UCIPM software contains several databases and management programs including: Pesticide Use Summaries Database, California Pesticide Registration Database, CDPR-UC Pesticide Survey Database, Weather database, Degree-Day Utilities, Phenology Model Database, Trap Data Management Program and Electronic Mail. Access to the program requires only that user's obtain an account (which determines access to some resources). There is no user fee (except for telephone charges) and the software can be accessed using communications software and a modem or via the Internet. The databases and programs on UCIPM are updated regularly, for example the California Pesticide Registration Database is updated every six months. The programs are designed to be user friendly and are menu driven. User's manuals and training are readily available.

COMPUTATIONAL TECHNIQUES USED IN HERBICIDE DISCOVERY. Harold K. Cox, Chemistry Department, Zeneca Ag Products, Richmond, CA 94804.

Abstract. Aids to the conventional empirical screening of chemical analogues include fairly powerful software programs which enable quantitative analysis of data. These programs can be used to develop understanding of structure activity relationships (SAR) and in some instances may provide predictive capabilities within a given chemical series. Software graphics allow for visualizations of inhibitor-active site complexes highlighting chemical, electrostatic, and spatial configurations. These graphic representations can provide researchers with an increased understanding of requirements for potent inhibitors and suggest options for additional inhibitors.

SCIENTIFIC DATA PRESENTATION USING COMPUTER GENERATED MULTI-MEDIA DISPLAY. Sean Hanser, Weed Science Department, Zeneca Ag Products, Richmond, CA 94804.

Abstract. The importance of functional and attractive visual aids for use in an oral presentation is well known. Clearly, visual aids which highlight or help elucidate key aspects of a presentation can increase the successful conveyance of ideas and messages. The technology for creating visual aids for use in oral presentations has evolved to the point where 'stunning visual' aids are accessible to everyone. Evolution has occurred in all aspects of visual aid technology including: software options, broad creativity, time required to obtain visual aids, quality, colors, and mechanisms for visual aid delivery during the presentation. Several software packages are currently available and each package has benefits and limitations, however, all offer the ability to achieve the look and feel you desire in the visual aids that are required for your presentations.

REGULATORY TRENDS: A REGISTRANT'S PERSPECTIVE. John Kieft, Environmental Sciences Department, Zeneca Ag Products, Richmond, CA 94804.

Abstract. Environmental Protection Agency pesticide registration policies and requirements have exhibited significant changes during the past few years which are impacting registrants' decision making process. This presentation will focus on several of the key changes which have occurred in registration requirements or policy in the areas of risk assessment and risk management. Examples of recent registration decisions on

dimethenamid, flumetsulam, imidacloprid, and acetochlor will be used to illustrate the magnitude of the changes which have occurred and what may be expected in the near term. The impact of the changes on new pesticide development will also be discussed.

REGULATORY TRENDS: A REGISTRAR'S PERSPECTIVE. Regina Sarracino, Department of Pesticide Regulation, Sacramento, CA 95814.

Abstract. Currently there are a number of emerging legislative issues that could impact the registration of pesticides in California. A current major effort is the resolution of differences in the requirements by EPA and DPR for the registration of pesticides in California. The effort involves scrutiny and evaluation of common data for a given pesticide registration and subsequent analysis of interpretation between the two agencies. The effort is designed to identify the differences between the two agencies with the desired outcome of developing a data set that will satisfy requirements of each agency.

EMERGING FOOD SAFETY ISSUES. Carl K. Winter, FoodSafe Program, University of California, Davis, CA 95616.

Abstract. While the famous Alar incident is now more than five years old, food safety concerns involving pesticide residues continue to receive widespread public, legislative and scientific attention. The National Research Council's 1993 report Pesticides in the Diets of Infants and Children concluded that significant improvements in the U.S. government's pesticide risk assessment and food tolerance establishment procedures were needed although the report did not conclude that the risks faced by infants and children from pesticide exposure were excessive. Strict interpretation of the Delaney Clause by the U.S. Ninth Circuit Court of Appeals has led to the elimination of several pesticide uses due to statutory, rather than scientific consideration; a variety of Congressional "solutions" to the Delaney problem have been proposed that could have broad impacts upon future pest management practices if adopted. Emerging issues include the safety of imported produce and the potential effects of trade agreement such as NAFTA and GATT upon U.S. pesticide residue standards.

WINTER ANNUAL GRASS WEED SURVEY IN KANSAS. P. W. Stahlman and D. E. Peterson, Research Weed Scientist, KSU Agricultural Research Center - Hays, Hays, KS 67601, and Extension Weed Specialist, Department of Agronomy, Kansas State University, Manhattan, KS 66506.

Abstract. The abundance and distribution of winter annual grass weeds in Kansas winter wheat (*Triticum aestivum* L.) fields appears to have increased in recent years. The scope and severity of winter annual grass weeds in Kansas winter wheat fields had never been assessed. Therefore, a mail survey of Kansas farmers was conducted to document the presence and severity of winter annual bromes, volunteer rye (*Secale cereale* L.), and jointed goatgrass (*Aegilops cylindrica* Host.) in winter wheat on a regional and statewide basis, and to document farmers perception of the effectiveness of various methods for control of these winter annual grass weeds.

The survey was conducted by the Kansas Agricultural Statistics Division of the Board of Agriculture in cooperation with the Kansas Agricultural Experiment Station and Kansas Cooperative Extension Service. Questioners were mailed after completion of the 1994 winter wheat harvest to a random sampling of 3,900 farm operators who previously were known to raised wheat. Distribution of the questionnaires was weighted by winter wheat acreage in each of nine crop reporting districts. After two weeks, nonrespondents were called and reminded to return the

questionnaire. Because some areas of the state have more than one winter annual brome species, and because many farmers can not accurately identify the species, they were not asked to distinguish between brome species. Rather, for simplicity, cheat (*Bromus secalinus* L.), downy brome (*Bromus tectorum* L.), and Japanese brome (*Bromus japonicus* Thunb. ex Murr) were collectively called cheatgrass.

A total of 3,074 usable questionnaires were returned. Statewide, winter annual bromes (cheatgrass) were more abundant in winter wheat fields than jointed goatgrass or volunteer rye. Cheatgrass and volunteer rye were most abundant in central, south-central, and southeastern Kansas. Continuous wheat cropping is widely practiced in these areas. Statewide, 42% of the respondents reported having wheat infested with cheatgrass. In the central Kansas, 58% of the respondents reported cheatgrass in wheat. Cheatgrass infested 13% of the statewide wheat acreage or more than 1.5 million A. Slightly more than 5% of the statewide wheat acreage or about 600,000 A was infested with volunteer rye. Less than 1% of the wheat acreage outside central and southeast Kansas contained volunteer rye. However, 44% of respondents from south-central Kansas reported volunteer rye in their wheat. Up to 14% of the wheat acreage in the south-central Kansas was infested with volunteer rye. Jointed goatgrass was more common in western and central Kansas than in eastern Kansas, but infested acreage did not exceed 3.5% for any crop reporting district. More than 15% of the respondents from central and western Kansas reported the presence of jointed goatgrass compared with only 3% from eastern Kansas. Jointed goatgrass infested 2.5% of the wheat acreage in the western two-thirds of the state or about 262,000 A statewide.

Thirteen percent more of all respondents felt cheatgrass had increased than decreased over the past 5 years, except in northwest and west-central Kansas where more than twice as many respondents felt cheatgrass had decreased over the past 5 years. Nearly half of all respondents rated the severity of cheatgrass as minor. However, over 20% rated cheatgrass and volunteer rye severity as serious, compared with 11% for jointed goatgrass.

Crop rotation was the most common and effective nonchemical method used to control winter annual grass weeds. Three-fourths of all respondents used crop rotation, with nearly 58% rating it excellent and 30% rating it moderate in effectiveness. About one-third of the respondents used burning or plowing and one-fourth used delayed seeding as control methods. More than half the respondents who used these methods rated their effectiveness as moderate. Only 13% of all respondents felt delayed seeding was an excellent method of winter annual grass control.

One-fourth of all respondents who reported having had wheat infested with cheatgrass or volunteer rye received dockage due to weed contamination. Only 12% having had jointed goatgrass received dockage. Statewide, 17% of respondents who had volunteer rye diverted infested wheat acres to another use. For those with cheatgrass and jointed goatgrass, 11 and 17%, respectively, of infested acres were diverted to another use.

Sixty-eight percent of the seed used to seed the 1994 winter wheat crop in Kansas was home grown and another 11% was grown by another farmer. Only 21% of the seed used was purchased from commercial sources.

PERSIAN DARNEL - AN ANCIENT WEED BECOMES A NEW WEED PROBLEM. J. H. Hunter, Research Scientist, Agric. Can. Res. Farm, Indian Head, SK, Canada S0G 2K0.

Abstract. Persian darnel, an annual grass introduced from southwestern Asia, was first reported in Saskatchewan in 1923. In 1950 it was considered an "established" weed, but in the 1966 weed survey it was not considered a problem weed. In 1976, Persian darnel ranked 30th on a relative abundance scale, and by 1979 it had increased to the 15th most common weed in Saskatchewan grain fields and was reported in 17 of 41 Agricultural Extension Districts. Persian darnel spread into Alberta where in 1981 it occurred in 14 of 65 municipalities. Persian darnel has also spread into Manitoba, and is reported to be a problem in Montana and North Dakota.

Persian darnel grows 15 to 45 cm high with erect tillers from the base. Leaf blades are narrower than wheat and have a lighter green color with an oily sheen. Spikelets are arranged dorsally on the rachis, in two rows on opposite sides of the stems, giving the plant the appearance of having been pressed.

Persian darnel flourishes in relatively dry areas, establishing dense stands in early spring and, despite its short stature, competes vigorously with most annual crops. Persian darnel seed germinates mainly in early spring. Cultural control by shallow cultivation can be reasonably effective. However, as tillage is reduced the weed problem increases.

Herbicide control is best if applied when Persian darnel is very young, preferably in the 1- to 3-leaf stage. In broad leaved crops such as flax and canola, several herbicides are now registered. In cereals, control has been much more limited. Research has recently resulted in registration of a new product, tralkoxydim, for selective control of Persian darnel, green foxtail, and wild oats in wheat and barley.

EVALUATION OF A LIGHT-ACTIVATED SPRAYER USED FOR BERM WEED MANAGEMENT.

Timothy S. Prather and Kurt Hembree, Regional IPM Specialist and Staff Research Associate, Statewide Integrated Pest Management Project, University of California Cooperative Extension, Kearney Agricultural Center, Parlier, CA 93648.

Abstract. Herbicides applied to berms for postemergent weed control contact soil as well as plants. Minimizing soil contact would improve the efficiency of weed control by reducing the amount of herbicide required to achieve the same level of control. A new sprayer, the Weedseeker[®], is commercially available for use on orchard berms that should improve application efficiency. The sprayer uses light reflected from plants to determine when to apply herbicide, operating each spray nozzle independently. Utility of this technology revolves around its ability to apply materials more efficiently than standard sprayers. The objective of these studies was to determine the actual output from the sprayer over a range of area covered by green vegetation.

Two studies were conducted where the area covered by green vegetation (% cover) was controlled experimentally, achieving a range of cover from 0 to 100%. The first of these studies used tomatoes grown in flats and thinned to achieve each percent cover. There was concern about an interaction between percent cover and the height of the tomatoes and so the second study was conducted using turf that achieved a range of cover from 0 to 100% by covering the turf with white paper. In a third experiment, the percent cover of weeds on berms of a new planting of peaches and nectarines was measured, achieving a range of cover from nearly 0 to 60%. The amount of material applied was determined by weighing a 19 liter tank before and after applying water to green vegetation. In the experiments where percent cover was controlled there were four replications. The field study contained multiple observations, but without replication at each percent cover. The relationship between the amount of water applied and percent cover was determined using regression analysis.

Below 40% cover the sprayer applied less than its maximum, down to 33% of maximum output at 5% cover. In controlled experiments, the sprayer applied an average of 168 l ha⁻¹ at 100% cover. At 5% cover the sprayer applied 47 l ha⁻¹, resulting in 28% of maximum output applied. There were no differences in the amount applied between the two controlled experiments, despite a difference in height of the vegetation (10 to 15 cm for the tomatoes and 0 to 2 cm for turf). The sprayer applied 74 and 94 l ha⁻¹, respectively in the tomato and turf experiments, corresponding to 44% and 56% of maximum output applied. Results were similar in the field study, where the sprayer applied 33% of maximum output at 5% cover. The sprayer applied water at its maximum output above 40% cover.

The volume applied nearly doubled in the controlled experiments when cover increased from 5 to 10%, demonstrating that application efficiency increases with decreasing percent cover. The sprayer is most efficient at low percent cover (below 40%) and would not provide any efficiency benefits over a conventional sprayer on heavily infested berms.

COMPARISON OF NEW NOZZLE TYPES ON A SELF PROPELLED POSTEMERGENCE

APPLICATOR. R. N. Klein and D. J. Thraillkill, Professor and Research Technologist, University of Nebraska West Central Research and Extension Center, North Platte, NE 69101.

Abstract. Recently new spray nozzles designed to reduce spray drift have been introduced by nozzle manufacturers. A study was conducted to determine the performance of Turbo FloodJet[®] (TF) or DG TeeJet[™] (Drift Guard/DG) nozzles relative to XR TeeJet[®] (extended range/XR) flat fan nozzles under actual field conditions when spraying paraquat with a Tyler[®] Patriot[™] spray rig. The nozzles were tested using carrier volumes of 10, 7.5, and 5 gpa. Paraquat plus atrazine (0.31 + 0.5 lb/A) with a non-ionic surfactant (0.25% v/v) was applied to winter wheat stubble on September 1, 1994 using each of the nozzle configurations described in the table below. The nozzle spacing was 30 inches and pressure was 30 psi. With the XR and DG nozzles the nozzle bodies were vertical while with the TF nozzles the bodies were rotated 45 degrees. All nozzles tested were purchased and new. Weed pressure at the site was high with the major weeds present being green foxtail, triazine resistant kochia and volunteer winter wheat. Weeds were under stress due to the lack of rainfall. Weed control ratings were made at 9 and 35 days after treatment and are summarized in the table.

Table. The effect of nozzle type on the performance of paraquat plus atrazine.

Nozzle	Volume	Speed	% Control*					
			Green Foxtail		TR Kochia	Vol. Wheat		
			9 DAT	35 DAT	9 DAT	9 DAT	35 DAT	
	gpa	mph						
XR11005	10	8.6	98 a	98 a	97 a	97 a	95 a	
DG11005	10	8.6	99 a	97 a	96 a	95 a	94 ab	
TF-VS2.5	10	8.6	95 bc	81 cd	79 c	80 c	69 d	
TF-VS2	7.5	9.2	94 c	78 d	70 d	71 d	65 d	
XR11004	7.5	9.2	98 a	95 a	97 a	95 a	93 ab	
DG11004	7.5	9.2	98 ab	91 ab	96 a	89 b	86 abc	
XR11003	5	10.3	98 ab	96 a	95 a	94 a	85 bc	
DG11003	5	10.3	96 abc	88 bc	89 b	90 b	83 c	
Untreated Check			0 d	0 c	0 c	0 c	0 c	
LSD (0.05)			2.9	6.3	3.6	3.7	8.9	

*Ratings followed by the same letter are not significantly different from each other using a t-test (LSD) at the 5% alpha = 0.05.

When comparing nozzle types within each carrier volume, weed control was significantly lower with Turbo FloodJet[®] (TF) nozzles compared to XR TeeJet[®] (XR) or DG TeeJet[™] (DG) flat fan nozzles at both 10 and 7.5 gpa at both rating dates and for all weeds rated. At 10 gpa and at 7.5 gpa no significant differences in weed control were detected when comparing XR nozzles to DG nozzles. With a carrier volume of 5 gpa, the XR nozzles provided significantly higher weed control than the DG nozzles for TR kochia and volunteer winter wheat at 9 DAT, and green foxtail at 35 DAT. The TF nozzles are not available in sizes small enough to allow testing at 5 gpa.

When comparing carrier volume within each of the nozzle types, a trend toward decreasing weed control when carrier volume is reduced was noted. The only significant reduction in weed control when reducing carrier volumes from 10 to 7.5 gpa occurred with the TF nozzles on kochia and volunteer winter wheat at 9 DAT. This suggests that the TF nozzles are more susceptible to reduced performance with paraquat as carrier volumes are decreased than XR or DG nozzles would be. When reducing carrier volumes from 10 to 5 gpa the DG nozzles had significantly lower weed control for all weeds rated and rating dates except green foxtail at 9 DAT. The XR nozzle showed no significant reduction in weed control when comparing 10 gpa to 5 gpa except for volunteer winter wheat at 35 DAT. We can conclude that the XR nozzles would be the least susceptible to a reduction in weed control as carrier volumes are reduced to 5 gpa.

THE APPLICATION PATTERNS OF VARIOUS HERBICIDE GRANULES USED IN ALFALFA.

B. Tickes, D. Monypeny, and A. Baber, Extension Agent, University of Arizona Cooperative Extension, Yuma and Gowan Company, Yuma, Arizona 85364.

INTRODUCTION

Interest in granular formulations of some herbicides has increased in recent years due to potential improved weed control, application efficiency and crop safety when compared to sprayable formulations. Herbicide granules can be made from different materials and are available in various sizes (Table 1). Montmorillonite, attapulgite and kaolin clay are the most common source materials used although sand, cellulose/clay mixtures and other materials are also used. Granule size is determined by screens. A 30/60 granule, for instance, will pass through a 30 mesh screen and not a 60 mesh screen. The resulting formulations sometimes contain a wide range of granule sizes. Commonly used granule sizes are 30/60, 24/48, 16/30, 20/40, 12/20, and 8/40. The variable size, density and concentration of granules can result in differences in application rate, distribution and weed control. Tests were conducted to compare these characteristics with five herbicide granules used in alfalfa.

Table 1. Characteristics of five herbicide granular formulations.

Herbicide	Granule size (sieve mesh)	Granule source	Bulk density (lbs/feet ³)	Granules/lb (Million)	Granules/feet ² *
Trifluralin 10G	30/60	Attapulgite clay	44 to 46	5.0 to 6.1	303 to 462
Trifluralin 10G	24/48	Montmorillonite clay	48 to 50	2.5 to 2.8	186 to 294
Trifluralin 10G	16/30	Cellulose/kaolin clay mixture	47 to 49	1.0 to 1.2	153 to 243
EPTC 10G	16/30	Kaolin clay	55 to 57	0.98 to 1.1	81 to 129
Norflurazon 5G	20/40	Sand core	87 to 97	0.8 to 0.9	108 to 144

*At 10 lb/A rate

MATERIALS AND METHODS

Tests were conducted at low labelled rates to evaluate differences in the relative calibration, distribution and weed control of five herbicide granular formulations used in alfalfa. Calibration was evaluated for a 30/60 trifluralin 10% granule on attapulgite clay, a 24/48 trifluralin 10% granule on montmorillonite clay, a 16 by 30 trifluralin 10% granule on a cellulose/kaolin clay mixture, a 16/30 EPTC 10% granule on kaolin clay and a 20/40 norflurazon 5% granule on a sand core. Distribution and weed control characteristics were evaluated only for the trifluralin granules. All formulations except the norflurazon granule are currently registered in alfalfa.

Application Rate. The purpose of this experiment was to determine the relative metering rate of the five granule formulations when the application equipment was set at a uniform position. A Valmar PT 1220 airflo pneumatic herbicide applicator with ground drive metering was set to apply 10 lb/A of the 30/60 trifluralin 10% granule on attapulgite clay. Cotton calibration bags were placed over all of the applicator outlets and the weight of granules applied from 10 revolutions of the metering roller was determined. This procedure was replicated four times for each granule tested. Bulk density, granules per pound and the number of granules applied per square foot were also determined. The weight per cubic foot and granules per pound for each formulation were determined in the laboratory. Six by eight inch sentry sticky boards were used to determine the number of granules per foot² applied. The Valmar PT 1220 applicator set to apply 10 lb/A and driven over the sticky boards placed 5 feet apart and parallel to the 16.5 feet applicator boom. This procedure was replicated three times for each formulation.

Distribution. The purpose of these tests were to determine the aerial and ground distribution patterns of the three trifluralin formulations; 30/60 attapulgite clay granules, 24/48 montmorillonite clay granules and 16/30 cellulose/kaolin clay mixture granules. The total swath width and distribution of granules within the swath were measured by using 6 by 8 inches sentry sticky boards placed 5 feet apart and perpendicular to the applicator. Twenty sticky boards for a total width of 100 feet were used in the aerial tests and seven boards for a total width of 35 feet were used for the ground tests. All treatments were replicated three times. A fixed-wing Ayers Turbothrust airplane with a laser altimeter was flown 50 feet above ground for the aerial tests and a Valmar airflow PT 1220 ground driven granular applicator with a 16 foot boom set 33 inches above ground was used for the ground tests. The Poisson index of dispersion was used to compare the relative uniformity of each treatment.

Weed Control. The purpose of this test was to compare the weed control activity of the three trifluralin granules; the 30/60 attapulgite clay, the 24/48 montmorillonite clay and the 16/30 cellulose/kaolin clay mixture. The test was conducted at the University of Arizona Yuma Mesa Agriculture Center approximately 4 miles south of the City of Yuma, Arizona on a two year old stand of CUF 101 alfalfa. Soil type was superstition fine sand. Annual ryegrass (*Lolium multiflorum*) was planted into the alfalfa as a indicator crop to measure weed control activity. The treatments were 1 lb/A of the three trifluralin granules applied with a Valmar Pt 1220 herbicide applicator and an untreated check. Plot size was 16 by 95 feet replicated three times in a randomized complete block. The test was established on 17 Nov 1994 and evaluated 55 days after treatment on 13 Jan 1995. Weed control was measured by counting annual ryegrass seedlings in a 1 foot² grid dropped randomly in 10 locations in each plot.

RESULTS AND DISCUSSION

Application Rate. Size and weight differences between the five granules used in this test resulted in significant differences in flow rate when metered through the Valmar applicator set at a uniform position (Table 2). When set to apply 10 lb/A (actual) of the trifluralin 30/60 attapulgite clay granule, increases in application rate (lb/A) from seven to 10% for the trifluralin 24/48 montmorillonite clay, 15 to 19% for the trifluralin cellulose/kaolin clay, 25 to 30% for the EPTC montmorillonite clay and 125% for the Norflurazon 20/40 sand core granule were measured. It is important, therefore, that applicators know that application equipment should be recalibrated when changing from one formulation to another.

Table 2. Application rate of five herbicide granules.

Herbicide	Granule size	Granule source	Application Rate (% difference when set to apply 10 lb/A (actual) of 30/60 attapulgite clay granule)
Trifluralin	30/60	Attapulgite clay	---
Trifluralin	24/48	Montmorillonite clay	+7 to 10
Trifluralin	16/30	Cellulose/kaolin mixture	+15 to 19
EPTC	16/30	Kaolin clay	+25 to 30
Norflurazon	20/40	Sand core	+100 to 125

Distribution. Table 3 illustrates the granule distribution that was measured by ground and aerial application using the sentry sticky boards placed 5 feet apart and perpendicular to the applicator. The aerial swath width ranged from 65 to 100 feet with the average for each treatment being 67 feet for the 16/30 cellulose/kaolin clay mixture; 75 feet for the 24/48 montmorillonite clay and 85 feet for the attapulgite clay. It is of value for applicators to know that swath width varies with these different formulations to avoid skips in the field. Wider swaths also mean fewer passes across the field. Swath width in the ground applications with the Valmar 16 foot boom applicator showed little variability between formulations. When dropped from 33 inches above ground,

swath width was consistently 20 feet for all three treatments. Deflector plates accounted for the two additional feet on each end of the boom.

Granule distribution within each swath and between replications was highly variable when applied by air 50 feet above ground. Distributions were evaluated by using the Poisson index for classifying dispersion patterns. This index is derived by subtracting the expected number of granules at each 5 foot location from that which was observed. The square of each of these numbers are totaled and divided by the mean of the entire swath. The lower the index number the more closely the observed matched the expected distribution. This index was high for all of the aerial applied treatments with the 16/30 cellulose/kaolin clay mixture being the lowest at 26 followed by 37 for the 30/60 attapulgite clay and 58 for the 24/48 montmorillonite clay. The index numbers derived for the ground applicators were much lower, indicating more uniform distribution patterns. The 30/60 attapulgite clay was lowest at four, followed by eight for the 24/48 montmorillonite and 11 for the 16/30 cellulose/kaolin clay mixture. Aerial application patterns were remarkably uneven in this test and would likely be worse if crops were in the field to offer obstruction.

Table 3. Swath width and Poisson index of dispersion for three different size and density trifluralin granules.

Granule size	Granule source	Swath width (ft) ^a		Poisson ^a index of dispersion	
		Aerial	Ground	Aerial	Ground
30/60	Attapulgite clay	85	20	37	4
24/48	Montmorillonite clay	75	20	58	8
16/30	Cellulose/kaolin clay mixture	67	20	26	11

^aAverage of three replications.

Weed Control. The effect of granule size, weight, and source material may be the most important factors relative to weed control evaluated in this study. The results of the efficacy study conducted at the University of Arizona Yuma Mesa Agriculture Center are presented in Table 4. The number of annual ryegrass seedlings were significantly lower for the 30/60 attapulgite and 24/48 attapulgite treatments than for the 16/30 cellulose/kaolin mixture. All three granule treatments were significantly different from the untreated check. When the 30/60 attapulgite and 24/48 montmorillonite treatments were compared alone, a significant difference was measured at the 0.1 significance level using the Duncan New Multiple Range test. This difference was not measured at the 0.5 level of significance with this same test. The number of granules/lb from a low of 1 million with the 16/30 cellulose/kaolin granule to a high of 6.1 million with the 30/60 attapulgite granule and the number of granules per square foot ranged from a low of 153 with the 16/30 granule to a high of 462 with the 30/60 granule. The greater number of granules on the ground may be responsible for the improved weed control with the 30/60 granule.

Table 4. Granules per pound, granules per foot² and ryegrass control with three different Trifluralin granule formulations.

Trifluralin granule size	Granule source	Granules/lb (Million)	Granules/feet ² (at 10 lb Rate)	Annual ryegrass control ^a (Seedlings/feet ²)
30/60	Attapulgite	5.0 to 6.1	303 to 462	13.8 a ^b
24/48	Montmorillonite	2.5 to 2.8	186 to 294	18.4 a
16/30	Cellulose/kaolin mixture	1.0 to 1.2	153 to 243	42.4 b
Untreated	---	---	---	79.9 c

^aAverage of three replications.

^bDuncan New Multiple Range Test at 0.05 significance level.

BASIC SCIENCES, ECOLOGY, BIOLOGY, PHYSIOLOGY, GENETICS AND CHEMISTRY

DETERMINATION OF THE BIOLOGICAL HALF-LIFE OF THREE CHLOROACETAMIDE HERBICIDES IN COLORADO SOILS. Patrick A. Miller and Philip Westra, Graduate Research Assistant and Associate Professor, Department of Plant Pathology and Weed Science, Colorado State University, Fort Collins, CO 80523.

Abstract. Field and laboratory studies were initiated in the Spring of 1994 to investigate differences in the efficacy and persistence of acetochlor (Harness+ and Surpass), metolachlor (Dual II), and dimethenamid (Frontier). The field studies consisted of replicated, 3 m by 10 m plots, in which bioassay species were planted at regular intervals following herbicide application. Barnyardgrass, wild-proso millet, pigweed, large crabgrass and sorghum were planted 0, 14, 28, 45, and 66 days after treatment (DAT). Evaluation of herbicide biological activity and persistence (half-life), was determined by indicator species biomass reduction. Bioassay species were visually evaluated and harvested 21 days after planting (DAP). Laboratory studies of the efficacy and persistence of the three herbicides consisted of incubating 8.5 kg quantities of soil under constant temperature and moisture conditions. Following incubation periods of 0, 1, 2, 4, 6, and 8 weeks, soil samples were seeded with an indicator species and evaluated 14 DAT for biomass reduction. Both field and laboratory studies indicated the initial efficacy of the herbicide treatments to vary with soil type, soil organic matter content, and species evaluated. In addition, the field and laboratory studies indicated the herbicides were ranked as follows with respect to biological persistence: metolachlor > dimethenamid > acetochlor. Additional studies are in progress to assess the influence of soil properties and herbicide physico-chemical characteristics on herbicide adsorption, the factor which most strongly influences herbicide biological activity and persistence.

WEED RESISTANCE DEVELOPMENTS IN NORTH DAKOTA. F. A. Manthey, R. K. Zollinger, and J. B. Fric, Research Scientist, Extension Weed Specialist, and Graduate Research Assistant, Department of Crop and Weed Sciences, North Dakota State University, ND 58105.

Abstract. Wild oat resistance to diclofop was first reported in the Red River Valley of eastern North Dakota and western Minnesota in 1992. Wild oat seed was collected in 1993 through assistance of farmers by use of a mailed survey, by crop consultants using field histories, and through random sampling. At each location, seed from each of 20 wild oat plants were collected. Wild oat seed was tested for resistance to ACCase inhibiting herbicides in 1994. A petri plate assay was developed to test wild oat seed under laboratory conditions. Germinated wild oat seeds were exposed to a fenoxaprop concentration of 1 ppm at 20 C, in the dark for 72 h. The control consisted of deionized water. Roots were excised after 72 h of exposure. Root weight was used to detect resistance in wild oat seed. Root weight greater than 50% the weight of the control was classified as resistant.

Wild oat seed was collected from 169 locations but seed from 146 sites were tested. Wild oat seed was documented as resistant to fenoxaprop in 45 locations. Seed from these 45 sites were planted in a greenhouse and wild oat plants at the 3- to 4-leaf stage were treated with diclofop, fenoxaprop, quizalofop, fluazifop, clethodim, and sethoxydim to document accuracy of the petri plate assay. Of the plants resistant to diclofop in the petri plate assay 73% (33/45) of were resistant to diclofop under green house conditions, 24% (11/45) to fenoxaprop, 16% (7/45) to quizalofop, and 7% (1) to fluazifop. This suggests that the petri plate assay was 73% accurate when allowing for type I error. Twenty seven percent of the susceptible plants were given a resistant classification (type I error). Wild oat plants that were classified as resistant to fenoxaprop in the petri plate assay were not resistant to clethodim or sethoxydim.

Table 1. Response of wild oat root weight to fenoxaprop.

Rate	Biotype	
	Susceptible	Resistant
ppm	mg/plant	
0	229	251
1	38	170
LSD (0.05)	Rate * Biotype = 53	

Table 2. Field history of diclofop use and wild oat resistance to diclofop.

Fields	Years of diclofop use		
	0	1 to 7	Greater than 7
	number of fields		
Sampled	5	13	20
Resistant	4	5	12

Table 3. Wild oat plants expressing resistance to ACCase inhibiting herbicides.

Herbicides ^a	Number of locations
Diclofop	33
Diclofop and fenoxaprop	11
Diclofop, fenoxaprop, and quizalofop	4
Diclofop, fenoxaprop, quizalofop, and fluazifop	1

^aNo wild oat resistance was detected to clethodim or sethoxydim. Previously documented resistant wild oat biotype UM1 was resistant to diclofop, fenoxaprop, and sethoxydim.

Research was conducted in 1993 and 1994 to study kochia response to sulfonyleurea, 2,4-D and dicamba. These herbicides are primary products used for kochia control in small grain production in North Dakota. A survey was conducted traveling five major east/west routes across North Dakota for kochia seed collection. Fields were sampled every 20 miles, kochia seed from 10 plants/site was collected, and a total 89 sites were sampled. Seed at each location was pooled. Kochia were grown in the greenhouse and herbicides were applied in greenhouse conditions. Tribenuron was applied preemergence at 0.125 lb/A and postemergence twice each at 0.031 lb/A plus surfactant. 2,4-D was applied twice each at 0.5 lb/A, and dicamba was applied twice each at 0.0625 lb/A. All postemergence applications were applied at 17 gpa to kochia 1 to 1.5 cm tall with 4 to 6 leaves. Results were taken 5 weeks after the first postemergence application.

Kochia was completely killed by tribenuron in 49 locations. At 16 sites up to 1% of the kochia plants survived, at 4 sites 1 to 10% survived, and at 16 sites 10 to 75% of the plants survived. Some kochia plants survived treatment of 2,4-D at all locations. Greater than 5% of the kochia plants survived at 39 locations. At these 39 locations, an average of 10 kochia plants/pot survived, but at one site, 39% of the plants survived. Kochia was completely killed by dicamba in 56 locations. At 25 sites up to 1% of the kochia plants survived, and at 8 sites 2% or more of the kochia survived. The percentage of plants that survived in the 8 locations were 37%, 23%, 10%, 4%, 3%, 2%, 2%, 2%. At one of these 8 locations kochia plants survived an additional application of 0.5 lb/A of dicamba. Additional testing was performed on the 8 locations that showed greater than 2% of the plants surviving. Experiments were established where dicamba was applied at 0.0625, 0.125, 0.25, 0.5, and 1 lb/A. Kochia plants survived in 8, 8, 7, 4, 1, and 0 locations tested, respectively.

Table 4. Kochia resistant biotypes surviving application of 2-way and 3-way combinations of tribenuron, 2,4-D, and dicamba.*

	Rate	Number of sites where kochia survived		
		+ 2,4-D	+ Dicamba	+ 2,4-D + dicamba
Metsulfuron	0.00375	9	4	2
Nicosulfuron	0.0314	9	2	2
Tribenuron	0.03125	9	3	3

*A total of 9 locations were tested that were previously documented as resistant to tribenuron.

In summary, kochia resistance to sulfonylurea herbicides were documented in over 30% of the total sites surveyed. Resistant biotypes were found in the northern and western sections of North Dakota but were also scattered randomly throughout the state. Resistance to sulfonylurea herbicides is expressed at various levels (low level to high level resistance). Kochia plants classified as resistant to sulfonylurea herbicides are initially affected by exhibiting stunted growth and yellowing. Resistant plants soon recover and continue growth.

Kochia populations exhibit a low level resistance to 2,4-D. 2,4-D did not control 100% of the plants at any location. Sites that exhibited greater than 5% of the kochia plants surviving applications of 2,4-D were classified as resistant to 2,4-D. Distribution of kochia plants resistant to 2,4-D were randomly scattered throughout North Dakota.

Kochia in 81 of the 89 sites sampled had less than 1% survival after treatment with dicamba. At 8 locations, 2% to 37% of the kochia plants survived dicamba treatment. All sites that had kochia resistant to dicamba were also resistant to 2,4-D. Surviving plants exhibited little growth regulator symptomology or phytotoxicity.

Kochia was found resistant to tribenuron plus 2,4-D at 13 sites, at 8 sites kochia was resistant to 2,4-D plus dicamba, and at 3 sites kochia was resistant to sulfonylurea herbicides applied in a 3-way tankmix combination with 2,4-D and dicamba. At 5 sites, kochia resistant to dicamba plus 2,4-D were susceptible to tribenuron. Current research is being conducted on green foxtail seed collected in the fall 1994 to determine response of germinating plants to trifluralin and selected ACCase inhibiting herbicides.

BASIS FOR DICLOFOP RESISTANCE OF WILD OAT BIOTYPES FROM THE WILLAMETTE VALLEY OF OREGON. S. S. Seefeldt, E. P. Fuerst, D. R. Gealy, A. Shikma, M. A. S. Marles, and M. D. Devine, Agronomist, USDA-ARS, Associate Professor, Department of Crop and Soil Sciences, Washington State University, Pullman WA 99164; Plant Physiologist USDA-ARS, National Rice Germplasm Evaluation and Enhancement Center, Stuttgart, AR 72160; and Post Doc., Graduate Student, and Associate Professor Department of Crop Science and Plant Ecology, University of Saskatchewan, Saskatoon, Saskatchewan, Canada, S7N 0W0.

Abstract. In 1990 two biotypes of wild oat from the Willamette Valley of Oregon were the first to be reported resistant to diclofop in the United States. Laboratory experiments were conducted in Pullman, WA and Saskatoon, Saskatchewan to determine the mechanism of resistance to diclofop in these two biotypes (designated "B" and "C" biotypes). Differences in uptake, translocation, and metabolism of diclofop-methyl were studied using ^{14}C -labeled diclofop-methyl. The resistant biotypes were not different from a susceptible biotype of wild oat in absorption, translocation, and metabolism of diclofop-methyl or in acetate incorporation. By day four, all biotypes absorbed over 90% of the herbicide and translocated less than 5% of that amount. There were no differences in metabolism of diclofop-methyl until 8 days after treatment, by which time the susceptible biotype had stopped metabolizing.

Changes in the incorporation of ^{14}C -labeled acetate into fatty acids in plants treated with a sublethal dose (0.16 kg/ha) of diclofop-methyl were determined in a time course experiment. Acetate incorporation was initially inhibited in all biotypes (50% in the susceptible and 65 to 70% in the resistant biotypes) followed by a recovery to normal untreated levels 2 days after treatment. After a crude purification of acetyl CoA carboxylase from leaf tissue, incorporation of ^{14}C labeled sodium bicarbonate by the enzyme was determined at several concentrations of diclofop acid or fenoxaprop acid. For diclofop, the I_{50} dose was 5.1 μM for the susceptible biotype and 15 μM for each of the two resistant biotypes (a resistance ratio of 3:1). At the whole plant level, the resistance ratio is 17:1 for the B biotype and 23:1 for the C biotype. For fenoxaprop, the I_{50} dose was 2.3 μM for the susceptible biotype, 2.5 μM for the B biotype and 6.8 μM for the C biotype (a resistance ratio of 3:1). At the whole plant level, the resistance ratio is 3:1 for the B biotype and 47:1 for the C biotype.

The results of the enzyme assays of acetyl CoA carboxylase extracted from the susceptible and resistant biotypes mirrored the whole plant responses to both diclofop and fenoxaprop. However, the resistant biotypes were not as sensitive in the whole plant studies. The discrepancy in the resistance ratios may be due to the hexaploid nature of wild oat. It may be that only one pair of the acetyl CoA carboxylase alleles is resistant in the resistant plants leaving perhaps 66% of the total acetyl CoA carboxylase enzymes susceptible. In the greenhouse, the B biotype can be killed by 10 kg/ha rates of diclofop, but the C biotype will survive applications of the undiluted formulation of diclofop (>50 kg/ha).

At the highest dose tested (100 μM diclofop acid), the acetyl CoA carboxylase from the B and C biotypes was two and three times as active as the susceptible biotype, which was inhibited 95%. The C biotype is also highly resistant to fenoxaprop and at the highest dose tested in the enzyme assay the C biotype had 3 times the enzyme activity as the susceptible. In both the enzyme assay and at the whole plant level, the B biotype was slightly more resistant than the susceptible biotype. The two resistant biotypes of wild oat, which have differing levels of resistance to diclofop-methyl and cross-resistance to other aryloxyphenoxy herbicides at the whole plant level, were found to have a similar pattern of resistance and cross-resistance to diclofop and fenoxaprop at the enzyme level.

EFFECT OF TRIALLATE ON EPICUTICULAR WAX DEPOSITION IN RESISTANT AND

SUSCEPTIBLE WILD OATS (*Avena fatua* L.). Anthony J. Kern¹, Larry L. Jackson², and William E. Dyer¹, Graduate Research Assistant, Professor, Associate Professor, ¹Department of Plant, Soil and Environmental Science, ²Department of Biochemistry, Montana State University, Bozeman, MT 59717-0312.

Abstract. A well-known symptom of triallate treatment is the inhibition of epicuticular wax deposition on new leaves. Because previous studies investigating this effect have yielded contradictory results in various species, we are using a combination of gas chromatography (GC) and mass spectrometry to quantify and identify major wax constituents in wild type and triallate-resistant wild oats. GC analysis indicates that epicuticular wax in both susceptible and resistant wild oat accessions consists predominantly (>95%) of a C₂₆ primary alcohol. To determine the effects of triallate on new wax synthesis and deposition, it was necessary to apply the herbicide to seedlings. Eight-day old plants (4 cm tall) were treated with 0.1 kg/ha formulated triallate using a belt sprayer. After 6 days, treated leaves clearly showed a "pinching" or constriction about half way up the leaf, marking the boundary between leaf before treatment (above the pinch) and after treatment (below the pinch). It was thus possible to determine wax deposition on the same leaf before and after treatment. Each leaf section was excised, weighed, and dipped in hexane for 1 sec x 10 to extract surface waxes. Treatment with triallate caused a 75% reduction in deposition of the C₂₆ primary alcohol wax in susceptible accessions, while inhibition in resistant accessions was only about 10%. Although the results indicate that wax deposition is not appreciably inhibited in resistant accessions, they do not distinguish between two possibilities: 1) the fatty acid elongases responsible for wax biosynthesis in resistant accessions are insensitive to triallate inhibition, or 2) resistant accessions are metabolizing triallate to inactive forms. We are currently quantifying the effects of triallate on *de novo* synthesis of the fatty acid precursors of surface waxes and examining triallate metabolism patterns to gain additional insight into the mechanism(s) of resistance.

REGULATION OF SEED DORMANCY BY GIBBERELIC ACID IN WILD OAT (*Avena fatua* L.).

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Abstract. The mechanisms regulating seed dormancy are poorly understood, but previous studies have suggested that the release of dormancy is controlled by specific genes in response to environmental cues. In particular, release of gibberellic acid (GA) by imbibing nondormant embryos is thought to play a key role in germination induction. Since exogenous applications of GA break dormancy in seeds of a number of species including *A. fatua*, GA-induced germination is hypothesized to be identical to physiologically normal germination as it occurs in nondormant seeds. We used clones corresponding to *A. fatua* genes that are preferentially expressed in either dormant or nondormant embryos during early imbibition to test this hypothesis. Specifically, we compared expression patterns in dormant and nondormant seeds imbibed either in water or 1mM GA₃. Expression of clones AFN1, AFN2 and AFN3 was not markedly changed by GA treatment. However, the expression pattern of clone AFD2 in dormant embryos induced to germinate by GA treatment was very similar to that of nondormant embryos, suggesting that elimination of AFD2 mRNA may be required for germination. The overall lack of correlation between GA-imbibed dormant embryos and water-imbibed nondormant embryos suggests that GA-induced germination may not be physiologically identical to "normal" germination of nondormant seeds.

TRIALATE SULFOXIDE: CHEMICAL SYNTHESIS AND IN VIVO SENSITIVITY OF SUSCEPTIBLE AND TRIALLATE-RESISTANT WILD OATS (*Avena fatua* L.). Erica K. Miller, Anthony J. Kern, Dwight M. Peterson, and William E. Dyer. Undergraduate Student, Graduate Research Assistant, Postdoctoral Research Associate, and Associate Professor, Department of Plant, Soil and Environmental Sciences, Montana State University, Bozeman, MT 59717-0312.

Abstract. Continuous use of triallate in several areas of the United States and Canada has selected for resistant wild oat populations. We have preliminary evidence that triallate metabolism is altered in resistant wild oats as compared to susceptible types. Further, we hypothesize that resistance is based on a lack of herbicide sulfoxidation (activation) in resistant plants. Therefore, we have developed methods to synthesize the triallate sulfoxide in order to test its relative activity in resistant and susceptible plants. ¹⁴C triallate was reacted with equimolar m-chloroperoxybenzoic acid in 95% ethanol at 0 C for 24 h. Purity of the resulting triallate sulfoxide was confirmed by HPLC analysis after which it was diluted into 0.1X Murashige and Skoog minimal salts medium containing 0.25% nonionic surfactant (incubation medium). Shoots of four-day old resistant and susceptible wild oat seedlings were excised and incubated in 40 µl incubation medium for 20 min, after which they were transferred to triallate-free medium. Shoots were harvested after 2 or 6 h, and extracted in 60% acetone. Extracts were analyzed for triallate metabolite profiles using HPLC and radioisotope detection. The results will help pinpoint the physiological mechanism(s) responsible for triallate resistance in wild oats.

ALTERNATIVE METHODS OF WEED CONTROL

INTEGRATION OF HERBICIDES WITH GRAZING FOR LEAFY SPURGE CONTROL. Rodney G. Lym, Donald R. Kirby, and Kevin K. Sedivec, Professor, Plant Sciences Department, and Professor and Rangeland Management Specialist, Animal and Range Sciences Department, North Dakota State University, Fargo, ND 58105.

Abstract. An experiment to evaluate herbicide treatment with grazing to improve long-term leafy spurge control compared to either control method alone was established in May 1992 on the Sheyenne National Grasslands and the Gilbert C. Grafton South State Military Reservation. The six treatments included a) grazing alone, b) picloram plus 2,4-D at 0.5 plus 1 lb/A fall applied, c) grazing in spring followed by picloram plus 2,4-D at 0.5 plus 1 lb/A fall applied, d) picloram plus 2,4-D at 0.25 plus 1 lb/A spring applied, e) picloram plus 2,4-D at 0.25 plus 1 lb/A spring applied followed by grazing of fall regrowth, and f) an untreated control. Leafy spurge was rotationally grazed at the Sheyenne National Grasslands but grazed season-long at Camp Grafton South.

The fencing necessary to prevent or delay grazing was established in May 1992 and leafy spurge density evaluated. The herbicides were applied in June or September in 1992 and 1993 for the spring- and fall-applied treatments, respectively. Leafy spurge root material for carbohydrate and protein content analyses was harvested in October 1992 and 1993.

Grazing combined with fall-applied herbicide treatment reduced leafy spurge density more than grazing alone. Also, season-long grazing as used on Camp Grafton South, either alone or combined with herbicides, reduced leafy spurge more than rotational grazing used on the Sheyenne National Grasslands. The best treatments averaged over both locations was picloram plus 2,4-D applied in the fall alone or preceded by spring grazing. These treatments reduced the stem density from an average of 16 stems/0.25 m² in 1992 to 0.3 stem/0.25 m² or 99% control in 1994.

Grazing alone reduced leafy spurge 74% at Camp Grafton South but had no effect at the Sheyenne National Grasslands. The difference in control is likely due to the type of grazing management. Continuous season-long grazing prevents the plant from restoring root nutrients because they are needed to restore topgrowth. However, rotational grazing apparently encourages bud growth from the roots after the first grazing cycle and without immediate re-grazing, sustains a stem density similar to the untreated control.

Picloram plus 2,4-D spring-applied provided 96% control at Camp Grafton South, but only 62% control at the Sheyenne Grasslands after two treatments. The average control with picloram plus 2,4-D at 0.25 plus 1 lb/A for many experiments in North Dakota is 65% after two treatments. A spring-applied herbicide treatment followed by fall grazing increased leafy spurge density at Camp Grafton South slightly compared to the herbicides applied alone. At the Sheyenne National Grasslands the stem density increased from an average of 10 to 16 stems/0.25 m² when spring applied herbicides were followed by fall grazing compared to the herbicides used alone. The reason for the increase in leafy spurge density when leafy spurge is grazed following a herbicide treatment is not known.

The effect of grazing and herbicide treatments alone or in combination on leafy spurge root nutrient content was minimal. All treatments reduced the root protein content at Camp Grafton South compared to the untreated control. The sucrose concentration in leafy spurge roots was similar regardless of treatment. However, the starch concentration declined by 60% in the grazed only and spring grazing followed by picloram plus 2,4-D fall-applied treatments compared to the control.

The sucrose and starch concentration in leafy spurge roots at the Sheyenne National Grasslands in 1993 after two growing seasons was similar regardless of treatment. However, the protein content was reduced by 67% in the grazed only treatment compared to the control even though stem density was high in the grazed plots. No other treatment affected root protein content at the Sheyenne National Grasslands after 3 years.

In summary, season-long grazing by goats reduced leafy spurge stand density but rotational grazing had no effect. Picloram plus 2,4-D applied in the fall alone or following grazing in spring were the best treatments averaged over location and resulted in 98% leafy spurge control. However, the effect on root nutrient content was inconsistent.

A MECHANISTIC APPROACH TO DEVELOPING WEED-RESISTANT CROPS. Milton E. McGiffen, Jr., B. S. Saharan, and E. J. Ogbuchiekwe, Extension Specialist, Visiting Professor, and Staff Research Associate, University of California, Riverside, CA 92521-0124; R. J. Mullen, Farm Advisor, University of California Cooperative Extension, Stockton, CA 95205; and G. Miyao, Farm Advisor, University of California Cooperative Extension, Woodland, CA 95695.

Abstract. Several studies have shown that crop cultivars differ in competitive ability with weeds. However, few studies have worked with the mechanisms of competition to develop new varieties that are resistant to weed interference. An excellent test crop for this approach is tomato. Tomatoes are grown in most parts of the world and can be adapted to a wide range of cropping systems. There is tremendous diversity in the wild species that are used in tomato breeding programs, and the mechanisms of tomato competition have been studied with a wide range of weeds. We examined canopy structure, leaf growth rates, and other potential sources of competitive advantage that may be selected for in breeding programs. The varieties widely used in California rapidly form a dense canopy. Midwestern cultivars have been bred for foliar disease resistance in a humid climate and have a more open canopy. Replacement series experiments with selected cultivars found that weeds whose canopies are above or below the crop tend to avoid competition. The greatest varietal differences in competitiveness were when the weed species had a canopy structure similar to tomatoes.

DEEP PLOWING FOR YELLOW NUTSEDGE CONTROL. Kurt J. Hembree and Timothy S. Prather, Staff Research Associate and Regional IPM Specialist, Statewide Integrated Pest Management Project, University of California Cooperative Extension, Kearney Agricultural Center, Parlier, CA 93648.

Abstract. Yellow nutsedge is a troublesome perennial weed in California. Control from herbicide application is not always sufficient to prevent serious yield losses. Burying tubers can result in high tuber mortality (80%) but it is difficult to bury tubers with most conventional equipment. A modified moldboard plow, the Kverneland plow, was designed to invert the soil profile to the plowing depth. This study was conducted to contrast the effectiveness of a moldboard and a Kverneland plow at burying yellow nutsedge tubers and preventing yellow nutsedge plants from emerging.

A field was selected that had a history of severe yellow nutsedge infestations. Plots were established on flat ground and were 14 m-wide, running the length of the field. Soil samples were collected from the plots on June 2, 1993 at three depths: 2 to 8 cm, 15 to 20 cm, and 25 to 30 cm. The samples were sieved through a screen mesh and the number of tubers were counted. The plots were plowed to a depth of 30 cm on June 2 and 3 and beds were listed. The plots were sampled again on July 12 from the center of the beds along the same transects and the tubers were counted. Emerged yellow nutsedge plants were counted on June 23, 21 days after plowing when plants were at the 2- to 5-leaf stage. Yellow nutsedge plant densities were counted on the bed tops and in the furrows. Changes in tuber numbers after plowing were tested using a general linear model procedure and means were separated using a least squares means procedure with $p=0.05$. Differences in plant densities in furrows or on beds, resulting from plow type, were tested using a general linear model procedure and means were separated using the LSD test with $p=0.05$.

Yellow nutsedge tubers were buried effectively with the Kverneland plow. At the shallow depth, 11.5 tubers (82%) per liter of soil were buried deeper in the soil profile. Although the middle level showed a 33% (1.3 tubers/liter of soil) decrease, it was not statistically significant. The number of tubers increased at the lowest depth by 500% (5.1 tubers/liter of soil). The moldboard plow was not effective at burying nutsedge tubers. There was a 17% decrease at the upper depth, and a 25% and 50% increase in numbers of tubers in the middle and lowest depths, respectively. Yellow nutsedge plant counts compared well with the distribution changes of tubers in the soil. There were 56% fewer yellow nutsedge plants on bed tops of the Kverneland plowed plots than the moldboard treatment, 43 versus 97 plants m⁻², respectively. Densities of yellow nutsedge plants in the furrows were not significantly different between the treatments. Yellow nutsedge tuber mortality was 93% at the lowest sampling depth in the Kverneland plow treatment, one year following plowing. The moldboard plow had little effect on tuber distribution in the soil profile. The Kverneland plow was effective, burying yellow nutsedge tubers below 23 cm.

MECHANICAL WEED CONTROL IN FLAX AND LENTILS WITH ROTARY HOEING AND HARROWING. Jerry D. Harris and Pat M. Carr, Research Associate and Adjunct Assistant Professor, Central Agricultural Research Center, Moccasin, MT 59462, and Dickinson Research and Extension Center, Dickinson, ND 58602.

Abstract. Production of flax and lentils is limited by the lack of available and effective herbicides. Successful weed control strategies using reduced or non-chemical methods could reduce chemical costs and increase the profitability of flax and lentil production. Field studies were conducted at Dickinson, North Dakota in 1993 and 1994, and at Moccasin, Montana in 1994 to determine the effect of rotary hoeing and harrowing on crop and weed yields in lentils and flax. Treatments included rotary hoeing, (once with herbicides, once without herbicides, twice without herbicides) harrowing, (once with herbicides, once without herbicides, twice without herbicides), a herbicide application without hoeing or harrowing, and a weedy check. A weed free check was included at Moccasin and the herbicide-tillage combination treatments were excluded.

At Moccasin, weed control and grain yield were similar among all treatments except the weed free check. The weed free check out yielded all other treatments by 30 to 50%. The two harrowing decreased lentil plant counts whereas tillage had no effect on flax plant counts.

At Dickinson, tillage increased yield compared to the weedy check in both crops. Flax yields from rotary hoe treatments were comparable to yields produced when herbicides were used. Broadleaf weeds were reduced by as much as 50% by tillage, whereas grassy weeds were not affected.

REFITTING TWO FAMILIAR TOOLS: ACTIVATED CHARCOAL BANDING AND PROPANE FLAMING. R. E. Peachey, R. D. William, and G. Crabtree, Research Assistant, Extension Weed Control Specialist, and Professor, Department of Horticulture, Oregon State University, Corvallis, OR 97330.

Abstract. Diminishing herbicide options for weed control in vegetable production have stimulated grower and processor interest in developing alternative weed control strategies, including activated charcoal protectants for increasing crop safety with preemergence herbicides and selective flaming for in-row weed control. Though these tools have often been explored in the past, current trends necessitate a new look at applications. Our research has focused on two opportunities. In cucurbits, the loss of chloramben has caused considerable difficulty in weed control, while in sweet corn the search for alternatives has been spurred on by the developing tolerance of pigweed to atrazine and the unsure position of atrazine in the future market. Therefore, the objectives of this research were: 1) to determine the tolerance of three cucurbit crops when applying

metolachlor, dimethenamid, and lactofen broadcast and preemergence with activated charcoal as a seed protectant banded over the row; and 2) to evaluate the tolerance of sweet corn to flaming at various stages of growth and the effectiveness of propane flaming to control in-row weeds.

Three years of experiments have tested the effectiveness of a 2-inch band of activated charcoal over the seed row to protect cucumbers, zucchini, and processing squash from broadcast preemergence herbicides. Finely ground activated charcoal was applied in a slurry of 60 g activated charcoal/L of water with 8006 nozzles operating at 30 psi. In 1991 through 1993 metolachlor and lactofen were applied preemergence and incorporated with irrigation water shortly after planting. In 1994 dimethenamid also was tested in an early and late planting on a sandy loam and silty clay loam soil. Activated charcoal provided good protection for all three crops at the 1X rate for all three herbicides. Some injury from dimethenamid was noted at 4 lb/A for cucumbers but only slightly reduced yields. Zucchini was very sensitive to lactofen while squash tolerated all three herbicides, even without the protectant. Weed control was excellent between rows and averaged approximately 70% control within rows. A survey of squash growers indicated that approximately 50% would consider using this technology under current conditions.

Selective flaming in sweet corn has potential because the growing point remains below the soil surface for an extended period and is protected by leaf and stem tissue. The expense of propane flaming limits use as a broadcast treatment but may be cost effective for in-row weed control. The objective of our research was to determine tolerance of sweet corn to propane flaming with variables of timing, application rate, and number of applications. The flame was directed from both sides of the row at 45 degrees from horizontal to cover an 8 inch band encompassing the crop row. The flame dispensers were mounted on skids such as used for directed herbicide application with a tractor speed of 3 mph. The burners were constructed by growers who are using this technology on field corn in Wisconsin.

Sweet corn was very tolerant of flaming, even when leaf burn was readily visible and at very high temperatures. However, there was little advantage to flaming the sweet corn when less than 6 inches tall because the application rate needed to kill weeds was more than the corn could tolerate. The most effective strategy was hilling at 4 to 6 inches with two or three passes at 10 through 24 inches in height. A rule of thumb at this speed and orientation was 1 pound of propane per inch of growth. Even 20 psi did not effect corn growth when applied at 24 inches of growth. With two appropriately timed applications at proper rates, weed biomass at 6 wap was reduced by as much as 80% compared to adjacent, unflamed rows. Weed control for the full season was adequate in some cases.

Table 1. Response of cucumbers to preemergence herbicides and activated charcoal, 1994.

Herbicide	Rate	Charcoal	Crop injury			Crop yield		
			Cucumbers	Zucchini	Processing squash	Cucumbers ^a	Zucchini ^b	Processing squash
			%			T/A		
Metolachlor	2	+	0	0	0	10.4	5.8	28.4
Metolachlor	4	+	8	0	0	9.2	6.7	27.9
Dimethenamid	1.25	+	4	5	3	10.3	7.8	25.1
Dimethenamid	1.25	-	63	10	3	8.3	5.7	23.5
Dimethenamid	2.5	+	4	0	0	8.7	5.5	25.1
Dimethenamid	2.5	-	89	0	46	2.2	5.2	19.1
Lactofen	0.125	+	18	23	2	10.2	5.6	25.1
Control	0	-	0	0	0	10.6	6.5	26.4
LSD (P=0.05)			15	12	23	4.9	NS	NS

^aData from first harvest only.

^bData from first four harvests only.

Table 2. Effect of propane flaming on weed biomass and sweet corn yield 6 weeks after planting, Corvallis, OR, 1994.

Plant height	Treatment		Weed biomass reduction	Sweet corn yield
	Application rate			
- inches -	gal/A		%	T/A
Unflamed, weeded			0	11.4
6	2.5		0	10.6
6	5		6	
6	1		48	10.7
10	5			
6	1		72	9.8
10	5			
16	10			
6	1		58	10.8
18	20			
10	5		47	12.3
10	5		80	11.1
16	10			
10	5		70	10.4
18	20			
16	20		68	10.6

RESEARCH PROJECT MEETINGS

PROJECT 1: WEEDS OF RANGE AND FOREST

Chairperson: Kirk McDaniel

Subject: Vegetation Change in the Great Basin Region and Economic Implications of the Endangered Species Act

Dr. Rick Miller, an ecophysiologicalist with the USDA-ARS at Squaw Butte, Oregon, presented an overview of geologic and botanical changes in the Great Basin region over the past 10,000 years. He pointed out that these plant communities have been very dynamic in the past, with significant climatic changes and physical disturbances (glacial, fire, volcanic, etc.) contributing to major shifts in plant community composition. Pollen, fossil and archeological records indicate changes back and forth between grass/forb dominated and shrub/tree dominated plant communities, with many open or unfilled niches. If exotic weedy species from Eurasia had been introduced naturally in some way prior to immigration by humans from the eastern hemisphere, there is no reason to believe they would not have become a part of Great Basin plant communities. However, they probably would not have dominated as they do now. Human-associated activities are believed to be the primary reason many of these exotic weed species have become a major element of some plant communities.

Dr. Miller said that the term "pristine" is misleading because it implies a single specific plant community for a given location. Plant communities in the Great Basin have been in a continual state of fluctuation and evolution for thousands of years, and there is no single combination of species and densities that could be called pristine. To characterize a "pristine" plant community would require the definition of a specific era with its associated climatic and physical conditions. He also said it is unrealistic to expect restoration of most Great Basin plant communities to their exact pre-1850 status. There has already been too much influence from human activities, and significant new variables (such as exotic noxious weeds) have been introduced.

A discussion followed, addressing questions about 1) specific factors responsible for modern increases in juniper and sagebrush incidence, 2) pros and cons of using prescribed burning as a method to restore forest and rangeland health, 3) the ideal sagebrush density in plant communities, 4) the likelihood of knapweeds spreading and becoming dominant in eastern Oregon, and 5) the philosophy of managing lands to achieve specific goals based on plant community potentials and intended use.

Dr. Allen Torell, an agricultural economist from New Mexico State University, presented results of a cost analysis study on protecting the Knowlton hedgehog cactus through the Endangered Species Act. He compared the potential economic impacts caused by disruption of oil and gas production, recreational opportunities, livestock operations, and weed control. Presently the cactus is found on a total of 12 A. The BLM is protecting the cactus by designating 4 sections (2560 A) as critical habit. U.S. Fish & Wildlife is proposing a much larger protection zone of 275 sections (176,000 A) to protect the cactus. The total value of economic practices and values that could be disrupted, including the added cost of weed control required by preclusion of herbicide use was compared for the two proposals. In the BLM proposal the value was \$842,900. In the U.S. Fish & Wildlife proposal the value was \$648,788,900. The increased costs associated with weed control operations alone were \$6,042 compared to \$493,234.

The main point of Dr. Torell's presentation was that much greater attention must be given to identifying the specific habitat requirements of endangered species, so that the size of protected areas can be reduced to the minimum amount needed to preserve the species. The local economic impacts of endangered species protection are significant, and minimizing those impacts should be an important consideration when determining the size of protection zones.

A lively discussion followed regarding pros and cons of the Endangered Species Act. It became apparent that there is considerable confusion on the topic, especially on exactly which activities and practices are prohibited or restricted in ESA protection zones.

The topics of "future research needs and priorities" and "possible funding sources" were scheduled for discussion, but there was not enough time.

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PROJECT 2: WEEDS OF HORTICULTURAL CROPS

Chairperson: Rick Arnold

Subject: EPA Worker protection Standards
Kay Rudolph, US-EPA, District 9, San Francisco
Steve Sutter, Farm Personnel Advisor, UC Cooperative Extension, Fresno, CA

Kay Rudolph began with a brief review of the EPA- Worker Protection Standards (WPS). She stated that the regulations currently in place cover registered pesticides, but not experimental chemicals. Provisions regarding Crop Advisors are in place, but were delayed until 1 January 1995. The revised standards exempt certain Crop Advisor activities, WPS only applies during or immediately after an application.

Steve Sutter continued, stating that research activities with registered pesticides are covered by WPS, there are no safety or training exemptions. Currently required field worker training, which would apply to field help in research projects, in California is similar to WPS. Research with non-registered chemicals must comply with US-OSHA regulations. Researchers are required to train and supervise all employees, including students. Researchers would be wise, in his opinion, to inform their supervisors (e.g. Deans, Extension Directors) of their activities and have the supervisor sign-off on training. Steve has training and compliance guides available from his office.

A number of questions came from the audience, the following are the responses from the panel.

How to get information on compliance. Guides are available from the EPA or Gemplers (a private safety catalog). See your local Agricultural Commissioner or County Agent. Pesticide labels now require information on personal protective equipment, and also discuss heat stress.

On decontamination facilities. The need for these relates to documented incidences of pesticide related illness being evident 30 days after exposure.

Will these rules be applied to ergonomics or work sites? EPA only deals with pesticide safety.

Are there exemptions for use of very small quantities, such as is common in research? No.

Subject: Transferring research results to end users.
Alan Bennett, Associate Dean for Plant Sciences, UC Davis
Jill Schroeder, Weed Scientist, New Mexico State University
Milt McGiffen, Extension Vegetable Specialist, UC Riverside
Carl E. Bell, Weed Science Farm Advisor, UCCE, Imperial County

Alan Bennett; Environmental and consumer interests are increasing, while budget cuts means fewer resources. The campus at UCD has been restructured to respond to these parameters. There are now four divisions; plant science, animal science, human health and development, environmental science and policy. These divisions are meant to foster work across departmental lines.

Jill Schroeder; Her assignment is research, not extension. She publishes an annual report of her research, but she feels the need to develop better communication with growers. The NMSU Chile Improvement Project is multi-disciplinary and includes new extension bulletins.

Milt McGiffen; He has a split assignment (CE/AES). But, there is little reward for doing extension work at his campus. He also feels grower needs are not being well addressed.

Carl Bell; He is an extension county agent with weed science assignment. He devotes the majority of his time to applied research.

According to Alan activities can be coordinated through new structures, such as the Vegetable Crop Research and Outreach Center at UCD. Jill and Milt discussed the traditional role of extension specialist. They feel this type of work is not being rewarded or considered for promotion, especially at UCR. The panel agreed that the end-user must be brought into the planning process for campus research. A general discussion ensued with the audience regarding this and related topics.

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PROJECT 3: WEEDS OF AGRONOMIC CROPS

Chairperson: Joan Campbell

There were no designated discussion leaders in the 56 participant discussion. Participants were asked to sit on the 'pro' or 'con' side of the room. A brief overview of the 'con' side of the subject was given to start the discussion.

Subject 1: Weed Thresholds: What Will They Do For Us?

Lively discussion erupted after a number of questions challenged basing weed management decisions on plant thresholds. What are thresholds based upon; number of plants or seeds? How do we sample for seeds or count plants? If only one plant produces seed, the threshold is probably exceeded after one year. How does seed dormancy enter the picture? How will plasticity be accounted: size, competitiveness, fecundity, dormancy of species? Multispecies effects such as weeds competing with weeds needs to be determined. Zero tolerance is the best way to have a positive effect. Following are some of the responses.

Threshold or zero tolerance varies with species and persistence/dormancy of the species. If an area is already infested, then it probably won't make sense economically to control it. Control a newly introduced species at all cost. The short term economics must be considered.

Economics in Scotland didn't justify scouting. Thresholds may also affect subsequent crops in rotation. Weed contamination effects on seed quality must be considered. Often weed seed is planted as even certified seed is not weed free.

Long term economic threshold doesn't mean anything to absentee landlords. Most growers practice zero tolerance, but they need to own the land.

The political dimension is that IPM principles, which have been developed by entomologists, don't always hold for weeds.

Consensus: The concept of zero tolerance is the ideal, but this will vary by crop, market value, ownership/tenant, and situation. It is more practical to practice zero tolerance against a new species, and economic thresholds are more realistic against an existing species. Someone must pay for long-term zero tolerance. Renters won't do it.

Subject 2: Do We Need Aerial Application of Herbicides?

The topic was introduced with reasons for eliminating aerial application. Aerial application produces a large distribution of droplet size, the spray is released too far from the target, prop wash and wing vortices affect terminal velocity and increase time for droplet to reach target. Technologies like shrouded booms, air assisted nozzles and booms, and floatation vehicles should replace aerial application. Active ingredients are more sensitive than in the past. Applicators are certified but planes are not. There is a problem with public perception: planes are more visible, people wonder if they are leaking, perceived risk is high -- will they crash? Participant comments follow:

No participants expressed support for the prohibition of aerial application. Many examples were cited where aerial application is essential.

Drift from aerial application is not a product problem, all active ingredients drift alike. Drift from herbicide is more visible than drift from insecticide or fungicide.

Regulation probably has prolonged the availability and use of some products/uses.

Aerial applicators tend to be pilots first and biologist second. They must have better training.

There is a need for better understanding of meteorological principles and conditions where drift is likely. Most aerial application is done late evening/early morning; those are the same times probability of inversion is highest. An understanding of equipment limitations due to weather needs to be communicated to regulators.

Weed scientists need to have more interaction with aerial applicators concerning herbicide education and drift potential. Many problems with aerial application are due to bad decisions in application. Applicators want to know the sensitivity of crops to herbicide in addition to the sensitivity of weeds.

Consensus: Promote standards of professionalism and don't push a negative perception. We must provide the data to support and defend the need and safety of aerial application.

Subject 3: Agenda For The Future

One focus across the entire western region should be managing to prevent the loss of existing tools and technology. Research needs to take a systems versus component approach. We need to practice/emphasize education and preventative weed control. We must actually communicate with the public and the government instead of just talking about it. Emphasize where weeds hit the taxpayer in the pocket. In the west, federal lands are perceived as the major harbor of weeds which are not being controlled because of lack of funding. Economic impact assessments are needed.

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PROJECT 4: EXTENSION, EDUCATION, AND REGULATORY

Chairperson: Richard K. Zollinger

Subject: Herbicide Registration, Research and Recommendations in Minor Use Crops

Four panel members were invited to take about five minutes to discuss the topics chosen for the discussion session. The panel members were Dr. Robert Parker, Extension Weed Specialist, Washington State University; Dr. Tom Lanini, Extension Weed Specialist, University of California, Davis; Mr. Rick Melnicoe, IR-4/PIAP Western Region, University of California, Davis; and Dr. George Fuller, Monsanto Agricultural Company, St. Louis, Missouri.

The topics of discussion were:

Subject 1: Extension Recommendations for Weed Control in Minor Use Crops.

Subject 2: Development of a Research Base on Weed Control in Minor Use Crops.

Subject 3: IR-4 Progress Toward Herbicide Registration in Minor Use Crops.

Subject 4: Industry Views on Herbicide Registration on Minor Use Crops.

Subject 5: Agenda for the future, Research Needs and Objectives, Funding Sources, and Priorities.

The session was positioned with opening remarks that the process of herbicide re-registration has had, and will continue to have a major impact on the "minor crops" production process. Questions posed were, How do we deal with this and how can we help the process in order to maintain the production tools available to our producers? How can we help producers in our states with their "minor crops" herbicide needs so they can have the tools they need now and won't have to consider using a herbicide that is not currently registered for the considered crop?

Dr. Robert Parker suggested several ways in dealing with weed management options available in any particular state. When requests are received for assistance in identifying those herbicides labeled for a minor crop, the crop should be identified correctly, state references for both in state and surrounding states should be checked for ideas, and other management tools should be considered, such as cultivation, rotation, etc.

An important point was made that it would be a good idea to share weed management ideas and publications from one state to another, thus providing some form of a data base for management ideas in minor crops.

Dr. Tom Lanini made a strong plea for electronic based delivery of information regarding the minor crops issue - label development, management options and research ideas. He pointed out the need to share ideas and needs in order to understand where the information gaps are.

Points to remember about research needs are: limited herbicide availability, consideration of all available management options (biological, flaming, irrigation practices, cultural, etc.), availability of herbicide registrations (Third Party Registration, Waiver of Liability, etc), and cost/benefits of weed management options.

Mr. Rick Melnicoe pointed out that IR-4, working with individual chemical companies, develop the tolerance for a particular herbicide in a particular commodity, then the company uses that information to develop a label. The major effort of the IR-4 program, currently, is the re-registration of pesticides.

Dr. George Fuller emphasized that the "cost/return" numbers is what drives the registration of a herbicide in the minor crop arena. Costs to develop and maintain the label and liability associated with the use of the particular herbicide are other factors which might influence a company in deciding to label a herbicide on a minor use crop. The "ADI" (allowable daily intake) is also a point of consideration for many herbicides.

Discussion comments and ideas:

When dealing with minor crop production, it is important to consider the "organic producers" needs. It was stressed that they must not be left out of the loop of consideration.

It was stressed that we need to be aware of the "smaller" companies that may be able to assist with the development of labels for herbicides which have been dropped by major companies. The dollars available may be small, but they may be willing to work in developing a label for a specific crop or situation. This illustrated the need to be more familiar with Third Party Registrations, Waivers of Liability, etc.

A major concern associated with the development of data for minor crop registration is the "GLP" requirements. These requirements account for 40% of the costs and make it difficult to attract researchers to do the work. Limited dollars for the IR-4 grants was also pointed out, but with the projects requested and the dollars available the decision can be to either fund fewer projects with more dollars or fund more projects with fewer dollars. This has been and will continue to be an area of concern for both IR-4 and the minor crop program.

The importance of using the correct labeled herbicide for the management of weeds was strongly recommended. Several examples were given of herbicides having cropland and noncropland registrations under different trade names, or two products labeled on cropland but a cheaper product is labeled for a major crop like soybeans and the more expensive product is labeled on the minor use crops. It was stressed that using a non-labeled product on a minor use crop, even though the active ingredient is labeled on that crop under a product with different tradename is an illegal application and should not be used or recommended. Use of an illegal herbicide may jeopardize the continuation of herbicides registered in minor crops and be justification for labeled herbicides to be discontinued and the registration dropped for that crop.

Some ideas to consider were to stress the importance of the Research and Progress Reports of the WSWS. It is a good avenue for sharing of research information. Not only does it identify the work that is being done, it also identifies the researcher doing the work. We need to work more at getting our minor crop researchers aware of the need to make their data and research ideas available.

It was recommended for the development of a regional "Specialty Crops Handbook".

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PROJECT 5: WEEDS OF AQUATIC, INDUSTRIAL, & NON-CROP AREAS

Chairperson: Barbra Mullin

Subject 1: Aquatic Vegetation Management Benefits to Fish & Wildlife

Terry McNabb, of Resource Management, Inc., and Joel Trumbo, California Department of Fish & Game, gave overviews of programs that have successfully managed aquatic and riparian vegetation for optimum habitat, flood control, and channel maintenance. Discussion centered around the need for more tools for control - including cultural, biological, and chemical - and the need to encourage public awareness of the problem. It was noted that examples of groups working together in a cooperative fashion that have been effective generally focus on one weed specie (i.e. - *Spartina* in Washington). Groups and programs that are impacted include: marina owners, mosquito abatement districts, flood control programs, fisheries, recreationists, and resource managers.

Subject 2: Development of Exotic Pest Plant Councils (EPPCs)

Nelroy Jackson, of Monsanto Company, and John Randall, of the Nature Conservancy, discussed the CalEPPC and the development of a national EPPC. EPPCs serve as advocacy groups that provide action to combat exotic species. CalEPPC has gained a large number of members since its formation and had over 250 people at its 1994 annual meeting.

There is no formal national group yet, but a Washington, D.C. level position is currently supported by the Florida EPPC and filled by Faith Campbell. They are working on changes in the Federal Noxious Weed Act and an increase in biological control research. There was a suggestion that WSWS and regional EPPCs might work together to sponsor a joint symposium. The potential topic was not well defined.

Ron Crockett of the Monsanto Company discussed the formation and activities of the Pacific Northwest EPPC. It is just getting a good start and has about 50 members. They sponsored a symposium on purple loosestrife at their February 1995 annual meeting.

How Can EPPC's, WSWS, and FICMNEW¹ Work Together: Janette Kaiser, with the USFS Washington Office, explained that a federal working group has organized to develop a coalition to address research and management of noxious, exotic, invasive, and poisonous weeds on Native American and Federal natural resource lands. Memorandum of Understanding was signed by the directors of 17 federal natural resource management agencies. This group has a number of working committees and welcomes input from other organizations. There was discussion on how all of these groups may be able to communicate and work together for good, effective weed control.

Research Needs for Weeds of Aquatic, Industrial, & Non-Crop Areas: Barbra Mullin, Project 5 Chairperson, led this discussion. It was a natural extension from the previous topics. Issues discussed included: 1) the need to coordinate integrated management plans to use all tools and resources to best utilize limited control dollars [the importance of developing state MOU's was discussed here] and 2) the need to identify impacts of weeds to translate to the public and administrators the need for weed management program funding. It was noted that the spotted owl has a lot of clout. Selling weeds is a marketing issue.

Actual needs to be addressed in developing an impact statement include:

- 1) Develop data on the invasion potential of weed species
 - study the ecology of weed species
 - possibly focus on one or two species to start with
 - use current imagery techniques

¹Federal Interdepartmental Committee for the Management of Noxious and Exotic Weeds

- 2) Outline needed research. Many of the controls that are effective have been identified, but additional research is needed in the areas of habitat restoration.
 - again, learn more about the ecology of the area
 - What may come back after control?
 - What may be the best vegetation for the area, based on use?
- 3) Long-term maintenance is critical, possibly use other funding sources as examples of the type of funding needed (flood water funding, clean water program, the fire model)
- 4) Information is needed on the weed threat to wildlife, wildlife habitat, and threatened and endangered species.
 - This would need to be specific studies on specific weeds in specific areas.
- 5) Possibly tie much of this information to wildlife and diversity issues.

1996 Officers of Project 5:

Chairperson: Bob Callihan
 PSES Dept./U of Idaho
 Moscow, ID 83843
 (208) 885-6617

Chairperson-elect: Nelroy Jackson
 Monsanto Company
 400 S. Ramona Ave. #212
 Corona, CA 91719
 (909) 279-7787

PROJECT 6: BASIC SCIENCES

Chairperson: Carol Mallory-Smith

Subject: Weed Science in Multidisciplinary Research Projects

Jill Schroeder, New Mexico State University, and Tim Prather, University of California Statewide IPM Project, led the discussion section for Basic Sciences. The first area of discussion was centered on multidisciplinary research projects and ways to make them more successful. Jill is involved with a project in chile production that includes a nematologist and a statistician, and is funded by a national competitive grant. Tim is the only weed scientist on a statewide IPM team. He works on several multidisciplinary projects. One project "Russian Thistle, Bugs, and Dust" deals with air quality regulations and how they impact other components of the system including insect and weed control.

From the ensuing discussion, the following recommendations to improve multidisciplinary research and team building emerged.

1. Researchers need to limit preconceived ideas. It takes time and commitment to build communication and trust between team members. Ownership of the project needs to be shared by all team members.
2. Researchers need to set the ground rules early. This is especially true since different disciplines have different expectations of research design and outcomes. Each team member must understand the responsibilities and obligations to the project. Make sure all team members are committed to completion of the project. Before the project starts decide upon authorship of publications.
3. Meet often to discuss progress and problems encountered. It is important to reexamine and redefine goals as the project proceeds. Name a meeting facilitator and have assignments to complete by the next meeting.
4. An administrator outside of the project can be important especially on a large project. This helps improve relationships between researchers since none of the principal investigators is in charge. An administrator can coordinate research and evaluate progress and quality of the project.

5. Multidisciplinary projects are expensive. It is important to have the level of funding required to successfully complete the project.

The second area of discussion was how to establish weed science as a component of Integrated Pest Management (IPM) in the eyes of other disciplines and within the national IPM initiative. Many, if not most, of the discussion participants felt that weed science as a discipline is not been well represented within the national IPM initiative and that funding for weed scientists has been limited at least in part by the review process for regional grants. One suggestion for action was to become more involved with the Western Regional IPM granting process and contact experiment station directors with concerns.

1996 Officers of Project 6:

Chairperson: Pat Fuerst
Washington State Univ.
Pullman, WA 99164
(509) 335-7484

Chairperson-elect: Mary Guttieri
University of Idaho
Aberdeen, ID 83210
(208) 397-4181

PROJECT 7: ALTERNATIVE METHODS OF WEED CONTROL

Chairperson: Bruce Maxwell

Subject: The Use of Crops to Manage Weeds

Approximately 40 people attended Project 7 and participated in the discussion of this topic. Dr. Matt Liebman, University of Maine, gave a short presentation on his research to manage weeds by using integrated cropping system.

Several weed control strategies may evolve from improving the efficacy of conventional inputs, substituting more benign inputs, and redesigning the agricultural system to better fit the ecosystem. Strategies tested in Dr. Liebman's research included rotational crops, green manure crops, cover crops, and tillage.

Crop rotation and nutrients source effects crop/weed interactions. Testing different cropping system shows that interaction between weed and crop depends on soil nitrogen. Green manure crop (clover) planted before corn increased corn yield and decreased weeds. This response may be attributed to the effect of green manure crop on soil nitrogen and allelopathic compounds produced by green manure crops. Dr. Liebman also discussed his work that involves developing integrated weed management systems in potatoes. Good weed control and high yields were obtained by using proper tillage practices, cover crops, two cultivation and two hilling operations.

Discussion following Dr. Liebman's introductory talk was focused on several topics:

- 1) What is, or what should be the objective of integrated weed management systems? It is a system to sustain rather than maximize yield or labor efficiency. This objective may be (and in some cases is) acceptable by some producers who want to reduce or eliminate pesticide use.
- 2) The point was made that integrated cropping systems are site specific and cannot be generalized to different environmental and soil conditions. Therefore, we as scientists and extension specialists must orient our research and technology transfer to developing an understanding of how systems work in a general sense rather than development of specific prescriptions for weed management, so that the producers are left with applying the technologies to their specific conditions.
- 3) It is difficult to quantify short-term economic benefits from more complex rotational systems, however, there seems to be increasing interest by growers to use these systems because of perceived long-term benefits.

4) High skills and management are needed to adapt these complex flexible rotation systems which creates the need to shift research direction and resources to develop integrated cropping systems and for us to determine the impact of the systems on weeds. Weed scientists need to be involved in the development of rotational systems. This may be accomplished by working more closely with soil scientists, plant breeders, ecologists, sociologists, and economist. Weed scientists also need to be creative in finding grant monies to support this kind of research.

5) An alternative perspective was raised that called for a simple solution to the problem (where the problem is defined as a need to decrease herbicide inputs). The solution offered, involved the use of the "perfect herbicide" that would be agreeable to the people that are promoting rotational cropping systems as part of an integrated weed management approach. The "perfect" herbicide could be used to remove all weeds allowing any cropping system including monocrops and thereby may be preferred by most farmers.

1996 Officers of Project 7:

Chairperson: Kassim Al-Khatib
Washington State Univ.
1468 Memorial Hwy.
Mt. Vernon, WA 98273-9788
(360) 424-6121
FAX (360) 428-1331

Chairperson-elect: Ed Peachy
Horticulture Dept.
Oregon State Univ.
Corvallis, OR 97331-7340
(503) 737-5442
FAX (503) 737-3479



1995 TO 1996 WESTERN SOCIETY OF WEED SCIENCE OFFICERS AND EXECUTIVE COMMITTEE

Seated (L to R): Tom Whitson, Immediate Past President; Jill Schroeder, Research Section Chairman; Wanda Graves, Treasurer/Business Manager; Barbra Mullin, Secretary; and Joan Campbell, Member-At-Large.

Standing (L to R): Gus Foster, President; Charlotte Eberlein, President-Elect; Paul Ogg, WSSA Representative; Kai Umeda, Education and Regulatory Chairman; and John O. Evans, CAST Representative.

MINUTES OF THE BUSINESS MEETING
WESTERN SOCIETY OF WEED SCIENCE
48TH ANNUAL BUSINESS MEETING
SACRAMENTO RED LION HOTEL
SACRAMENTO, CALIFORNIA
MARCH 16, 1995

The meeting was called to order by President Tom Whitson at 7:30 a.m. Minutes of the 1994 General Business Meeting were approved as printed in the 1994 WSWs Proceedings.

COMMITTEE REPORTS

Local Arrangements Committee. Mick Canevari

- a. A preconference tour was held that included viewing local agriculture and local wineries.

Program Committee. Gus Foster

- a. Program Committee members Rick Boydston and Stott Howard were commended for their efforts in putting together the program for the 1995 WSWs meeting.
- b. Breakdown of papers.
 1. General Section - 4 invited presentations including Presidential Address.
 2. Poster Section - 23 posters including 5 graduate student posters.
 3. Education and Regulatory Section - 6 invited presentations.
 4. Research Section - a total of 37 volunteered papers, 11 of which were entered in the graduate student paper competition.
- c. Special Discussion Session- Weed Science Discipline: Challenges and Issues for the Future
Donn Thill served as moderator for this special session on the future of weed science.
- d. Complimentary Sponsored Activities
Welcome/Retiree Reception - Monsanto
Special Discussion - American Cyanamid
Refreshment Breaks - Sandoz Agro.
Graduate Student Breakfast - Miles & Ciba Crop Protection
Spouse Breakfast - Zeneca Ag Products
WSWS Business Meeting - DowElanco

Research Section Committee. Rick Boydston

- a. The 1995 Research Progress Report was assembled in the same manner as in 1994.
- b. At the request of WSWs program chair Gus Foster, each project was asked to include a discussion on the future research needs and priorities in weed science, as per WSSA past president Alex Ogg's request of each regional society. The results of those discussions and will be summarized and forwarded to the WSSA.

Education and Regulatory Section Committee. Stott Howard

- a. Two sessions were planned in this section. The session topics were "Computer and Software Applications in Weed Science" and "Issues Influencing Herbicide Registration." Each session contained three presentations.

Treasurer-Business Manager. Wanda Graves

- a. 304 people registered for this years meeting compared to 301 on 1994. 240 pre-registered for the meeting. 28 graduate students and 6 spouses also registered.
- b. The current balance for the WSWs stands at \$206,840.10.

Finance Committee. Roland Shirman

- a. The finances of the WSWs were reviewed by the finance committee and a spot audit was conducted. The Society's current financial status is very favorable and documentation of all transactions is available.
- b. The committee wishes to thank the many individuals for helping keep our various projects in the black.
 1. John Orr was commended for keeping the Coeur d'Alene, Idaho meeting expenses below budget.
 2. Rod Lym and Steve Miller were commended for the editorial changes made in the proceedings and progress reports to keep the expenses low.

- c. The committee also reported on the commitment of WSWs dollars for the following expenses:

WSSA Congressional Science Fellow	\$2,000.00
Contribution to the WSSA for support of services from AESOP Enterprises, Ltd.	\$2,000.00
Production of a video titled "A Kid's Journey to Understanding Weeds"	\$1,000.00
Purchase of easels and display boards for future poster sessions	\$2,860.00

- d. The committee also wishes to acknowledge support of the sustaining members of the WSWs.

ABC Labs, Pan Ag Division
AgrEvo USA Company
American Cyanamid Co.
BASF Corporation
DuPont Ag Products
Ciba Crop Protection
DowElanco
FMC Corp.
ISK Biotech Corporation
Maratho-Agric Env Consulting
Miles, Inc.
Monsanto Agricultural Group
Pioneer Hi-Bred Int'l
R & D Sprayers
Rhone Poulenc Ag Company
Rohm and Haas Company
Sandoz Agro, Inc.
United Agri Products
Zeneca Ag Products

Past President. Doug Ryerson

- a. The WSWs Welcome and Retirees reception hosted by Monsanto Ag Products was a success.

Member-at-Large. Vanelle Carrithers

- a. The member-at-large was asked by Tom Whitson, WSWs President, to develop contacts with groups involved in weed management that otherwise are not typically involved with the WSWs. A representative from The Nature Conservancy, Exotic Pest Plant Council, California Dept. of Fish and Game, Bureau of Land Management and US Forest Service all attended the WSWs meeting.

CAST Representative. Jack Evans

- a. New CAST Vision and CAST Mission Statements were presented to the WSWs membership.
 1. CAST Vision Statement: On January 1 of the year 2000 legislators, regulators and the media consider the CAST the most credible interdisciplinary interpreter of scientific information about food and fiber, the environment, and other agricultural issues.
 2. CAST Mission Statement: CAST mission is to identify food and fiber, environmental and other agricultural issues and to interpret related scientific research information to legislatures, regulators and the media for use in public policy decision making.
- b. During 1994 CAST published 8 reports and sponsored a three day conference entitled "Sustainable Agriculture and the 1995 Farm Bill."

WSSA Representative. Paul Ogg

- a. New WSSA officers elected for 1995 are Cal Messersmith, Vice President and Ed Stoller, Member-at-Large. New board members from regional societies are Dallas Peterson, NCWSS and Paul J. Ogg, WSWs.

Fellows and Honorary Members Committee. Bart Brinkman.

- a. 1995 Fellows selected - Stephen D. Miller, University of Wyoming and Jack T. Schlesselman, Rhom and Haas Co.
- b. 1995 Honorary Member - K. James Fornstrom, University of Wyoming.

Nominations Committee. Paul Ogg

- a. Officers for the WSWs were selected from 143 ballots returned to the nominations committee.
 1. President-Elect - Charlotte Eberlein
 2. Secretary - Barbra Mullin
 3. Research Section Chair-Elect - Rodney Lym
 4. Education and Regulatory Section Chair-Elect - Jack Schlesselman.

Resolutions Committee. Carol Mallory-Smith

- a. Resolution 1

WHEREAS, triazine herbicides are currently under special review by the US Environmental Protection Agency; and

WHEREAS, these herbicides are a significant part of the effective and economical weed control programs in crops such as; corn, sorghum, tree fruits, turf grass, rangeland and ornamental crops; and

WHEREAS, triazine herbicides are a critical components of the conservation tillage crop production systems which are vital for the protection of our nation's soil and water resources; and

WHEREAS, the continued use of these herbicides is important to assure a continued plentiful of supply of healthy and economical food for the American public;

THEREFORE, be it resolved that the members of Western Society of Weed Science (WSWS) review of risk/benefit data and until such time as the data show otherwise the WSWs fully supports the registration and judicious use of triazine herbicides.

It was M/S/C to accept the resolution.

Distribution will be to:

Members of the US House of Representatives for the Western states
Members of the US Senate for the Western States
Members of the House Committee on Agriculture
Members of the Senate Committee on Agriculture, Nutrition and Forestry
Secretaries or Commissioners of Agriculture for the Western States
US Secretary of Agriculture
Administrator of the EPA
EPA Public Response and Program Resource Branch
President's of commodity producer organizations
Weed Science Society of America Board of Directors.

b. Resolution 2

WHEREAS, the 1995 program presented a thought provoking and relevant message; and

WHEREAS, the meetings were run smoothly and efficiently; and

WHEREAS, the facilities were excellent and the staff helpful and courteous;

THEREFORE, be it resolved that the Western Society of Weed Science expresses its appreciation to Gus Foster and the Program Committee, Mick Canevari and the Local Arrangements Committee, and to the management and staff of the Sacramento Red Lion Hotel.

It was M/S/C to accept the resolution.

Public Relations Committee. Jack Schlesselman

- a. Various agricultural publications and organizations were notified of the 48th meeting of the WSWS.
- b. A standardized sign-up sheet was used at the 1995 WSWS meeting that included 5 of the 8 states that require continuing education credits for consultants. Washington, Oregon, and Idaho continue to require individual sign-up sheets.

Placement Committee. Bob Stougaard

- a. As in the past there were more individuals seeking positions than there were positions advertised.
- b. The committee is seeking input on increasing the effectiveness of this committee.

Site Selection Committee. Jack Orr

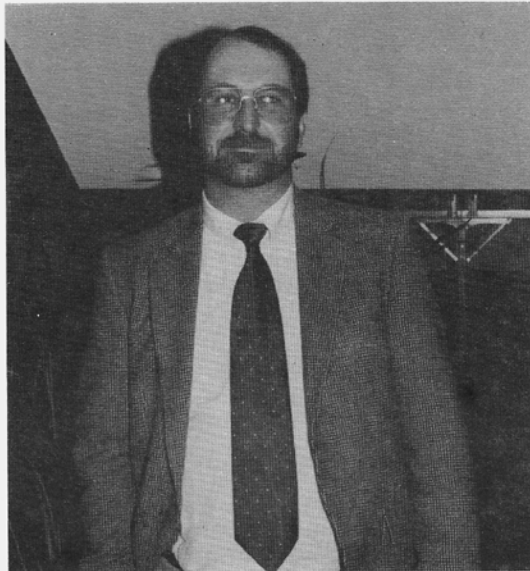
- a. The location for the 1998 WSWS meeting is at the Royal Waikoloan Hotel, Kona, Hawaii.

Awards Committee. Ed Schweizer

- a. Outstanding Weed Scientist Award
 1. Public sector recipient was Larry Mitich, Univ. of California, Davis
 2. Private sector recipient was Paul J. Ogg, American Cyanamid Co.

Student Paper Judging Committee. Kai Umeda

- a. A total of 16 students entered the student paper competition. Eleven of those students gave oral presentations and 5 students gave poster presentations.
- b. Winners of the student paper contest.
Poster presentations-
 1. First place- M.P. Waldrop, New Mexico State University.



1995 WESTERN SOCIETY OF WEED SCIENCE STUDENT PAPER, FIRST PLACE WINNER
Brian R. Correiar



1995 WESTERN SOCIETY OF WEED SCIENCE PRESIDENTIAL MERIT AWARD RECIPIENT
John E. Orr

2. Second place- Troy M. Price, Utah State University.

Oral presentations-

1. First place- B.R. Correiar, UC Davis.
2. Second place- Patrick A. Miller, Colorado State University.
3. Third place- Anthony J. Kern, Montana State University.

Necrology Committee. Barbra Mullin

- a. Committee reports the death of 3 individuals. Ralph E. Althaus, Tom H. Wright and Bryan Truclove.

Poster Committee. Joan Campbell

- a. Cloth covered display boards were purchased at a cost of \$1,800.00 for 30 boards.
- b. Easels with telescoping legs were purchased at a cost of \$1,060.00 for 30 easels.
- c. The display boards and easels will be stored in Laramie, Wyoming and transported to Albuquerque, New Mexico for the 1996 meeting by Paul Ogg.

Sustaining Membership Committee. Charles Hicks

- a. The WSWS has 19 sustaining members for 1995.

Publications Committee. Steve Dewey

- a. More than 46,000 copies of the Weeds of the West have been sold in United States, Canada, and other countries with retail sales exceeding \$1 million. The current balance in the WSWS publications committee account is approximately \$83,000.
- b. Ten copies of Weeds of the West were donated to US Department of Interior officials at a recent briefing held in Washington, DC.

Legislative Committee. George Beck

- a. The Intermountain Noxious Weed Advisory Committee has worked with the WSSA, The Nature Conservancy, Exotic Pest Plant Council, Natural Resource Defense Council, and members of congress to further refine amendments to the Federal Noxious Weed Act and develop several position papers that support the amended Federal Noxious Weed Act and implementation of section 15, the management of undesirable plants on federal lands by federal agencies.

Editorial Committee Report. Rodney Lym and Stephen Miller

- a. Volume 47 of the WSWS Proceedings contained 98 papers on 158 pages.
- b. 273 copies of Volume 47 have been sold for a net income of \$1,382.
- c. The 1995 WSWS Research Progress Report contains 109 reports from 79 authors.
- d. Reports were printed at a total cost of \$1,070 and binding cost of \$400. It was decided that the cost of the research progress report would be lowered to \$15 for 1996.

Weed Management Short Course Committee. Barbra Mullin

- a. The Noxious Weed Management Short-Course will be held in Bozeman, Montana from April 24 - 27, 1995. The cost of the course is \$350.00. The registration fees are being handled through the WSWS.

Herbicide Resistant Weed Committee. Steven Seefeldt

- a. The committee viewed a draft version of a herbicide resistant weeds video. It was decided that the video will be edited further before distribution sometime later in 1995.

Student Education Enhancement Program Committee. Paul J. Ogg

- a. Eleven students have indicated their desire to participate in the program this year. The program is sponsored by universities and the chemical industry.

New Business

- a. Proposed constitution and by-laws change. The proposed change would enable a person to become better prepared for the offices of President-Elect and President. If approved by the general membership the change would become effective for officers elected for 1996. The proposed constitution and by-laws changes would be as follows: The elected secretary will advance to the offices of President-Elect and President in the following 2 years. Annual election of officers for the Western Society of Weed Science would include secretary, research section chair, and education and regulatory section chair.

Discussion followed on the pros and cons of the constitutional change. It was felt that the general membership would need time to consider this change.

John Orr moved to table the discussion for any constitutional and bylaws changes until next year and the motion was seconded.

The motion carried with 56 members in attendance voting in favor of tabling the discussion and 18 members in attendance voting against.

The meeting was adjourned at 9:05 a.m.

Respectfully submitted,

Don W. Morishita, Secretary



WINNERS OF THE 1995 WSWs STUDENT POSTER AND STUDENT PAPER

(L to R): Mark P. Waldrop (1st Poster), Troy M. Price (2nd Poster), Patrick A. Miller (2nd Paper), and Anthony J. Kern (3rd Paper).



President-elect Gus Foster gave special mementos of appreciation to present and former University of Wyoming weed scientists before and during the 1995 Annual Meeting.



IN TURN, THE RECIPIENTS EXPRESSED THEIR APPRECIATION TO GUS!

WESTERN SOCIETY OF WEED SCIENCE
FINANCIAL STATEMENT
APRIL 1, 1994 THROUGH MARCH 31, 1995

CAPITAL

1993-1994 Brought Forward	\$160,699.96
Current Earnings	<u>37,658.28</u>
	198,358.24

DISTRIBUTION OF CAPITAL

Mutual Funds	\$115,400.00
Certificate of Deposit	17,165.27
Money Market Savings	48,894.95
Checking Account	<u>16,898.02</u>
	\$198,358.24

INCOME

	1994	1995	
Conference Registration	\$ 420.00	15,975.00	
Spouse Registration		180.00	
Preconference Tour		2,746.50	
Sustaining Membership		7,000.00	
Membership Dues	1,050.00	30.00	
Proceedings	1,743.39	2,441.50	
Research Progress Report	1,796.27	2,381.50	
Weeds of the West Book	94,752.90		
WSWS History Book	30.00		
Noxious Weed Mgmt Short Course		5,040.00	
Bank Interest	<u>3,177.61</u>		
TOTAL INCOME YTD			\$138,764.67

EXPENSES

Postage & Post Office Box Rental Fee	900.19		
Bulk Mail Permit Fee & Handling	150.66		
Office Supplies	179.92		
Phone	397.60		
Executive Board Planning Meetings	345.74		
Weeds of the West	68,288.68		
CAST Membership Dues	520.00		
Noxious Weed Management Short Course		2,209.94	
Wyoming Pest Council (Educational Video)		1,000.00	
Franchise Tax Annual Filing Fee	10.00		
Tax Accountant	175.00		
Business Manager	3,900.00		
Printing			
Stationary	474.13		
Proceedings	2,463.00		
Research Progress Reports		1,474.67	
Newsletters	818.63		
Programs	1,359.01		
Audio Visuals		1,264.13	
guest Speakers Expense	366.40		
Graduate Student Awards & Expenses		610.00	
Poster Session		1,800.00	
Award Plaques	156.30	158.59	
Awards Luncheon	4,854.93	3,754.93	
Miscellaneous Meeting Expense	75.19	81.00	
1995 Conference Tour		2,634.75	
WSWS Editors Expense		443.00	
Refunds-Registration Fees		<u>240.00</u>	
TOTAL EXPENSES YTD			\$101,106.39



1995 WESTERN SOCIETY OF WEED SCIENCE FELLOWS AND HONORARY MEMBER
(L to R): Steve Miller (Fellow), Jack Schlesselman (Fellow), and K. James Fornstrom (Honorary Member).



1995 WESTERN SOCIETY OF WEED SCIENCE OUTSTANDING WEED SCIENTISTS
(L to R): Larry Mitich and Paul J. Ogg

1995 FELLOW AWARD
WESTERN SOCIETY OF WEED SCIENCE

Stephen D. Miller

Dr. Stephen Miller is currently a professor of Weed Science at the University of Wyoming, Laramie. He received his B.S. degree from Colorado State University and his M.S. and Ph.D. degrees from North Dakota State University. After receiving his Ph.D. in 1973, Stephen was a faculty member in the Department of Agronomy at North Dakota State University. In 1984 he moved to his current position at the University of Wyoming.

Dr. Miller is a very proficient and prolific author. He has authored four books, 46 refereed journal articles, 158 proceeding and abstracts, 443 research reports, 29 extension bulletins, and 41 miscellaneous reports.

Dr. Miller received the Outstanding Weed Scientist Award from the WWS in 1991 and has held numerous positions within the WWS including: Editor of the Research Progress Report (1987 and 1994), Research Chairman (1988), Member at Large (1990), President-Elect (1991), and President (1993). Stephen has served on six committees with the Weed Science Society of America and held a similar number with the North Central Weed Control Conference.

Dr. Miller has served as a major advisor for 43 undergraduate students. He has served as major advisor for thirteen master's and nine doctoral students. He is currently serving as major professor for four graduate students.

Dr. Miller's opinion is well respected by his peers, colleagues, agricultural producers, and industry representatives. His knowledge and expertise is sought after by the weed science profession. He constantly is striving for new and innovative ways to improve weed science and sound productive agriculture.

1995 FELLOW AWARD
WESTERN SOCIETY OF WEED SCIENCE

John T. (Jack) Schlesselman

Jack Schlesselman, a resident of Reedley, California is a Field Research and Development Representative with Rohm and Haas Company. Jack Received his B.S. and M.S. degrees from California State University, Fresno, in 1971 and 1979, respectively.

Prior to employment with Rohm and Haas Company, Jack worked with the University of California Kearney Agricultural Experiment Station from 1972 to 1980 in weed science research. While employed with the University, under the direction of Dr. Art Lange, his main responsibilities included statewide field research with all aspects of herbicide screening in tree crops as well as row crops. During this time frame, Jack either authored or co-authored 85 publications in the area of weed science including co-authoring the textbook - *Principles of Weed Control in California*.

Jack's career with Rohm and Haas Company began in 1980 with heavy involvement in weed control projects involving Goal herbicide. His efforts in this area resulted in one of the first food uses for Goal earning him the appropriate nickname of "Captain Onion". Since that initial registration, Jack's direct involvement with Goal herbicide has led to additional labeling in over 50 crops. Additional areas that have directly benefitted from Jack's tireless efforts include training new employees in weed control identification, serving as regional coordinator for many exploratory pesticide projects and presenting project summaries at company and professional meetings.

Jack has been very active in the WWS and has contributed substantially to its accomplishments and success during the past two decades. He has served on many assignments and committees, including Secretary (1991 to

1992), chairman of public relations (1986 to the present). One additional attribute that Jack brings to the WSWs as well as his company is his excellent skill in photography. Many of the excellent quality pictures that you see in WSWs publications as well as Rohm and Haas Company brochures and advertising are the result of Jack being on the "back end" of a camera. His innate ability and love for photography show in his professional work as well as his many backpacking trips across the Sierra Nevadas.

Jack is a tireless worker and demands much of himself and stresses excellence in every activity that he is involved with, both in WSWs and in his employment with Rohm and Haas Company.

1995 HONORARY MEMBER AWARD
WESTERN SOCIETY OF WEED SCIENCE

K. James Fornstrom

Dr. K. James Fornstrom is a Professor of Civil Engineering at the University of Wyoming, Laramie. He received his B.S. degree from the University of Wyoming in Agricultural Engineering in 1964 and his Ph.D. in 1968 from Ohio State University in Agricultural Engineering. He has been a faculty member at the University of Wyoming since 1968.

Dr. Fornstrom has published over 65 papers and reports relating to his work with sugarbeets and many other articles on conservation tillage in row crops and small grains. Early on Jim recognized the fact that weeds were a primary deterrent to growers adoption of plant to stand techniques in sugarbeets and conservation tillage practices in both small grains and row crops. In addition, he is well known for his work in irrigation management and was instrumental in developing the checkbook method of irrigation scheduling. Much of his research efforts have directly benefitted weed science.

Dr. Fornstrom research work has been mission oriented and dedicated to improving agriculture. This quality has greatly contributed to the benefit of the people in Wyoming and the western states. Currently Dr. Fornstrom and Dr. Steve Miller are cooperating on several important projects directly related to weed science issues in western irrigated agriculture. The projects include: "Economics of weed management systems in sugarbeets", "Bean herbicide carryover to sugarbeets under different tillage and irrigation management systems", "Removal dates of spring seeded cover crops for maximum soil protection", and "Impact of fertilizer application techniques on weed populations in reduced and no-till corn".

Dr. Fornstrom teaches lower level, upper level and graduate courses in the Engineering College all with great proficiency and quality. Several of these courses have direct application to many of the students in agronomy/weed science.

1995 OUTSTANDING WEED SCIENTIST AWARD
PUBLIC SECTOR

Larry W. Mitich

Dr. Larry Mitich is an Extension Weed Control Scientist at the University of California - Davis. He was born and raised on a ranch near Newcastle, Wyoming and began his agronomic teaching career at the University of Kabul in Afghanistan in 1954. In 1963 he joined the Cooperative Extension Service at North Dakota State University, and in 1980 he joined the staff at UC-Davis.

Larry is known and respected in the field of weed science and a friend to all colleagues. He is widely known for his long running "Intriguing World of Weeds" series that began in *Weeds Today* and has continued in *Weed Technology*. This series of publications has educated both scientists and the public about the history, usefulness, and the associated problems of weeds in our world. His outreach activities include over 370

leaflets, bulletins, and extension publications; the use of television to bring weed control recommendations into urban and rural homes; and how to grow succulent plants.

Larry also has been very active on committees and officer activities in the North Central Weed Science Society, Western Society of Weed Science, and the Weed Science Society of America. He was president of WSWS in 1987 and WSSA in 1991. Larry has received more Fellow awards than any other weed scientist that I know of --- he is a Fellow of the NCWSS, WSSA, WSWS, and the Cactus and Succulent Society of America.

Here's a few quotes from the letters written by your nominator and supporters.

"Dr. Mitich has served weed science well whether working in Afghanistan, North Dakota, or California. He has always been a leader in the field whether pioneering a new extension position at North Dakota State University, describing the intriguing world of weeds, or educating both the public and agricultural audiences".

"Larry's strongest characteristic is his communication ability in writing and orally".

"I think of Larry as the historian of Weeds because he does an excellent job in presenting the history of a weed species through his presentations and in his articles in WEED TECHNOLOGY".

"The bottom line is that Larry is a gentle giant among weed scientists. His accomplishments are immense, yet he remains a very modest and friendly person. He is an excellent teacher and researcher, but most of all, he is an excellent person".

1995 OUTSTANDING WEED SCIENTIST AWARD PRIVATE SECTOR

Paul J. Ogg

Mr. Paul Ogg is a Senior Research Scientist with the American Cyanamid Company. He was born and raised on a farm in Worland, Wyoming. After he received his master's degree in weed science from the University of Wyoming in 1970, he began his weed science career with American Cyanamid. During his 25 years with American Cyanamid, he has worked at Fresno, CA, Monticello, IL, and Longmont, CO.

Paul has worn several hats and made many contributions to American Cyanamid and western agriculture. Since arriving in Colorado in 1976, he has been responsible for coordinating field activities and setting research priorities in Colorado, Kansas, Nebraska, New Mexico, Oklahoma, Texas, and Wyoming. Paul has been directly involved in the development of:

Prowl for weed control in corn, dry beans, alfalfa grown for seed

Avenge for wild oats control in cereals

Arsenal for industrial weed control

Assert for wild oat control in cereals

Pursuit for weed control in soybeans, conservation reserve acreage, chemical fallow, dry beans, and alfalfa

In addition to his research activities associated with product registration, Paul has:

Initiated strong cooperative research programs on imidazoline herbicide carryover under irrigation in the High Plains

Conducted numerous studies research on herbicide-insecticide interactions in corn

Hosted annual field days for his cooperators to keep them apprised of new developments and upcoming projects.

Paul has willingly served on numerous committees in both the Western Society of Weed Science and the Weed Science Society of America, as well as serving WWS in all of our offices, including being our President in 1991 to 1992.

Paul, here's a few quotes from the letters written by your nominator and supporters.

"Paul has always had an interest in helping students and with his efforts the implementation of the WWS Student Educational Enhancement Program was initiated in 1993. This program has had great success in educating weed science students by allowing them to visit production agriculture and weed science research in other areas of the United States".

"Fellow development representatives call upon Paul as a resource because he is so respected by his peers".

"Paul is an excellent contact for accessing new and developing chemistries and their fit in western agriculture. He accepts the challenge of positioning new compounds into growers' hands, but will not compromise his research to simply add another product to the field".

"Paul strives for excellence. He offers no short cuts, just good hard work".

1995 NECROLOGY REPORT

Ralph E. Althaus, age 69, died on August 17, 1994. Mr. Althaus grew up in Bluffton, Ohio and received his undergraduate degree from Bluffton College in 1949. He earned a master's degree from Ohio State University in plant pathology in 1951. He worked for B. F. Goodrich Company and Merck Chemical Company before starting work with Monsanto Company in 1960. He served in Monsanto's agricultural chemical product development department, as regional marketing manager, and as manager of product development in the United States and Canada before becoming director of international product development in 1978. He retired from Monsanto Company in 1985. Mr. Althaus served in the 84th Army Infantry in World War II and was taken prisoner during the Battle of the Bulge. He was active in the Greater St. Louis POW Association. He is survived by his wife, Joan; two daughters; a son; a brother; a sister; and two grandchildren.

Dr. Tom H. Wright, age 48, died October 31, 1994 in the crash of an American Eagle flight outside of Chicago. He was born in North Carolina and was a graduate of Clemson University. He earned his doctorate at the University of Kentucky. He worked for Eli Lilly Company in the western United States and made many friends in this area. He served as manager of personnel for Elanco Ag Chem and Animal Health, as director of European product development, and director of Global Field Research and Discovery Biology. At DowElanco he held the position of Global Human Resources Director and was named Director of Global Field Research and Development in 1992. He is survived by his wife Ann; one son; one daughter; and his mother.

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norflurazon (Zorial) 4-chloro-5-(methylamino)-2-(3- (trifluoromethyl)phenyl)-3(2 <i>H</i>)- pyridazinone	49	terbacil (Sinbar) 5-chloro-3-(1,1-dimethylethyl)- 6-methyl-2,4(1 <i>H</i> , 3 <i>H</i>)-pyrimidinedione	23
oxyfluorfen (Goal) 2-chloro-1-(3-ethoxy-4- nitrophenoxy)-4-(trifluoromethyl)= benzene	36	thifensulfuron (Harmony) 3-[[[(4-methoxy-6-methyl-1,3,5- triazin-2-yl)amino]carbonyl]= amino]sulfonyl]-2-thiophene carboxylic acid	38
paraquat (Gramoxone) 1,1'-dimethyl-4,4' bipyridinium ion	48	[tralkoxydim] proposed (Achieve) 2-[1-ethoxyimino]propyl]-3-hydroxy-5- mesitylcyclohex-2-enone	46
pendimethalin (Prowl) <i>N</i> -(1-ethylpropyl)-3,4-dimethyl- 2,6-dinitrobenzenamine	33	triallate (Far-go) <i>S</i> -(2,3,3-trichloro-2-propenyl) bis(1-methylethyl)carbamoithoate	24,56,57
phenmedipham (Spin-Aid, Betanal) 3-[(methoxycarbonyl)amino]phenyl (3- methylphenyl)carbamate	38	triasulfuron (Amber) <i>N</i> -(6-methoxy-4-methyl-1,3,5- triazin-2-yl)aminocarbonyl-2- (2-chloroethoxy)- benzenesulfonamide	37
picloram (Tordon) 4-amino-3,5,6-trichloro-2- pyridinecarboxylic acid	13,26,31,58	tribenuron (Express) 2-[[[(4-methoxy-6-methyl-1,3,5- triazin-2-yl)-methylamino]carbonyl]amino]= sulfonyl]benzoic acid	38,52
[prosulfuron] proposed (CGA-152005) [Peak] 1-(4-methoxy-6-methyl-triazin-2-yl)-3-[2-(3,3,3- trifluoropropyl)-phenyl]= sulfonyl]-urea	37	trifluralin (Treflan) 2,6-dinitro- <i>N,N</i> -dipropyl-4- (trifluoromethyl)benzenamine	22,34,49
pronamide (Kerb) 3,5-dichloro(<i>N</i> -1,1-dimethyl-2- propynyl)benzamide	23,24,36	2,4-D (Several) (2,4-dichlorophenoxy)acetic acid	13,14,31,37,38,52,58
prometryn (Caparol) <i>N,N'</i> -bis(1-methylethyl)-6-(methylthio)-1,3,5- triazine-2,4-diamine	16,41		

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