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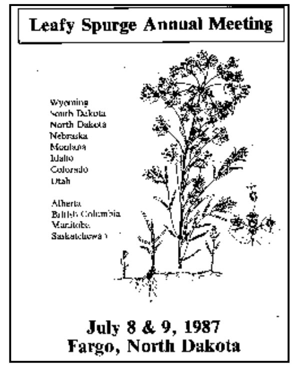

1987 Leafy Spurge Annual Mtg.

GPC-14 Leafy Spurge Control in the Great Plains
July 7-9, 1987
Doublewood Inn, Fargo, North Dakota

Introduction / Program / Minutes

Introduction

DAVID G. DAVIS

Chairman, 1987 GPC-4 Committee, USDA/ARS, Fargo, ND, 58105. New telephone number: (701) 239 1247.

These proceedings are the latest information on much of the research being conducted in the Northern United States pertaining to the control of leafy spurge. These meetings have been held annually since 1979 and have served to gather scientists of several disciplines from government, universities, industry, farms and ranches, as well as individuals involved in Nature Conservancies, in which leafy spurge is becoming an increasing problem. A meeting on spurge control in one of their conservation areas by the Minnesota Nature Conservancy soon after these proceedings attests to the importance of leafy spurge research in their programs, also, and the need to communicate research results as soon as possible. These proceedings are intended for rapid publication to communicate ongoing research. In fact, the term rapid communication applies mostly to the technical reports printed at the end of this publication, since they are synopses of the most recent field trials from Montana, North Dakota and Wyoming. The first part of this publication consists of abstracts of papers presented at the symposium in Fargo in July 1987, and their publication was delayed purposely to contain all of this information in the same booklet. A few extra copies of these proceedings will be available to those who contact me.

Contributions from other states and Canada have been a significant part of the proceedings in past years, and it is hoped that in future years this will continue. Individuals from California, Colorado, Idaho, Minnesota, Nebraska, Maryland, North Carolina, Pennsylvania, South Dakota, and Texas attended the Fargo meetings and contributed to the discussions, but all except Dr. Lee Miller (Univ. Nebraska) chose not to present formal talks. In an unscheduled talk over lunch, Dr. Lloyd Wendell, USDA/APHIS, Mission, Texas, summarized the role that APHIS will be playing in the near future. The shifting of much of the biocontrol work from Albany, CA to Bozeman, MT was of special interest.

The 1988 meeting is scheduled for 12-13 July at Rapid City, SD. Dr. Dennis Clarke, 804 Plum Drive, Pierre, SD 57501 is Chairman and organizer. This is the first time the meetings will be held in South Dakota. It is hoped this information will be passed on to those who might not receive these proceedings. We have discussed the possibility of having Brainstorming Sessions at the South Dakota meetings, to come up with new ideas. It should be an interesting program, with a visit to Mt. Rushmore as a highlight. Since the Black Hills is a vacationland, perhaps that will entice a few more individuals to attend who might otherwise be hesistant.

I wish to thank all of the individuals involved in organizing and helping with the Fargo meetings, and of course to the speakers at the symposium. Special thanks are also due to Dr. Rodney Lym, Dr. Claude Schmidt, Dr. Russell Lorenz, Dr. Cal Messersmith and the North Dakota State University Agronomy Department for their assistance. Mrs. Jeanette Kraft, Mrs. Brenda Jacobson and Mrs. Geraldine Schmidt were extremely helpful. The Fargo Visitor's Bureau and of course the Doublewood Inn also assisted greatly in organizing the meetings.

Program

Tues, July 7 - all day - N. Dak. State Univ. Weed Control Field Plots: AM at Casselton, PM near NDSU

7:00-9:00 PM Registration and Social Hour - Doublewood Inn.

Wed. July 8 - morning session:

6:30 Group Breakfast

7:30 Registration - 7:30 - 12:00

8:30 Introduction - D. G. Davis, Chairman GPC 14 committee.

8:40 History - R. Lorenz, ARS collaborator/NDSU Range Science. How we got where we are in leafy spurge.

8:50 Public Relations - Wayne Colberg Cass County Weed Officer.

9:05 Mapping Systems - R. Elliston (Supervisor, Cook County WY Weed and Pest Control Board) and L. E. Miller (Professor and Remote Sensing Coordinator, Univ. Nebraska) Mapping leafy spurge with airborne color video and microcomputer image processing.

9:20 Coffee

9:45 Growth of Plants - Davis, David G. and Martin Blankendaal. Problems with artificial media for greenhouse plants.

10:00 Biocontrol - Carlson, Robert B. and Donald A. Mundal. Development and overwintering of gall midge and flea beetles from 1986 releases.

10:15 Fay, Peter K. Electronic goat herding for leafy spurge control.

10:30 CHEMICAL WEED CONTROL:

10:30 DiTomaso, Joseph M. The effect of sulfumeturon-methyl and 2,4-D combination on leafy spurge.

10:45 Hickman, Michael and Calvin G. Messersmith. Picloram release by leafy spurge roots.

11:00 Lym, Rodney G. and Calvin G. Messersmith. Leafy spurge control in North Dakota - 1987.

11:15 Moxness, Kevin, and Rodney G. Lym. Absorption and Translocation of ^{14}C picloram in leafy spurge.

11:30 Swenson, O. R. and Rodney G. Lym. Leafy spurge control and soil residue with sulfometuron.

11:45 Whitson, Tom D. and M. A. Ferrell. Control of leafy spurge with fluoxypyr.

12:00 Lunch - Doublewood

Wed, July 8 - afternoon session:

1:15 WORKSHOPS - To meet in separate rooms. One individual will be assigned as a recorder to provide a brief synopsis of each workshop to be included in the proceedings. Workshops will start at the prescribed time, but can continue on if desired. Movement between the sessions may be desirable.

1:15 BIOCONTROL - Includes a discussion of posters.

Posters available = R. Hosford and G. Statler, Diseases of Leafy Spurge. G. Statler and R. Hosford, Rusts on Leafy Spurge.

Discussion topics will include the use of artificial diets and will include chemistry, tissue culture, etc.

2:15 MAPPING - Includes a discussion of traditional mapping systems by Terry Volk, Weed Control Officer, Bottineau County, ND.

3:15 Coffee

3:45 CHEMISTRY AND PHYSIOLOGY - Includes allelopathy, general physiology, chemical analysis of leafy spurge. There will be some overlap with the biocontrol workshop (artificial diets).

4:45-5:25 PLENARY SESSION:

4:45-5:15 HIGHLIGHTS OF THE WORKSHOPS - given by recorders, 7 min each.

5:15-5:25 CONCLUSIONS AND OVERVIEW - C. Schmidt, USDA/ARS, Met. Lab Director, and Location Coordinator, Fargo.

6:00-6:45 - Dinner at Bonanzaville, a frontier town museum.

6:45-9:00 - Self guided tour of Bonanzaville.

Thurs, July 9 - morning session:

7:00 Group breakfast - FOLLOWED BY GPC-14 COMMITTEE MEETING.

9:00 Field Tours

------- (1) Cass County Weed Control Office, conducted by Wayne Colberg.

------- (2) Biocontrol Plots near Lake Ashtabula - about 60 miles west of Fargo. Requires 4-wheel drive vehicles to get into.

12:00 Sack lunch brought from the Doublewood Inn.

1:00 Morning field trips end. Return to Doublewood Inn.

1:30 Additional tours.

------- (3) Leafy spurge plots near Chaffee, ND, about 1/2 hour west of Fargo. End about 4:00 to 4:30.

------- (4) Metabolism and Radiation Research Laboratory.

GPC-14 Executive Committee

Dr. David G. Davis - President
Dr. Dennis Clarke - Vice President
Dr. Robert M. Nowierski - Secretary
Dr. Don E. Anderson - Administrative Advisor

Local Arrangements Committee

Dr. David G. Davis
Dr. Rodney G. Lym
Mr. Wayne Colberg
Dr. Claude H. Schmidt

Minutes of the GPC-14 meeting Doublewood Inn, Fargo, ND July 9, 1987

The meeting was called to order at 8:00 a.m. by Dr. David Davis. Minutes of the 1986 meeting were read by Dennis Clarke. Clarke moved the approval of the minutes as read. Second by Russ Lorenz. Motion carried.

Administrative Director’s Report

Dr. Davis called on Dr. Don Anderson for comments and responses relative to letters he had sent Dr. Terry Kinney, ARS, and Bert Hawkins, APHIS. The purpose of the letters was to lobby for more resources for spurge control. In the communications he suggested spurge control was a long term battle, a priority needing continued emphasis and that the long term solutions will require both biological and chemical control on a broad scale. He urged both Mr. Hawkins and Dr. Kinney to continue to emphasize this in their agency's research programs. Dr. Anderson read the responses received from Lawrence Christie of Dr. Kinney's office and Mr. Hawkins. Mr. Christie's letter stated the control of leafy spurge is one of the more important goals of the ARS weed science research program. He related that in addition to the biological control agents already released, several insects and one pathogen are being studied as possible control agents. He indicated GPC-14 is doing a good job of coordinating the efforts of those involved with leafy spurge control research and that the committee is providing an excellent forum for idea exchange between the research community and state and local control agencies. Mr. Christie also indicated he was open to working with the committee in the future.

Mr. Hawkins notified Dr. Anderson that APHIS agrees that research has identified enough beneficial agents to make implementation of biological control of leafy spurge both a timely and highly successful venture. Hawkins stated APHIS supports the efforts of the leafy spurge research control committee.

Dr. Anderson referenced additional communications. Following a February meeting in Mission, Texas, he wrote APHIS urging additional resources be placed at the Bozeman Lab. This has and is being accomplished. He indicated we may want to further discuss some of the things that are transpiring at the Bozeman facility.

He emphasized that this meeting is the membership meeting of GPC-14 and should include every person interested in research, extension and action programs relating to leafy spurge. He stated that if interested persons were not designated as official representatives on the committee, they should have their administrator contact him asking that they be named as a committee member as membership is open to persons interested in the committee's programs relating to leafy spurge and other noxious weeds.

Dr. Anderson commented on the reorganization of the Great Plains Council committees outlined by Norm Landgren last year. Reorganization has been implemented. GPC-14 is now a task force of the crops and soils standing committee. We are in good standing with the parent committee. At the last annual meeting of the Great Plains Council at Ft. Collins, the council was very supportive of GPC-14. Directors with spurge problems in their state recognize the committee has been very active and serves the purpose of successful communication and coordination of research programs. We have been licensed and encouraged to continue what we've been doing. Dr. Anderson passed a registration sheet around to obtain a record of those present and interested in spurge control.

In closing, Dr. Anderson thanked those responsible for getting the spurge effort initiated and structured. He especially thanked Dr. Peter Fay and Dr. Cal Messersmith.

Business

Newsletter - Dr. Russell Lorenz reported there were some problems with the mailing list. About 50 names were lost during a computer transfer. He feels the system is now functioning adequately.

He indicated that getting material in was still a problem. If people get him the facts he will put the articles together. Article length is a concern. Therefore some articles must be held over until the next issue.

Sufficient funds are available for 1 more year, based on 3 issues. Currently, 900 copies are mailed. New names are being added to the list.

In response to a question of how the newsletter would be funded once the Dow grant was gone, Dr. Lorenz stated he was hopeful we could find a benefactor.

The possibility of charging for the newsletter was advanced. In response to this suggestion, production costs were discussed. Dr. Lorenz stated that, not counting his time, it costs $100-150/issue, including postage. Dr. Anderson stated administrative costs are small. He feels we'll find a sponsor. No action taken.

Dr. Lorenz agreed to continue as newsletter editor. The need to purge the mailing list every three years was discussed. In 1988 it will be necessary to include a return card with one of the issues.

1987 Meeting - Dr. Davis discussed the format of and planning for this year's meeting. Return of the response cards included in the February newsletter was poor. He related this was disappointing as it made planning difficult. Meals were included in the registration cost because it solved several problems in dealing with the motel.

Forty-nine people registered for the meeting. Many people bought the proceedings and came only for one day's activities. There were about 70 people in the room yesterday. Concerning finances associated with the meeting, Dr. Davis stated he feels we'll come out OK, maybe even a little ahead. He has started a savings account and obtained an IRS number. The account will be transferred to the new chairman.

There was general agreement that inclusion of meals in the registration fee was a good idea, but possibly should be limited to breakfast and/or lunch with evenings left open.

The concept of charging a pre-registration fee that is lower than registration at the meeting was well received.

1988 Meeting - Dennis Clarke reported on the preliminary plans for the 1988 meeting. He announced that the meeting will be held in Rapid City July 12-13.

The tentative schedule included a paper session the morning of July 12, plot tours in Hill City area that afternoon, a chuck wagon supper and for concluding the day's activities by attending the lighting ceremony at Mt. Rushmore. July 13 would be used to finish papers and cover control topics.

Discussion of the 1988 meeting plans yielded the following:

1. Dr. Davis likes the idea of the break in the middle of the session.
2. 2. Dr. Fay feels a need for structured discussion sessions, like those at the Western Weed Society Meeting.
3. Dr. Lym indicated a need to leave time for discussion after each paper is presented. Possibly we should increase each slot to 20 minutes.

4. Dr. Anderson noted that July 12 and 13 are the dates of the NC Research Director's meeting.
5. Dr. Lym reminded everyone of the purpose of GPC-14. It is a meeting of the research people involved with leafy spurge control and not a meeting to educate local weed control officers and county agents. He indicated he felt papers shouldn't be downgraded because the audience has mixed scientific expertise.
6. Dr. Davis feels we may be trying to cram too much into too little time.

Future Meeting Site - Dr. Davis reviewed future meeting sites as being Rapid City in 1988 and Bozeman in 1989. He related there had been a suggestion that the 1990 meeting be held in Nebraska. There also has been a suggestion to meet in Wyoming in 1990.

Dr. Lym suggested that the chairman should be from the host state. He stated that if we keep our normal rotation, we would go to Wyoming, therefore he nominated Tom Whitson to be president in 1990. Dr. Bob Nowierski seconded the nomination.

Dr. Lorenz asked that we call on the party from Nebraska to hear his proposal.

Gene Lehnert discussed his local program, which is being implemented through RC&D and the Range Forage and Livestock Council they have organized. A spurge problem is developing in meadows that are a source of hay shipped out of the area. It is projected that in 5-10 years hay sales will no longer be possible because of spurge. He would like to invite the group to his area for the meeting.

Chairman Davis called for further discussion on the motion to hold the 1990 meeting in Wyoming.

Russ Lorenz stated he would like to help Nebraska with their problem. It offers an opportunity to control leafy spurge at the fringes of the infestation. If holding the meeting in Nebraska would help or if we could help by setting up some sort of special meeting, we should consider the proposal.

Dr. Lym stated he felt we needed to establish some continuity before we move to Nebraska.

Lynn Loughary reminded the group that last year people from Nebraska attended the meeting in Wyoming. There is a demonstrated need. Also she cited Colorado and Kansas interests in spurge control.

Peter Fey stated two other areas we need to consider are Colorado and Idaho. He agrees with Dr. Lym that it would be tenuous to hold a meeting someplace where we didn't have sufficient past history of commitment.

Don Anderson suggested we could support Nebraska's need for assistance with expertise from the group in some way, such as through forming a committee to go to Nebraska and help them get started.

In response to a request to locate the meeting in a more accessible area of Wyoming for ease of travel, it was the consensus of those present that the meeting needs to be held near spurge infested areas. Most people like to look at the plots. The present main target area in Wyoming is near Sundance.

Claude Schmidt suggested that as the 1989 meeting would be in Rapid City an hour to an hour and a half on the program could cover the Nebraska situation.

The question was called. Motion Passed. The 1990 meeting will be in Wyoming; Tom Whitson will be chairman.

Biocontrol - Russ Lorenz asked if the committee needs to help the APHIS effort and commitment relative to biocontrol. Floyd Wendell responded that he feels the effort started here is continuing. There is concern that additional material needs to be brought in for tests. Work on diets also needs to be increased. He would like to ask for a substantial increase in support.

Dr. Anderson expressed a concern that the Albany lab is being phased out. He asked that their efforts be carried out at other locations. He stated that the biocontrol effort needs to be increased as we don't know where the breakthrough will come.

Gary Cunningham, USDA APHIS, informed the group that biocontrol of weeds at Albany is not being totally phased out. Some personnel have been relocated. Two to three people were left there. Some efforts have been redirected. Albany will still be a quarantine site.

Dr. Nowierski stated that he feels the main bottle neck with biocontrol is collection and screening. We need state people to help with this effort.

Dr. Anderson stated we need to support the efforts of and work with other groups, such as Ag Canada.

Motion by Dr. Messersmith to adjourn. Second by Peter Fay. Motion carried. Meeting adjourned at 9:07 a.m.

Dr. Dennis C. Clarke
Acting Secretary

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Overview of the 1987 leafy spurge annual meeting

CLAUDE H. SCHMIDT

Laboratory Director, MRRL, U. S. Dept. Agriculture, Agricultural Research Service, Fargo, ND

When Dr. Davis asked if I could briefly address the group on this topic, I told him this would be a pleasure since I was involved in the leafy spurge effort from the beginning. Our lead-off speaker, Dr. Russell Lorenz, who was instrumental in getting the leafy spurge program off and running, presented an excellent historical perspective. He pointed out that much has been accomplished in the past 8 years since the first leafy spurge symposium was held in June 1979 in Bismarck, ND, and the follow-up Northern Regional Conference which met in Billings, Montana, in December of that same year. The need for good communication was greatly enhanced with the formation of the GPC-14 Committee in 1980; this group has been very effective and productive.

Then Wayne Colberg reminded us of the importance of public relations. Without an effective on-going public relations program, very little can be accomplished, especially if one is to deal extensively with the public. We cannot depend on others to do this for us if we are to make any real progress.

We were then treated to an elegant demonstration of a new, reasonably low-cost, visual technology that can be used to pinpoint the growth of leafy spurge. This will be especially useful in mapping more inaccessible areas. Thus, air-borne color video combined with microcomputer image processing will be of tremendous help to enable us to know where the spurge is growing. This is the first step towards control. Now we have a technology within the economic means of the user, and a quantum leap forward has been made.

There is a great deal of continued interest in the biocontrol of leafy spurge. Flea beetles and gall midges were released in 1985 and 1986. They have been able to overwinter and are multiplying slowly, according to Bob Carlson and Don Mundahl of North Dakota State University. Peter Fay, Montana State University, really caught our attention when he discussed the use of preconditioned goats for leafy spurge control. There should be some interesting possibilities for biocontrol by getting rid of a few unwanted behavior traits in goats. We are looking forward to hearing of further fascinating developments in biological control at the next meeting of this group which will be held in Rapid City, South Dakota, in 1988.

Chemical control research is alive and doing well, in spite of limited funding. It was encouraging to see some emphasis on more basic studies in attempts to explain what is happening within the plant -- in other words, plant/chemical interactions. This should prove to be a fruitful avenue of research and may lead to improved control methodologies. As an example, one of the more interesting studies was on the effect of sulfometuron on the shoots formed from roots of leafy spurge.

We were told that there is no magic one-shot treatment for the control of leafy spurge on the horizon and now we are faced with additional problems not envisaged 8 years ago. Very few new chemicals are coming down the pike, and to make the situation worse, EPA may put further restrictions on some of the more effective chemicals we are using today; such as 2-4-D and picloram.

The workshops were quite informative with much give and take and the inclusion of posters was a novel innovation. In the mapping workshop, Terry Volk from Bottineau, ND, showed that traditional mapping systems (low technology) with color overlays can really be used to advantage in a weed-control program.

If there is one items that kept recurring during the meetings, it was the matter of funding; or rather the lack thereof. From a modest beginning, when the pump was primed a few years ago, the amount of funding for research has been decreasing. This is a dangerous trend because the leafy spurge problem keeps growing. We must all work together to try to strengthen the research effort and its funding. On a brighter note, we learned that APHIS is becoming involved and is implementing a leafy spurge biocontrol project with State cooperators and ARS. They will use the new laboratory facility at Bozeman, MT, to enhance their efforts at Mission, TX, to mass-produce insects. Overall, this was a most informative meeting.

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Public relations - How it works for me

WAYNE J. COLBERG

Cass County Weed Control Officer, West Fargo, ND

Public relations is a management function which evaluates public attitudes, identifies policies and procedures of an organization and plans and executes a program of action to earn public understanding and acceptance.

As professionals who are not trained or highly skilled in public relations, we normally do not become that involved in public relations work, nevertheless we usually find ourselves doing public relations in our daily work. We are continually striving to obtain a better understanding and acceptance of our work whether it be with our administration, co-workers, staff or the general public.

Public relations means good communication. We must practice and be prepared to operate in whatever media is appropriate. Our written communication, whether it be through reports, letters or reporting to the news media is important, however it does not cover it all. The public responds through the spoken word. This may come from the neighbors, friends, co-workers, families and what they hear in public places. How we react to face-to-face situations is extremely important. The public usually reacts more negatively to what they don't know than what they do know. Sometimes those who are our best supporters may ask some extremely probing questions - how do we react to these situations? Some of the frustrations and failures that I have experienced have come about because my public just didn't have all the facts or information for them to fully understand what my work was all about. Never miss the opportunity to discuss your work with people, whether it involves your administration, co-workers, or the public. Show interest and enthusiasm for what you are doing. Always take the time to visit with your contacts. These are the people who might be helpful to you in getting that extra piece of laboratory equipment or additional funding to support or expand your program.

As professionals, we see our role in public relations in different dimensions. To the researcher, it may involve only interactions with the administration, co-workers and staff. Conversely those of us who are in educational or industrial work, see our major efforts in public relations directed to the general public. A public more diversified and perhaps less knowledgeable about our programs. We must always probe to determine how "our public" perceives us in our work. It is better to help shape public opinion than to allow them to arrive at their own conclusions as to the importance of our programs.

While public relations is a day-to-day unscheduled activity, we must also be mindful that we must plan and project our public relations activities into the future. This is especially true when it comes to implementing new programs, budgets and staffing. Don't wait until the deadline to make your "pitch" for additional support. If you wait too long, important decisions may have already been made as to any additional support that might be forthcoming. Don’t be fearful of becoming an “empire builder.” You are in control of your destiny. No one is going to build it for you.

In summary, public relation is a management function that all professionals must exercise daily. Our goals are to give understanding and acceptance of our programs. Good communication skills are important and use of these skills in whatever media is appropriate. We must also plan and project our public relations work to the future.

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Mapping leafy spurge with airborne color video and microcomputer image processing

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Vertical color or color infrared images can be economically gathered using a local aircraft and a video camera and recorder or a 35 mm camera. If these images are gathered at time of peak inflorescence of a specific weed type and from suitable altitude, they can be used to prepare a reference map for control measures. The companion image interpretation and mapping operation can also be economically completed using a desktop based microcomputer image interpretation system which can be easily operated by the weed control agent. Uses of such maps and procedures include:

– initial weed stand detection,

– documenting requests for State cost-sharing programs,

– planning private landowner cooperative programs,

– pre-eradication contract negotiations,

– monitoring effectiveness of earlier treatments, etc.

A test utilizing these low-cost image collection and analysis procedures was completed in a portion of Cook County, Wyoming, with vertical color video images. The images were flown for the area of a township at the time of yellow inflorescence of leafy spurge (*Euphorbia esula*) in mid-July. Individual video frames were interpreted using a personal computer equipped with a color video digitizer (video frame grabber) and color image computer display interface and monitor. The user simply advances the video tape to the frame of interest, strikes a key, and that frame of video is digitized in color in a fraction of a second. A sample yellow area (i.e., a display cell) representing a known occurrence of spurge in flower is then pointed out on the stationary image using a mouse and all areas of similar color are flagged or color coded in red by the program. The user continues to select additional sample points until the stands of spurge are marked in red on the current frame. Usually pointing out 10 to 20 sample points would be sufficient if good quality video is available.

This computer aided interpretation system has been designed to be very simple to operate so that it can be directly used by someone experienced with the weed conditions in the local area but not experienced with computers. Only this local agent can select various colors and sample points representing weed stand density to prepare a map of various levels of infestation. For example, they can decide that they wish to color-code the dense and most severe stands or portions of stands in bright red, medium in bright orange, and low levels in bright yellow. They simply select these colors from a legend on the right side of the screen and point to the sample cells selected to represent that severity based upon their intimate knowledge of the field conditions or upon the original color of that point in the image displayed. All similarly colored points are assigned the color-code selected for that severity level. Every time they add or subtract a sample point to a category, the color identification legend at the right of the screen is updated to show the area in acres of each severity class mapped up to that point. After the user is satisfied with the map of the specific frame, a legend can be added from the keyboard such as its location in section, township, and range notation and a hardcopy color map prepared on a color printer. The whole process, from digitizing the frame to the display of a completed map with area legends and identifying annotations, takes less than 5 minutes, not including the time to prepare a color hardcopy print or a 35 mm slide and print.

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Control of leafy spurge with fluroxypyr

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Two experiments were established in 1985 to compare times of application and sequential treatments following fluroxypyr (Ef689). Applications of fluroxypyr at 0.5 lb ai/A were applied in two studies. The first area received fluroxypyr on July 24, 1985. One year following initial applications of fluroxypyr areas within both studies were retreated with fluroxypyr, dicamba, 2,4-D(LVE) and picloram at 0.5, 2.0, 2.0 and 0.5 lb ai/A, respectively. Dates of each of the series of retreatments in both studies were June 2, 1986 and July 28, 1986. Each of the treatments was compared to an untreated check and an area treated with only an initial fluroxypyr application at 0.5 lb ai/A.

Treatments were applied with hand-held sprayers applying 40 gallons per acre of herbicide solution.

Evaluations were taken, two years following treatments, on May 18, 1987. No differences were found between the initial treatments of fluroxypyr applied in July and August, 1987 (Tables 1, 2, 3 and 4). Both of the initial treatment times provided similar control when followed by retreatments applied the same day. All retreatments applied on July 28, 1986 controlled considerably higher percentages of leafy spurge than the same treatments applied on June 2, 1986 (Tables 1, 2, 3 and 4).

Fluroxypyr set-up treatments followed by retreatments provided more effective control of leafy spurge than would be expected from any retreatment used alone. More research should be done to further determine the time and application rates to be applied.

Table 1. Hallam Ranch - Lander, Wyoming.

Herbicide		lbs ai/A	Date of application	Percent control
1.	fluroxypyr	0.5	7/24/85	48
	+ fluroxypyr	0.5	6/2/86	
2.	fluroxypyr	0.5	7/24/85	46
	+ dicamba	2.0	6/2/86	
3.	fluroxypyr	0.5	7/24/85	29
	+ 2,4-D (LVE)	2.0	6/2/86	
4.	fluroxypyr	0.5	7/24/86	69
	+ picloram	0.5	6/2/86	
5.	fluroxypyr	0.5	7/24/86	11
6.	check	–	–	0

Table 2. Hallam Ranch - Lander, Wyoming.

Herbicide		lbs ai/A	Date of application	Percent control
1.	fluroxypyr	0.5	7/24/85	65
	+ fluroxypyr	0.5	7/28/86	
2.	fluroxypyr	0.5	7/24/85	87
	+ dicamba	2.0	7/28/86	
3.	fluroxypyr	0.5	7/24/85	59
	+ 2,4-D (LVE)	2.0	7/28/86	
4.	fluroxypyr	0.5	7/24/85	97
	+ picloram	0.5	7/28/86	
5.	fluroxypyr	0.5	7/24/85	11
6.	check	–	–	0

Table 3. Hallam Ranch - Lander, Wyoming.

Herbicide		lbs ai/A	Date of application	Percent control
1.	fluroxypyr	0.5	8/26/85	34
	+ fluroxypyr	0.5	6/2/86	
2.	fluroxypyr	0.5	8/26/85	35
	+ dicamba	2.0	6/2/86	
3.	fluroxypyr	0.5	8/26/85	36
	+ 2,4-D (LVE)	2.0	6/2/86	
4.	fluroxypyr	0.5	8/26/85	50
	+ picloram	0.5	6/2/86	
5.	fluroxypyr	0.5	8/26/85	5
6.	check	–	–	0

Table 4. Hallam Ranch - Lander, Wyoming.

Herbicide		lbs ai/A	Date of application	Percent control
1.	fluroxypyr	0.5	8/26/85	73
	+ fluroxypyr	0.5	7/28/86	
2.	fluroxypyr	0.5	8/26/85	86
	+ dicamba	2.0	7/28/86	
3.	fluroxypyr	0.5	8/26/85	63
	+ 2,4-D (LVE)	2.0	7/28/86	
4.	fluroxypyr	0.5	8/26/85	97
	+ picloram	0.5	7/28/86	
5.	fluroxypyr	0.5	8/26/85	5
6.	check	–	–	0

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Leafy spurge control in North Dakota - 1987

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Annual picloram plus 2,4-D treatments, leafy spurge control along ditchbanks and under trees, and evaluation of sulfometuron have been the emphasis of the leafy spurge control field research in 1987.

An experiment to determine the number of annual applications of picloram needed to provide 90 to 100% leafy spurge control and to investigate possible synergism between picloram and 2,4-D was established at two locations in North Dakota. The experiment was begun on 25 August 1981 at Dickinson and on 11 June 1982 at Valley City. All treatments were applied annually except 2,4-D alone, which was applied biannually (both spring and fall). Picloram treatments were applied in late August 1981 and in June of 1982 through 1984. Thus, the Dickinson site has received six picloram and picloram plus 2,4-D treatments and 11 2,4-D treatments, while the Valley City site has received five and eight treatments, respectively. The plots were 10 by 30 feet and each treatment was replicated four times in a randomized complete block design.

Picloram at 0.25, 0.375 and 0.5 lb/A provided 58, 77 and 86% leafy spurge control, respectively, in August 1986 when averaged across the Dickinson and Valley City locations (Table 1). Control had gradually increased for all treatments. 2,4-D alone provided approximately 50% control of leafy spurge after biannual applications for 6 years.

Leafy spurge control tended to increase when 2,4-D was applied with picloram (Table 1). Leafy spurge control in May 1987 increased an average of 25, 15 and 13% with picloram at 0.25, 0.375 or 0.5 lb/A plus 2,4-D at 1.0 to 2.0 lb/A, respectively, when compared to the same picloram rate applied alone. Picloram + 2,4-D at 0.25 + 1.0 lb/A provided 85% leafy spurge control which was similar to picloram at 0.5 lb/A alone and was about 10% less than picloram at 0.5 lb/A plus 2,4-D. The picloram at 0.25 lb/A plus 2,4-D treatment required 1 to 2 years longer to reach 80 to 90% leafy spurge control than picloram at 0.5 lb/A but cost approximately 50% less. Leafy spurge control declined 30% or more between the fall and following spring evaluations each year until control was 70% or more (data not shown). Thereafter, the decline was less than 10% between treatments and leafy spurge control was approaching 100%.

An experiment to evaluate leafy spurge control along ditchbanks was begun on 27 June 1986 in Fargo. The plots were 10 by 40 feet with four replications. Amitrole and fosamine were applied at 2 to 8 lb/A, respectively, with a single nozzle hand-held sprayer. Both amitrole and fosamine at the highest rates provided about 90% leafy spurge control 11 months after treatment but there was 81 and 57% grass injury, respectively (Table 2).

Sulfometuron, glyphosate and picloram were evaluated for leafy spurge control under trees in two experiments near Valley City. The experiments were established on 26 June and 3 September 1986 with 12 by 20 feet plots and four replications. Ash, elm, and Russian olive were the predominate trees present. Glyphosate applied in June provided excellent leafy spurge control but also nearly 100% grass injury (Table 3). Glyphosate applied in September provided only 65% leafy spurge control, but still nearly complete grass kill. Sulfometuron alone did not control leafy spurge, but control averaged 99% when sulfometuron was applied with glyphosate or 2,4-D. However, the sulfometuron + 2,4-D treatment also resulted in 66% grass injury. Picloram applied at a solution concentration of 1:7 [picloram (Tordon 22K):water, v/v] with a hand-held controlled-droplet applicator provided 86 to 99% leafy spurge control with little grass injury. There was a slight curling of the leaves on some ash trees 12 months after picloram application.

Sulfometuron alone did not control field infestations of leafy spurge regardless of rate or application date (Table 4). However, leafy spurge control averaged from 76 to 96% 11 months after sulfometuron was applied with an auxin herbicide in the spring. Similar treatments applied in the fall had less long-term control. Long-term control was better when sulfometuron was mixed with picloram than with 2,4-D or dicamba. Picloram at 0.25 lb/A applied 12 or 15 months after the initial sulfometuron treatment provided 80% or more leafy spurge control regardless of the original sulfometuron rate or auxin herbicide mixture.

Table 1. Leafy spurge control from annual picloram or picloram plus 2,4-D treatments and biannual 2,4-D treatments at two locations in North Dakota.

		Site and 1987 evaluation date		Months after treatment			
		Dickinson	Valley City				
Herbicide	Rate	June	May	12[a]	24	36	48
	(lb/A)	(% control)					
Picloram	0.25	51	48	39	48	48	58
Picloram	0.375	65	74	65	62	52	77
Picloram	0.5	76	77	65	71	81	86
2,4-D bian	1	55	24	22	30	38	50
2,4-D bian	1.5	48	48	22	24	26	45
2,4-D bian	2	54	55	19	30	26	54
Pic+2,4-D	0.25+1	79	67	52	66	63	85
Pic+2,4-D	0.25+1.5	81	74	58	66	70	85
Pic+2,4-D	0.25+2	75	76	57	62	66	83
Pic+2,4-D	0.375+1	79	90	69	72	70	90
Pic+2,4-D	0.375+1.5	85	84	68	74	76	93
Pic+2,4-D	0.375+2	82	90	68	59	76	91
Pic+2,4-D	0.5+1	82	92	71	75	84	94
Pic+2,4-D	0.5+1.5	86	97	64	73	80	97
Pic+2,4-D	0.5+2	86	96	76	75	81	95
LSD (0.05)		20	20	18	14	19	14

[a] Mean values include data from the Sheldon location which was discontinued after 1985.

Table 2. Leafy spurge control along ditchbanks, Fargo, ND.

		Evaluation date		
		Aug 86	May 87	
Treatment	Rate	Control	Control	Grass injury
	(lb/A)	----------------------------	(%)	----------------------------
Amitrole	2	99	69	23
Amitrole	4	100	91	64
Amitrole	8	100	87	81
Fosamine	2	5	14	3
Fosamine	4	19	58	10
Fosamine	8	40	90	57
LSD (0.05)		19	17	42

Table 3. Leafy spurge control under trees near Valley City, ND.

		Application and evaluation dates				
		26 June 86			3 Sept 86	
		Aug 86	28 May 87		28 May 87	
Treatment	Rate	Control	Control	Grass injury	Control	Grass injury
	(oz/A)	--------------------------------		(%)		--------------------------------
Glyphosate	8.5	9	92	88	...	...
Glyphosate	17	41	96	98	65	99
Sulfometuron	0.5	15	0	0	...	...
Sulfometuron	1	9	0	0	...	...
Sulfometuron	2	9	28	15	...	...
Sulfometuron	2+8.5	24	96	96	...	...
Sulfometuron+glyphosate	1+8.5	13	99	99	...	...
Sulfometuron+glyphosate	0.5+8.5	13	98	98	...	...
Sulfometuron+2,4-D	2+17	...	...	…	99	66
Picloram (CDA)	1:7[a]	99	95	0	86	9
Sulfometuron+glyphosate	2+17	...	...	...	99	99
LSD (0.05)		19	8	14	26	17

[a] Solution concentration Picloram (Tordon 22K):water, v/v.

Table 4. Sulfometuron plus auxin herbicides for leafy spurge control near Hunter, ND.

		Application and evaluation dates								
		27 June 1985					4 Sept 1985			
		1985	1986		1987		1986		1987	
Treatment	Rate	Aug	May	Aug	May (Alone)	May (Retrt)[a]	May	Aug	May (Alone)	May (Retrt)[a]
	(oz/A)	(% control)								
Sulfometuron	0.5	...	...	...	...	...	16	0	0	54
Sulfometuron	1	0	6	0	0	87	95	7	23	77
Sulfometuron	1.5	0	63	25	12	88	...	...	...	...
Sulfometuron	2	0	36	6	3	87	...	...	...	...
Sulfometuron+2,4-D	1+16	95	76	26	8	84	99	17	3	92
Sulfometuron+dicamba	1+32	96	85	40	35	98	97	23	15	91
Sulfometuron+picloram	1+8	70	96	59	51	100	99	74	33	83
Sulfometuron+2,4-D	0.5+16	...	...	...	...	...	95	24	21	87
Sulfometuron+dicamba	0.5+32	...	...	...	...	...	97	51	19	83
Sulfometuron+picloram	0.5+8	...	...	...	...	...	99	40	17	86
Sulfometuron+metsulfuron	2+0.5	0	60	24	0	98	88	13	0	83
DPX-L5300	1	...	...	...	...	...	44	6	4	76
Control		...	...	...	...	63	...	...	...	73
LSD (0.05)		25	22	26	24	21	26	30	36	29

[a] Picloram at 0.25 lb/A applied 27 Aug 1986.

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Leafy spurge control and soil residues with sulfometuron

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Sulfometuron, a sulfonylurea herbicide, has shown potential in controlling leafy spurge. Sulfometuron could provide cost efficient and effective control of leafy spurge compared to herbicides presently used.

Experiments were established to evaluate sulfometuron alone and in combination with auxin herbicides for leafy spurge control. The experiments were conducted on ungrazed dense stands of leafy spurge at sites near Dickinson and Chaffee, North Dakota. Spring and fall applications were compared in the first experiment. Sulfometuron alone and in combination with 2,4-D, dicamba or picloram were applied in June and September 1986. Sulfometuron and auxin herbicides were spring applied at comparatively low rates to leafy spurge in the second experiment. The plots for both experiments were 10 × 30 ft and each treatment was replicated four times in a randomized complete block design.

Sulfometuron spring applied at 1 and 2 oz/A provided 3 and 13% leafy spurge control, respectively, in August 1986 when averaged across the Dickinson and Chaffee locations. Sulfometuron at 1 oz/A applied with picloram at 8 oz/A, dicamba at 32 oz/A or 2,4-D at 16 oz/A gave 82, 27 and 57% control, respectively. Leafy spurge control was less than 34% for all spring applied treatments when evaluated 12 months after application. Sulfometuron alone or with 2,4-D, dicamba or picloram applied at similar rates in the fall provided 17, 65, 84, 61 and 37% control, respectively, in June 1987. Fall treatments of sulfometuron and sulfometuron plus auxin herbicides caused grass injury at both locations. Grass injury ranged from 25 to 65% with the most injury from sulfometuron at 2 oz/A. Sulfometuron applied at 0.5 oz/A with picloram at 4 or 2 oz/A, dicamba at 16 or 8 oz/A or 2,4-D at 8 or 4 oz/A did not provide adequate control of leafy spurge 12 months after application.

An experiment to evaluate the effect of sulfometuron and sulfometuron plus auxin herbicides on forage production and species composition of native grasses was established at sites near Manning and Fargo. Spring applied treatments did not decrease warm or cool-season grass production.

Sulfometuron will be used on many different soils and under various conditions if proven to be effective in controlling leafy spurge. An experiment to determine soil mobility of sulfometuron was conducted in the greenhouse. Soil was collected near leafy spurge treatment sites at Chaffee, Dickinson and Valley City. Sulfometuron at 2 oz/A was leached through hand packed soil in a 26 inch column by a volume of water corresponding to an annual rainfall of 18 inches. Treatments were replicated four times for each soil type.

Sulfometuron movement was greatest when water was applied continuously for 48 h. Sulfometuron was leached the entire length of the 26 inch soil column for all three soil types. Movement of sulfometuron was less when water was applied in 2 inch increments over 9 weeks. Sulfometuron was detected in Dickinson, Valley City and Chaffee soil at maximum depths of 12, 8 and 16 inches, respectively.

An experiment to determine the surface movement of sulfometuron applied to a sloped area was established at sites near Valley City and Dickinson. Natural slopes of 0-2%, 6-8% and 14-16% were treated with sulfometuron at 2 oz/A in July 1986. The plots were 10 × 30 ft and each treatment was replicated three times in a completely random design. Soil samples were collected downslope from the treated area in August 1986 at depths of 0 to 6 and 6 to 12 inches. A corn root bioassay was conducted to estimate sulfometuron residue.

Movement of sulfometuron from the treated area was minimal on the 0-2% and 6-8% slopes at both locations. The highest concentration of sulfometuron detected downslope from the treated area was 0.4 ppb. Movement of sulfometuron was greatest on the 14-16% slope at Dickinson. However, the highest concentration detected was still less than 1 ppb.

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Biological control of leafy spurge

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Crown and root rot

On June 24, 1987, Dr. Dave Davis and his technician, Prudence Olson, found a crown rot killing numerous stems of leafy spurge at Kindred, North Dakota. We are isolating fungi and bacteria from the lesions at the base of the stems and will start pathogenicity tests, first with a *Fusarium* species that is appearing among the isolates.

A *Fusarium* species was isolated from the few dead and dying leafy spurge (*Euphorbia esula*) plants found by Dr. Hosford in Washington and Wyoming in June-July, 1986. Inoculation of soil around spurge plants in the greenhouse with the *Fusarium* alone has not, to date, resulted in wilt or root rot. In November, 1986 a *Fusarium* fungus was repeatedly isolated by Mr. Jordahl from brown streaks in roots of wilting leafy spurge plants growing in Sunshine Mix (a soilless mixture of peat moss, perlite and vermiculite from Canada). Spurge plants inoculated with this fungus have remained healthy.

Alternaria species

In September, 1985 Dr. Hosford observed a disease killing some influorescences and then the flowering stem of leafy spurge in western North Dakota, central Montana, and southern Oregon. The disease was scattered in patches of spurge at one site in North Dakota, one site in Montana, and abundant in a solid 100 acre stand of leafy spurge covering a valley in southern Oregon (4). In May, 1986 Dr. Hosford and Mr. Don Mundal observed a similar disease in eastern North Dakota. *Alternaria* was repeatedly isolated from the advancing edge of stem lesions from all these sites. Using wet periods of 36-65 hours, isolates B1-1 and B1-6 of *Alternaria* from central Montana caused small dark spots to extensive dark lesioning, killing flowers, leaves and stems of leafy spurge biotypes 113, 110 and 108 in greenhouses in Fargo, ND. All 27 conidial inoculated plants developed spotting and/or top dieback. The 25 water inoculated check plants were not spotted. *Alternaria* resembling B1-1 and B1-6 were reisolated from the lesions and not from healthy check plants. On April 30, 1986 Dr. Joe Krupinsky sent us two of his stem killing isolates of *Alternaria* from Mandan, North Dakota (6). To date his two isolates have caused the greatest stem killing of any of the *Alternaria* isolates. On June 26, 1987 District Ranger John A. Madden sent us leafy spurge plants from near Fairfield, Idaho. Many of the stems were dying from the top down. We are isolating microorganisms from the advancing edge of the dying areas and expect to find an *Alternaria* pathogen.

In the prairie provinces of Canada, *Alternaria* spp. have caused leaf spotting to top dieback in up to 10 percent of the leafy spurge at some sites (8). *A. tenussima* f. sp. *euphorbiae* caused leaf spotting and top dieback in North Dakota, but artificial field inoculation at 3 sites in 1984 resulted in only a little infection, probably due to inadequate moisture (6, L. J. Littlefield, personal communication).

Uromyces striatus

The rust, *Uromyces striatus*, was detected killing leafy spurge near Lidgerwood in southeastern North Dakota in 1982. It spread slowly from plant to adjacent plant through 1982-84. In 1985 it spread to scattered plants over 3 acres of spurge, perhaps by aerial spores (5,7). In 1985 Mr. J. G. Hoch found its uredospores on alfalfa in the fields, then produced them in the greenhouse and stored in liquid nitrogen. On May 7, 1986 Dr. Hosford and Mr. Mundal found a rust disease resembling *U. striatus* killing a few plants near Lisbon, ND but not in an adjacent alfalfa field. We have a report of this rust on a few leafy spurge plants south of Carrington, ND. The rust kills the spurge plant. In the spring of 1987 Dr. Statler, his technicians Melinda McVey and Mr. Jordahl, found that the rust continued to spread slowly at Lidgerwood and Lisbon. We are looking for another alternate host other than alfalfa or clover (3) from which spurge may be infected.

Melampsora euphorbiae, Uromyces spp. and *Endophyllum* spp.

In September, 1985 Dr. Hosford found *Melampsora euphorbiae*-like rust on an Oregon State University herbarium specimen of *E. esula* collected in Medford, Oregon in 1964. He did not find the rust in Medford, but M. R. Hubbell, who collected it in 1964, is looking for it for us (4). *Melampsora* rust spp. occur on *Euphorbia* spp. and are highly specific for their hosts. This, combined with their urediospore on *Euphorbia* spp., makes them good candidates for biocontrol of leafy spurge. *Melampsora euphorbiae* was collected at Victoria, B.C. by Dr. Littlefield in August, 1984 and sent to the Plant Disease Research Laboratory (PDRL) at Frederick, Maryland. *Uromyces euphorbiae* was collected by Dr. Littlefield on a collecting trip to Eastern Europe in the spring of 1984, and that rust was also sent to PDRL. Evaluation of these rusts for host range, prior to release to us, is in progress. At Frederick, Dr. W. L. Bruckart is studying these and other microorganisms that he, Dr. Littlefield and others have collected (1). Dr. Bruckart reports that in Swiss studies by Dr. G. Defago et al., *Uromyces scutellatus* is reducing stands of cypress spurge by 90% (1,2). He found that *M. euphorbiae* from Eastern Europe caused very limited infection on spurge collections other than those from which it came (1). We are looking for these fungi on leafy spurge in the United States. Harris et al. (3) recommended the "autoecious rusts, such as *Melampsora euphorbiae* (Schub.) Cast., *Uromyces scutellatus* (Pers.) Lev and *Endophyllum* species, as possible biocontrol agents for control of North American leafy spurge." Recently, Dr. Sam Young joined Dr. Bruckart at Frederick to work on biological control of weeds.

On Oct. 21, 1986 Dr. Larry Littlefield sent us the uredial/telial stage of an autoecious rust (*Uromyces prominens* or *U. Magorii?*) on *Euphorbia dentata* (?), toothed spurge, in Oklahoma. On August 19, 1986, Sharon Collman, County Agent for King County, Washington, sent us an orange rust severely rusting petty spurge in Cowlitz County. On Nov. 7, 1986, Jack Waud, County Agent for Clallam County, Washington, sent us an orange rust and leaf spots on small to medium sized spurge plants in Clallam County has determined that these rusts cause only fleck reactions on leafy spurge.

Sclerotium rolfsii

Dr. Littlefield obtained *Sclerotium rolfsii* isolates through State-Federal clearance from southern United States to test an leafy spurge in North Dakota (7). On January 28, 1986 10 ml of 2 two-week-old petri plate cultures containing sclerotia and mycelium of *S. rolsii* in 50 ml of water plus 2 drops of Tween 20 were poured on the base of each of 5 plants of leafy spurge biotype 113. The plants in each of 5 pots were watered daily. By 8-18 days after inoculation, the stems of the inoculated plants were killed at the soil surface, but new stems grew from the roots. Five water inoculated check plants were undamaged. This fungus damages many important plants and crops in the southern United States. It is assumed that it will not survive northern winters. If it were to survive, it might become a serious problem. We have studied this fungus only in the greenhouse in the winter and sterilizing all experimental remains. As stated, it kills some stems of leafy spurge, but others grow to replace them.

Conclusions

We should continue studying crown and root rot diseases for a potential control of leafy spurge, look for more virulent or aggressive isolates of *Alternaria* and autoecious rusts, such as *Melampsora euphorbiae* (Schub.) Cast, *Uromyces scutellatus* (Pers.) Lev., and *Endophyllum* species, on North American leafy spurge. We should also look for any other organisms, fungi, bacteria, viruses, nematodes, etc. that may be damaging leafy spurge.

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Alfalfa rust (*Uromyces striatus*) as a possible control of leafy spurge

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Leafy spurge (*Euphorbia esula*) is a serious pest in pasture lands of North Dakota and other states. Controls are being sought. *Uromyces striatus* (alfalfa rust) is a possible candidate for biological control of leafy spurge. Alfalfa rust was found infecting leafy spurge but not alfalfa (*Medicago sativa*) in the fall of 1982, southwest of Lidgerwood, N.D., in a meadow of alfalfa and bromegrass. This site has been monitored for disease spread.

The rust (*U. striatus*) spread slowly during 1982-84. In 1985, it spread to scattered plains over about 3 acres of spurge. Spread was slower in 1986. Urediospores were found on alfalfa in the field in 1985, then produced in the greenhouse and stored in liquid nitrogen.

There are problems conducting research with *U. striatus*. The most difficult is that leafy spurge is the alternate host. The pycnial and aecial stage occur on spurge. The cycling stage (uredial) and the overwintering stage (telial) occur on alfalfa. Therefore, in order to inoculate spurge, one must produce and germinate teliospores. We have been unsuccessful to date in transferring rust from alfalfa to leafy spurge due to difficulties of teliospore germination.

In order to successfully conduct research of this nature, we need to find a rust which cycles on leafy spurge since *U. striatus* cycles on alfalfa. Dr. Hosford has collected and we have tested several isolates of *Melampsora* that have uredial stage on petty spurge. To date, we have found only necrotic flecks after inoculation.

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Electronic goat herding for leafy spurge control

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Introduction

Goats eat leafy spurge. In fact, they have a strong preference for leafy spurge. In 1981, Charles Egan, County Agent, and Wayne Pearson, Weed District Supervisor, in Columbus, Montana, discovered that goats eat a great deal of leafy spurge. They have conducted a program for the past two years where goats are used for leafy spurge control on fishing accesses in their county. This is the only use of goats for spurge control right now, and the concept is strictly a curiosity. It is not a viable solution for leafy spurge control.

There are two basic problems with goats. First, they need herders at all times, since they tend to wander. Second, there is no major market for goats at the present time. These two problems prevent goats from being used for leafy spurge control on a large scale.

The purpose of our study was to test a commercial dog containment system for goat control in an attempt to eliminate the need for a herder. The Invisible Fence Company® from Pennsylvania, manufactures a product which prevents dogs from leaving private property. The system consists of a transmitter and a transducer which sends a weak electronic field through 14 gauge wire which encircles the containment area. The dog wears a leather collar which contains a small plastic case containing a radio receiver. When the dog approaches the wire at a distance of ten to fifteen feet the plastic case emits a beeping tone. The animal has two seconds to back out of the electronic field or receive a shock. A system with six collars was purchased from the Invisible Fence Company and is the focus of this research project.

Training the goats

In order to train the goats, a fenced area, 100 feet by 100 feet was erected. A single strand of 14 guage wire was placed on the fence. Collars were placed on six goats in the enclosed area. The system, which is powered by a twelve-volt battery, was turned on and within a few minutes, the goats approached the fence and received shocks. Within approximately twenty minutes, the goats huddled in the middle of the enclosed area to avoid shocking. The goats were fully trained to the system in approximately half a day. The fence was removed; however, the goats did not leave the containment area.

Experiment one

The first experiment conducted took place in adjoining pastures (Figure 1). Pasture I had approximately 60% brush cover with the remainder of the area heavily infested with leafy spurge. Pasture II was approximately 80% infested with leafy spurge. Both pastures were 100 × 45 feet and contained two collared. A permanent 50-foot transect was placed in the middle of each pasture with corresponding transects established outside of each pasture for comparison. The height of leafy spurge was measured along the transects daily for eight days.

After three days the goats began to utilize leafy spurge heavily in both pastures (Figure 2). There was more utilization of leafy spurge in pasture II, which contained little or no brush. Other data, not presented here, indicate that goats utilized a large number of plant species in addition to leafy spurge in pasture I. They had a strong preference for chokecherries, houndstongue, and wild rose.

Experiment two

The purpose of the second experiment was to measure goat containment in a natural setting. A site was located in Whitehall, Montana and was one square acre. Eleven goats, six with collars and five without, were placed in the Invisible Fence containment area. Measurements taken included the presence of the animals in or out of the experimental area six different times each day. In addition, the number of leafy spurge stems per square meter in twenty-five 1 m^2 areas were counted and the number of flowering stems was recorded. One square meter clips were taken every fourth day to determine the percent grass, forb, brush, and leafy spurge component of the experimental area in order to determine plant preference and total utilization by goats.

Preliminary results indicate the containment system works perfectly. No collared goats have left the experimental area in eight days of testing. The uncollared goats leave occasionally but never wander more than 50 to 100 feet from the containment area. Third, leafy spurge utilization increased dramatically after about the third day when brush species were less available. It appears that goats have a strong preference for several species of brush and leafy spurge.

Summary

The results of the two studies conducted to date indicate the Invisible Fence system works well for goat containment. The results also indicate that goats have a strong preference for leafy spurge and with further testing on the containment system goats could represent a viable solution for leafy spurge in certain habitats.

There have been problems encountered in this research. Goats are extremely individualistic. One goat was not trainable to the collar system, and was eliminated from the collared portion of the herd so some goats cannot be trained. Out of seven goats tested, six became trained. One of the eleven goats, an uncollared goat, tends to wander off alone so some culling will be needed in a herd of leafy spurge grazers.

It appears that the dog system is not powerful enough. It is designed for backyard containment of dogs. At present, we have approximately 1000 feet of wire surrounding the containment area with a transmitting zone from the wire electric field of approximately 10 feet. We would prefer to have an electronic field of at least 20 to 25 feet to discourage the animals from enduring shocks for only 20 feet if they were to escape the system.

Presently the Invisible Fence system costs about $600 for one collar, a transmitter, a transducer, and wire. The price could come down dramatically if a market for grazing animals is developed. We also verified that goats eat everything, not just leafy spurge. They eat a great deal of brush so if an infested area is heavily infested with brush as well as leafy spurge, there will be significant utilization. If the brush is desirable and grazing is not a goal, forget goats.

In summary, the research will terminate this summer with a number of goat barbecues throughout the Gallatin Valley of Montana to test consumer reaction in an attempt to develop a market for goat meat.

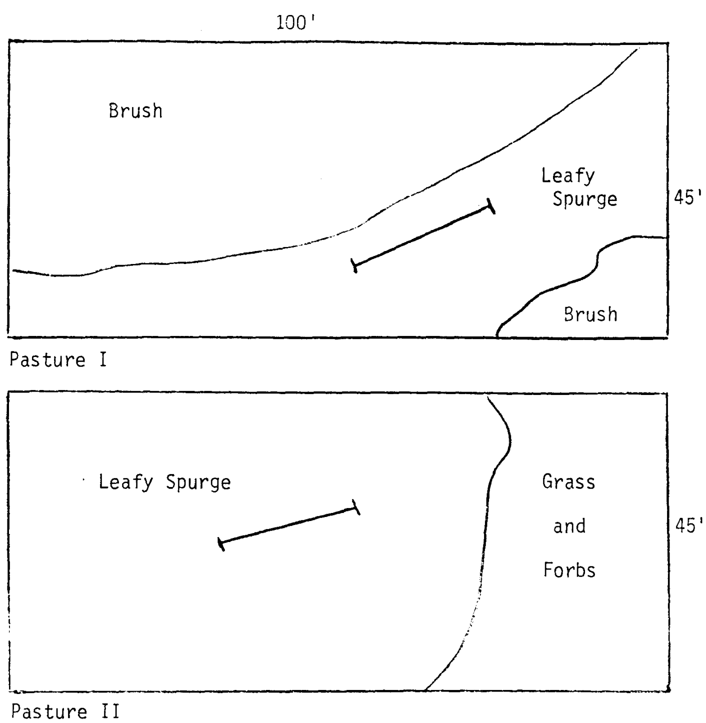

Figure 1. The vegetation cover of two pastures grazed by goats for eight days. Each pasture contained one permanent 50-foot long transect in leafy spurge.

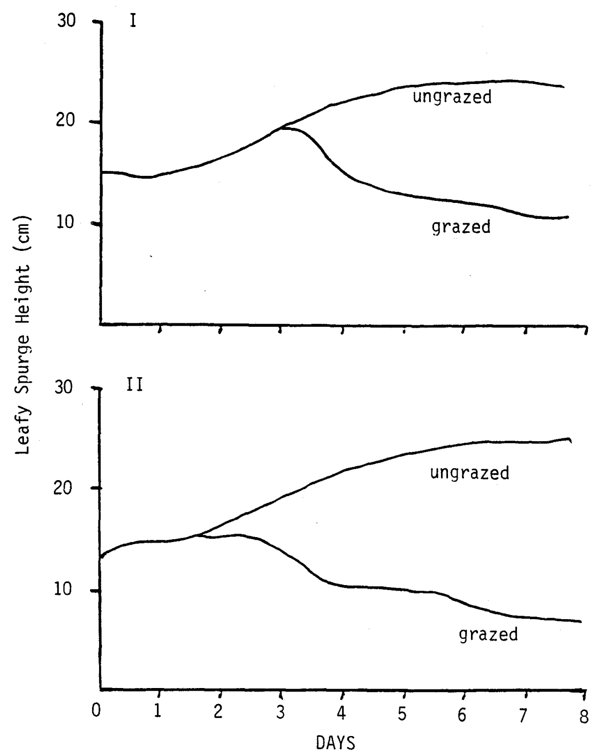

Figure 2. The reduction in leafy spurge height in eight days of grazing by goats in a pasture with 60% brush cover (I) and 5%, brush cover (II).

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The effect of sulfometuron and 2,4-D combinations on leafy spurge

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It has been suggested that 2,4-D {(2,4-dichlorophenoxy) acetic acid} in combination wito sulfometyron {2-[[[[(4,6-dimethyl-2-pyrimidinyl) amino] carbonyl] amino] sulfonyl] benzoic acid} may produce a synergistic response when applied to leafy spurge (*Euphorbia esula* L.) (1,2). It was demonstrated that postemergence field application of sulfometuron + 2,4-D at 1 oz/A and 1 lb/A, respectively, severely inhibited root bud growth (1).

This reported study was initiated to evaluate, under greenhouse conditions, the response of leafy spurge treated with a variety of concentration combinations of 2,4-D and sulfometuron.

Individual leafy spurge plants were grown in large PVC pipes, 4" diameter and 39" long. Plants had been transplanted by root cuttings two years prior to the experiment and had, therefore, developed an extensive root system extending to the base of the pipe. Each spurge plant was cut to 1" above surface of soil five weeks prior to treatment. Herbicide treatments included every possible combination of five rates of both 2,4-D and sulfometuron: 2,4-D - 0, 0.125, 0.25, 0.5, and 1.0 lb/A ai; sulfometuron - 0, 0.25, 0.5, 1.0 and 2.0 oz/A ai. Treatments were applied with a backpack sprayer (5 reps/ treatment). The plants were subsequently placed in a greenhouse with 16h light and at a temperature range of 20 to 30°C. Treatments were evaluated twice a week for four weeks. After four weeks the plants were cut to 1 inch above the soil surface and again evaluated weekly for regrowth and injury.

Results after four weeks of treatment indicate nearly complete control of leafy spurge at 0.5 and 1.0 lb/A 2,4-D regardless of the concentration of sulfometuron. In each case the symptoms observed were those classically associated with phenoxy herbicides. All treatments of sulfometuron alone had no effect on leafy spurge growth.

The Colby method (3) of evaluating herbicide combinations indicated that no clear synergistic response existed between 2,4-D and sulfometuron in leafy spurge. Injury symptoms apparently depend only on the concentration of 2,4-D.

After six weeks of regrowth (10 weeks after treatment), 2,4-D and sulfometuron combinations demonstrated the opposite effect. Although no treatment inhibited the number of new shoots or their initiation, dramatic differences in both shoot height (82% reduction at 2.0 oz/A) and the appearance of symptoms were observed. The reduction in shoot growth, however, correspond to sulfometuron concentrations and not to the concentrations of 2,4-D. In addition, chlorosis, thin leaves, and stunting were associated with sulfometuron treatments, but not with 2,4-D alone.

Results of this study suggest that sulfometuron and 2,4-D combinations in leafy spurge do not produce a synergistic response in either treated shoots or new shoots initiated after treated shoots were removed. However, soil applied sulfometuron may elicit an entirely different response, as the herbicide would be available for root absorption over a longer period of time.

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Absorption and translocation of ^{14}C-picloram in leafy spurge

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The influence of ammonium salts, 2,4-D and spray solution pH on the absorption and translocation of ^{14}C-picloram was determined in leafy spurge. Absorption and translocation of ^{14}C-picloram in leafy spurge were greater when ^{14}C-picloram was applied with 0.1 and 0.5 g/100 ml ammonium sulfate than when applied alone. Absorption and translocation of ^{14}C-picloram in leafy spurge were similar when ^{14}C-picloram was applied alone and with 0.1 and 0.5 g/100 ml ammonium nitrate.

Leafy spurge absorbed and translocated more ^{14}C-2,4-D than ^{14}C-picloram. Addition of 2,4-D to ^{14}C-picloram or picloram to ^{14}C-2,4-D did not increase translocation of either ^{14}C-herbicide to leafy spurge roots compared to the respective ^{14}C-herbicide applied alone.

Absorption and translocation of ^{14}C-picloram in leafy spurge were similar regardless of unbuffered treatment solution pH. Absorption and translocation of ^{14}C-picloram were greater when ^{14}C-picloram was applied in buffer solutions at pH 4.8 than at pH 3.1, 6.4 and 10.3. Buffered treatment solutions at pH 4.8 but not 3.1 or 6.4 increased ^{14}C-picloram absorption in detached leafy spurge leaves compared to unbuffered treatment solutions at a similar pH.

Absorption of ^{14}C-picloram in detached leafy spurge leaves increased as the citrate buffer concentration increased from 0 (unbuffered) to 0.1 M. Absorption of ^{14}C-picloram in detached leafy spurge leaves increased as time after treatment increased from 1 to 24 hours. Trisodium citrate increased ^{14}C-picloram absorption in detached leafy spurge leaves more than any other buffering agent tested compared to an unbuffered treatment solution.

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Picloram release by leafy spurge roots

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Previous research in the field and laboratory have shown that picloram was present in soil when only leafy spurge foliage was treated, which suggested that picloram was absorbed by the shoots and then was released by roots. Laboratory and greenhouse experiments were conducted to evaluate the processes involved in release of picloram by leafy spurge roots. Factors examined included exudation over time, root temperature, picloram application rates, and the addition of 2,4-D with picloram.

General procedure. All experiments were conducted using rooted cuttings of leafy spurge accession 79-MN-008. The cuttings were grown in a peat moss:perlite mixture for a minimum of 6 weeks. Plants were selected for uniform size and age and were transferred to aerated, dilute nutrient solution for equilibration 3 days before treatment. ^{14}C-picloram at about 70,000 dpm/plant was applied to a single, mature leaf. The ^{14}C-picloram application was preceded and followed by 5 µl of a 0.1% surfactant solution. All plants were harvested by sectioning into treated leaf, stem, and roots. The treated leaf was washed to determine the unabsorbed herbicide, and the plant material was dried, weighed and combusted. Nutrient solutions were concentrated by freeze drying and were redissolved in an ethanol-water solution. ^{14}C content was determined by liquid scintillation spectroscopy.

Exudation over time. Plants were treated as above and were grown for 120 hours before harvest. The nutrient solution was changed for half of the plants at 12, 24, 48, 72, 96, and 120 hours after ^{14}C-picloram application.

Comparison of the total exudation after 120 hours for the changed and unchanged solutions found no difference in the total amount of ^{14}C- picloram exuded. Comparison of ^{14}C-picloram recovered for each 24-hour period also showed no difference. Therefore, there was a linear relationship when the recovered ^{14}C-picloram amounts were accumulated with time.

These experiments suggest that picloram release is a linear process that begins within 12 hours of application and continues beyond 120 hours.

Temperature. Plants treated as previously described were placed into water baths that maintained root and solution temperatures of 14, 19, and 31° C. The topgrowth was maintained at room temperature throughout the experiments. The plants were harvested after 48 hours.

No differences were detected in released ^{14}C-picloram in solutions from any temperature treatment. A Q_{10} value was calculated for each repetition using the means for each temperature. The Q_{10} is a ratio of the rate of exudation for the high and low temperatures when there is a 10º C temperature difference. A Q_{10} value below 2.0 usually indicates a non-metabolically active process. The overall Q_{10} for picloram release by leafy spurge was 1.3 ± 0.77, with a range from 0.28 to 2.29.

These data suggest that picloram release is a passive process which is not affected substantially by environmental conditions.

Picloram application rate. Unlabeled picloram was applied by a greenhouse pot sprayer to plants immediately prior to applying ^{14}C-picloram and surfactant as previously described. The picloram rates were 0, 1/64, 1/32, 1/16, 1/8, and 1/4 lb ai/A.

Analysis of ^{14}C-exudation 48 hours post-treatment found no difference in exudation rate over these picloram rates, so total exudation increased directly with application rate. Previous research in the field, where picloram rates up to 2 lb/A were used, found increases in soil residues with rate of application.

Picloram plus 2,4-D. Tank mixing low rates of picloram and 2,4-D has resulted in enhanced leafy spurge control. Picloram plus 2,4-D were applied to plants treated with unlabeled- and ^{14}C-picloram as described previously at rates of 0 plus 0, 1/8 plus 0, 0 plus 1/4, 1/8 plus 1/4, 1/8 plus 1/2, and 1/8 plus 1 lb/A, respectively.

No differences in herbicide exudation were detected between any of the treatments. The synergism of these two herbicides in leafy spurge apparently is not due to reducing picloram exudation when 2,4-D is present. Results of all ^{14}C-picloram experiments. The ^{14}C-picloram distribution in leafy spurge, averaged across all experiments, is presented in Table 1. About 58% of the picloram applied to leafy spurge never entered the plant. Of the absorbed herbicide, about 75% remained in the stem and leaves and 25% was moved to the root zone (37 vs. 12.2%, respectively). Of the herbicide in the root zone, 64% was outside the plant (8% in nutrient solution vs. 4.4% in roots). In total, only 1.7% of the applied picloram was recovered from the roots. Since picloram is released passively from the roots, it appears that increased control of leafy spurge with picloram will be accomplished through increased absorption and translocation into the root zone.

Table 1. Summary of ^{14}C-picloram distribution in leafy spurge, averaged over 284 plants from all experiments.[1]

Plant section	Percent of applied		Percent of absorbed	
	Mean	Range	Mean	Range
	(%)			
Unabsorbed	58 ± 17	35.7 - 89.0	---	---
Stem and leaves	15 ± 7	3.5 - 31.8	37 ± 19	20.3 - 85.6
Root zone				
Roots	1.7 ± 1	0.3 - 3.4	4.4 ± 2.8	0.8 - 11.6
Nutrient solution	4.0 ± 6	0.2 - 19.3	8.0 ± 10	1.0 - 33
Total	5.6 ± 6	0.6 - 21.5	12.2 ± 10	1.8 - 37

[1]An average of 70,000 dpm/plant were applied. Overall recovery averaged 79% and overall absorbance averaged 42%, based on percent of applied.

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Problems with artificial media for greenhouse plants of leafy spurge

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Leafy spurge plants have been grown and maintained in greenhouses of the Metabolism and Radiation Research Laboratory for eight years. Some of the same accessions have been maintained for the entire duration by occasional transplanting of roots, or by taking apical portions of vigorous shoots and transplanting them after they have rooted. This study was undertaken to determine if there were other media that would be more appropriate and perhaps more convenient to maintain plants for experiments requiring large numbers of uniform plants.

Plants were grown in a variety of potting media for several months to determine those that will give optimum growth of uniform plants for experimental purposes and for the long term maintenance of plants under greenhouse conditions. All plants were obtained from apical cuttings of a single accession: 1978 MI 001 collected in Michigan. Ten cm long cuttings were rooted in vermiculite watered with 1/4 strength Hoagland's nutrient solution with chelated iron. Then they were transplanted to several media (Table 1) in 10 cm plastic pots, placed into stainless steel trays and watered as needed with the same nutrient solution. Eight plants were used per treatment. When the plants were large enough, five plants were selected and transplanted to 18 cm plastic pots to the same medium and to different media. The media tested were: vermiculite (Terralite® horticultural grade), Sunshine Mix (a commercial mixture of limestone and sphagnum moss), soil (a mixture of 3 parts sandy loam soil and 1 part peat moss), washed sand, or to a mixture of Sunshine Mix and the soil (50% of each v/v). In the last experiment a second source of Sunshine Mix was included to compare to the Sunshine Mix used in the previous experiments. Plant growth was monitored by measuring plant height and counting the number of stems per pot. At the time of transplanting to the various media, the shoots were cut off and weighed. The roots were then tested for subsequent growth from already developed subterranean buds and newly formed buds. Growth was monitored again, shoots were cut off once more and new stems developed. At the end of the experiments the roots and newly grown stems were weighed separately, the number of shoot buds on the roots was determined, and the plants were discarded. Measurements of pH of the nutrient media in which the plants were grown were taken weekly for a one month period during the second experiment.

Cuttings grown in Sunshine Mix (SM) or a mixture of soil/SM (50% each, v/v) initially grew about as well or better than those cuttings grown in vermiculite, soil or sand (Table 1). The cuttings grew fairly uniformly in the various media. However, upon subsequent transfer to the same or alternate media, some obvious differences appeared; cuttings transferred from Sunshine Mix or to 50% soil/SM grew noticeably poorer than the other plants in two out of three experiments (Tables 1 to 3). Plant heights, numbers of stems, shoot and root fresh weights and numbers of root buds were all reduced significantly in this treatment, compared to plants maintained in vermiculite (which generally gave the most vigorous growth of all the treatments). Variations in the data were often large; standard deviations ranged from 2% to 83% of the mean values, with the great majority being less than 50% of the mean values.

The results of the second experiment were more complex because all plants transplanted to Sunshine Mix or the 50% soil/SM grew very poorly initially. They died when they were clipped off for the regrowth test. Other treatments that grew poorly in this experiment were: (a) plants in vermiculite transplanted to soil, to sand, and to the 50% mixture; (b) plants in Sunshine Mix transplanted to all other media; (c) plants in soil transplanted to soil, to sand and to the 50% mixture; (d) plants in the 50% mixture transplanted to Sunshine Mix, to soil and to sand. Therefore, it appears that the plants were generally less vigorous than in the first experiment.

In the third experiment, the results were even more variable and difficult to interpret. In this case the only plants that grew well upon transplanting were those grown in vermiculite for the entire experiment. Most of the plants grew poorly after they were transplanted into the various media. A large number of them died. The vermiculite-grown plants had shoots that averaged 59 cm high with 9 tillers, shoot fresh weight of 43 g, root fresh weight of 39 g and 150 buds on the roots (Table 3). However, even one of these plants died after the last transplanting. In comparison, plants grown in all other media were reduced in all parameters, and dead plants were observed in all but three of the treatments.

Part of the reason for the poor growth in Sunshine Mix may have been due to the lower pH, which was measured weekly over a one month period during the second experiment. The pH in Sunshine Mix ranged from 5.9 to 6.4, whereas the pH of the vermiculite ranged from 6.1 (initial) to 8.4. The pH ranges of the other media were: 6.3 to 6.7 for soil, 6.3 to 6.8 for the soil-Sunshine Mix, and 7.0 to 7.4 for the sand. This aspect has not been pursued further.

Conclusions

Vermiculite watered with Hoagland's nutrient proved to be the best medium for growing leafy spurge plants when they were grown as described above. Other media (such as Sunshine Mix) initially looked good, but upon subsequent transplantings growth was poor. The initial vigor of the shoots may have occurred at the expense of the root system, so that subsequent transplantings may have had a root system that was not developed enough to withstand the shock of transplanting. Perhaps the vigor of the cuttings obtained from this accession diminished with time. The reasons for the loss of vigor of the plants with time are unknown, although it is possible that the time of the year in which the experiments were run may have had a greater influence on the growth than anticipated. The first experiment was run during the summer of 1986 when leafy spurge in the field is growing luxuriantly. The second experiment was in the fall, and the third one was during the winter. Although they were all under somewhat controlled environments (greenhouse), the light, temperature and day length were not identical. The plants maintained in vermiculite were generally in better condition than the others in all three experiments, although one plant died even in that medium in experiment 3. Perhaps the stems were cut off too soon after transplanting to allow sufficient vigor to develop, especially for plants grown during the winter months (experiment 3).

In general, the Sunshine Mix appears to be a poor medium for continued maintenance of leafy spurge plants; bud development on the roots was particularly poor on those plants maintained in that medium with or without the addition of soil.

Table 1. Growth and development of leafy spurge plants grown in various media and transferred to the same or different media. Cuttings were obtained from shoot apices grown in vermiculite and transferred to the same or different media on 6/26/86. The stems were cut off on 7/23/86 and the regrowth was measured on 10/19/86.

	Date, 1986									
	5/27	6/20	6/26	Growth to 7/23		Growth from 7/23 to 10/9				
Medium	Stem Ht.[a] (cm)	Stem Ht. (cm)	Trf. to	Avg. Ht. (cm)	No. Stems	Avg. Ht. (cm)	No. Stems	Sht. FW (g)	Rt. FW (g)	No. Rt Buds
Vermic.	5.0	9.2	Vermic.	22	12	24	1.7	25	35	41
			Sunmix.	26	14	22	8	13	22	5
			Soil/peat	15	26	17	28	14	22	21
			50:50[b]	28	20	15	13	10	14	2
			Sand	15	18	21	24	16	28	9
Sunmix	5.1	11.2	Vermic.	18	8	22	14	16	15	14
			Sunmix	22	4	10	2	3	3	1
			Soil/peat	16	16	17	19	11	17	8
			50:50	21	8	14	3	5	7	1
			Sand	13	11	17	14	11	23	13
Soil/ peat	5.2	6.7	Vermic.	18	6	21	11	16	14	6
			Sunmix	28	7	23	7	14	18	5
			Soil/peat	15	8	19	12	12	14	33
			50:50	26	10	20	11	14	18	6
			Sand	11	6	19	11	11	16	12
Sand	5.6	9.4	Vermic.	20	11	23	18	24	25	13
			Sunmix	25	14	19	7	12	18	4
			Soil/peat	12	12	16	19	14	18	23
			50:50	29	13	20	22	18	27	5
			Sand	22	10	20	18	15	28	42
Avg.	5.2									

[a]Abbreviations are: Ht. = height; Trf.=transferred; Avg.=average; No. = number; Sht.=shoot; Rt.=root; FW = fresh weight.

[b]Soil/Sunshine Mix (50% each).

Table 2. Growth and development of leafy spurge plants grown in various media. Cuttings were obtained from shoot apices, grown in vermiculite and transferred to the same or different media on 9/4/86; cut back on 9/4/86 and 11/3/86.

	Date, 1986									
	9/3		Growth 9/4 to 11/3			Growth 11/3 to 12/22				
Initial Growth Medium	Stem Ht.[a] (cm)	Trf. to:	Avg. Ht. (cm)	No. Stems	Sht. FW (g)	Avg. Ht. (cm)	No. Stems	Sht. FW (g)	Rt. FW (g)	No. Rt. Buds
Vermic.	37	Vermic.	29	12	16	35	14	26	28	68
		Sunmix.	34	7	21	36	9	20	25	53
		Soil	19	9	3	21	4	5	9	24
		50:50	15	5	3	7	2	1	4	12
		Sand	16	8	3	12	3	1	11	31
Sunmix	41	Vermic.	15	3	4	9	3	4	4	5
		Sunmix	2	0	0.1	0	0	0	0	0
		Soil	11	5	2	12	3	2	5	14
		50:50	6	1	0.4	0	0	0	0	0
		Sand	14	5	4	6	3	1	8	18
Soil	28	Vermic.	33	5	10	31	6	14	18	38
		Sunmix	32	7	19	28	11	14	24	52
		Soil	19	6	3	21	4	5	8	19
		50:50	31	10	17	22	8	9	20	41
		Sand	21	6	6	18	3	3	10	9
50:50	34	Vermic.	19	6	9	16	7	10	12	18
		Sunmix	17	2	5	9	3	3	6	16
		Soil	9	6	1	8	4	2	5	9
		50:50	26	6	11	28	8	14	18	40
		Sand	7	2	1	3	0.2	1	2	3
Sand	27	Vermic.	28	3	7	36	5	14	11	26
		Sunmix	34	4	12	32	8	20	20	61
		Soil	15	6	2	24	5	9	13	31
		50:50	38	5	15	36	7	16	20	43
		Sand	14	2	1	19	2	3	4	11

[a]Abbreviations as in Table 1.

Table 3. Growth and development of leafy spurge plants grown in various media. Cuttings were obtained from shoot tips, grown in vermiculite and transferred to the same or different media on 12/18/86; cut back on 1/21/87.

		Growth 1/21 to 5/4/87					
Initial Growth Medium	Trf. to[a]	Avg. Ht. (cm)	No. Stems	Sht. FW (g)	Rt. FW (g)	No. Rt. Buds	No. Dead Plants
Vermic.	Vermic.	59	9	43	39	150	1
	Sunmix	23	3	6	9	88	3
	Soil	29	2	6	9	74	1
	50:50	37	4	9	10	46	1
	Sand	17	3	1	3	2	1
	SUSM[b]	23	3	4	5	20	1
Sunmix	Vermic.	13	2	2	3	4	2
	Sunmix	30	2	5	7	27	1
	Soil	24	3	6	9	59	0
	50:50	29	6	7	9	55	3
	Sand	18	3	2	4	4	1
	SUSM	34	3	8	7	21	3
Soil	Vermic.	17	3	2	5	8	0
	Sunmix	43	2	9	13	67	2
	Soil	23	33	5	7	34	2
	50:50	30	3	8	8	57	1
	Sand	9	5	1	2	1	2
	SUSM	25	2	5	6	31	1
Sand	Vermic.	20	2	4	7	7	1
	Sunmix	46	3	7	10	57	2
	Soil	27	3	5	6	55	1
	50:50	34	3	8	9	35	1
	Sand	15	3	1	3	4	3
	SUSM	16	2	1	3	11	0
50:50	Vermic.	6	1	0.1	1	1	3
	Sunmix	19	2	3	5	39	3
	Soil	26	2	4	8	48	2
	50:50	30	2	4	8	48	2
	Sand	14	2	1	3	0	4
	SUSM	8	1	0.3	0.4	0	3
SUSM	Vermic.	4	3	0.1	1	1	4
	Sunmix	21	1	2	3	22	4
	Soil	19	3	3	4	47	3
	50:50	0	0	0	0	0	5
	Sand	9	1	0.4	2	6	4
	SUSM	0	0	0	0	0	5

[a]Abbreviations as in Table 1.

[b]Sunshine Mix obtained from N. D. State Univ. Agronomy Dept.

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Testing granular formulations of picloram for leafy spurge (*Euphorbia esula* L.) control

P. K. FAY and E. S. DAVIS

The Dow Chemical Company has ceased production of Tordon 2K, a dry pellet formulation of picloram. The loss of Tordon 2K will impact Montana since it was especially useful for spot treatment of pioneer patches of leafy spurge. Many ranchers and weed district personnel have used small amounts of Tordon 2K for many years effectively controlling the noxious rangeland weed. These experiments were established in an attempt to find substitute dry formulations of picloram. Complete fertilizer (14-14-14), ammonium sulphate fertilizer, "Tidy Kat," "Hagen," and a locally made organic cat litter were placed on a plastic sheet and sprayed with Tordon 22K using an atomizer. The herbicide was applied in numerous sprays and thoroughly mixed between applications. The final concentration for each material is shown in the table. Oat (*Avena sativa* L.) kernels were autoclaved and soaked in known amounts of Tordon 22K for 24 hours, removed from the solution, and air dried. They imbibed 1% (w/w) picloram as Tordon 22K. The dried materials and Tordon 2K granules were hand applied to 7 by 25 foot plots at Bozeman and Whitehall, MT on May 14, 1986. Tordon 22K was applied using a CO_2-pressurized backpack sprayer in 15 gpa. There were 3 replications arranged in a randomized complete block design at both locations. Leafy spurge control was visually rated in June of 1986 and 1987 at both locations (Table).

Tordon 22K, the liquid formulation of picloram was ineffective at both rates tested at both locations. Tordon 2K, the extruded pellet formulation, provided effective control 13 months after application. The impregnated fertilizer treatments were very effective at the highest rate tested. The impregnated cat litter formulations were also effective at both locations when applied at the rate of 1 lb a.i./A. Dead oat kernels imbibed with Tordon 22K were erratic at Bozeman but provided complete control at Whitehall. It appears that picloram can be impregnated on many types of substrates and maintain good activity on leafy spurge. (Montana Agric. Exp. Sta., Bozeman, MT 59717.)

The effect of picloram impregnated on several substrates for leafy spurge control in Bozeman and Whitehall, MT.

Picloram Formulation Type	Formulation Active Ingredient	Picloram Rate	Leafy Spurge Control			
			Bozeman		Whitehall	
			6-12-86	6-15-87	6-26-86	6-15-87
		lb/A	(%)			
Tordon 22K	2 E.C.	0.5	84	31	0	28
Tordon 2K	2%	0.5	48	73	43	92
14-14-14 fertilizer	0.43%	0.5	35	46	13	59
NH_4 SO_4	0.43%	0.5	37	45	35	99
"Tidy Kat" cat litter	2%	0.5	27	40	53	99
"Hagen" cat litter	2%	0.5	40	59	48	100
Organic cat litter	1%	0.5	45	64	32	60
Dead oat kernels	1%	0.5	43	50	30	97
Tordon 22K	2 E.C.	1.0	98	55	13	48
Tordon 2K	2%	1.0	65	87	82	99
14-14-14 fertilizer	0.43%	1.0	58	100	53	100
NH_4SO_4 fertilizer	0.43%	1.0	67	94	92	100
"Tidy Kat" cat litter	2%	1.0	94	99	87	100
"Hagen" cat litter	2%	1.0	71	98	35	100
Organic cat litter	1%	1.0	75	96	43	100
Dead oat kernels	1%	1.0	37	83	62	100
Control	---		0	0	0	0
LSD .05			31	31	21	14

EXPERIMENT NO.: 85015005

TITLE: HERBICIDES FOR LEAFY SPURGE CONTROL.
BRASS LANTERN ESTATES
BOZEMAN, MONTANA

CROP INFORMATION

Crop: RANGE	Seeding Method
Variety:	Seeding Depth:
Planted:	Row Width:
Experimental Design: RCB	Seeding Rate:
Replications: 3	Plot Size: 7 FT X 25 FT

SOIL INFORMATION

Soil Type: GRAVELLY LOAM	Previous Crop: RANGE
Organic Matter: 3% pH: 8.0	Fertilizer Used: NONE

HERBICIDE APPLICATION TREATMENT 1-24

Date: 6-28-85	Surfactant Used: NONE
Mixed By: FAY	In Trt:
Applied By: DAVIS	Surfactant Rate:
Propellant: CO2	Sprayer: BACKPACK
Pressure: 40 PSI	Volume: 25 GPA
Time: 2:30 P.M.	Nozzles: 8002
Cloud Cover:	Rel. Humidity: 19%
Wind Speed: 0-4 MPH	Air Temperature: 86 F
Wind Direction: NORTH	Soil Temp.: 2"91 F 4"
Note:	

Crop Stage: RANGE

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	EARLY SENESCENCE	HEAVY

RATING INFORMATION number 01 OF 03 TOTAL RATINGS
Rated By: DAVIS Date: 7-29-85
Crop Stage: RANGE
Rating Method: 0=NO CONTROL 100= COMPLETE KILL

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	SEED-FILL	HEAVY

RATING INFORMATION number 02 OF 03 TOTAL RATINGS
Rated By: FAY Date: 6-12-86
Crop Stage: RANGE
Rating Method: 0=NO CONTROL 100= COMPLETE KILL

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	EARLY FLOWER	HEAVY

RATING INFORMATION number 03 OF 03 TOTAL RATINGS
Rated By: FAY, MCKONE Date: 6-15-87
Crop Stage: RANGE
Rating Method: 0=NO CONTROL 100= COMPLETE KILL

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	MID BLOOM	HEAVY

SUMMARY

Two years after application only Tordon at a rate of 2 lb/acre provided control of leafy spurge. The rate of control was only 72% illustrating the frustrations being voiced by people trying to control spurge chemically.

EXPT. LOCATION:BRASS LANTERN EST. BOZEMAN, MT
RESEARCH BY:FAY/DAVIS INITIATED:06/28/85 COMPLETED:06/15/87

TRT. NO.	PESTICIDE NAME	FORMU.	LBai/A	APPLI-CATION TYPE	% LEAFY SPURGE 7/29/85	% LEAFY SPURGE 6/12/86	% LEAFY SPURGE 6/15/87
01	GARLON	EC 4.0	4.0	SPOST	69	10	3
02	GARLON	EC 4.0	8.0	SPOST	81	0	0
03	GARLON	EC 4.0	2.0	SPOST	46	0	0
	XRM 3972	SC 3.0	2.0	SPOST			
04	GARLON	EC 4.0	3.0	SPOST	51	3	3
	XRM 3972	SC 3.0	3.0	SPOST			
05	GARLON	EC 4.0	.5	SPOST	74	3	3
	2,4-D AM	SC 4.0	1.0	SPOST			
06	GARLON	EC 4.0	1.0	SPOST	81	3	5
	2,4-D AM	SC 4.0	2.0	SPOST			
07	TORDON	SC 2.0	.5	SPOST	81	36	13
08	TORDON	SC 2.0	1.0	SPOST	56	57	10
09	TORDON	SC 2.0	2.0	SPOST	78	96	72
10	XRM 4703	SC 1.5	.25	SPOST	77	8	3
11	XRM 4703	SC 1.5	.5	SPOST	66	25	0
12	XRM 4703	SC 1.5	1.0	SPOST	79	39	8
13	XRM 3972	SC 3.0	2.0	SPOST	52	5	0
14	XRM 3972	SC 3.0	4.0	SPOST	50	8	0
15	XRM 3972	SC 3.0	.5	SPOST	64	18	5
	STARANE	SC 1.67	.5	SPOST			
16	XRM 3972	SC 3.0	1.0	SPOST	59	3	3
	STARANE	SC 1.67	1.0	SPOST			
17	XRM 3972	SC 3.0	2.0	SPOST	79	10	3
	STARANE	SC 1.67	2.0	SPOST			
18	STARANE	SC 1.67	1.0	SPOST	79	0	5
19	STARANE	SC 1.67	2.0	SPOST	81	10	13
20	STARANE	SC 1.67	4.0	SPOST	91	10	7
21	CHECK				0	0	0
22	KRENITE	SC 4.0	2.0	SPOST	48	7	0
23	KRENITE	SC 4.0	4.0	SPOST	25	8	5
24	KRENITE	SC 4.0	8.0	SPOST	58	63	12
				LSD(0.05) =	28	18	12
				STANDARD DEVIATION =	17	11	7
				COEFF. OF VARIABILITY =	26	63	98

EXPERIMENT NO.: 86020001

TITLE: TESTING DPD FOR CONTROL OF LEAFY SPURGE.
RAY GILLESPIE RANCH, WHITEHALL, MT.

CROP INFORMATION

Crop:
Variety:
Planted:
Experimental Design: RCB
Replications: 3

Seeding Method
Seeding Depth:
Row Width:
Seeding Rate:
Plot Size: 7 FT. X 25 FT.

SOIL INFORMATION

Soil Type: GRAVELLY LOAM
Organic Matter: 3% pH: 7.0

Previous Crop: PASTURE
Fertilizer Used: NONE

HERBICIDE APPLICATION TREATMENTS 1-5

Date: 6-20-86
Mixed By: DAVIS
Applied By: BIGLEN
Propellant: CO2
Pressure: 40 PSI
Time: 12:00 NOON
Cloud Cover:
Wind Speed: 4-6 MPH
Wind Direction: SOUTH
Note:

Surfactant Used: LI-700
In Trt: 1-5
Surfactant Rate: 2 QT./100 GAL.
Sprayer: BACKPACK
Volume: 34 GPA
Nozzles: 8002
Rel. Humidity: 60%
Air Temperature: 74 F
Soil Temp.: 2"92 F 4"73 F

Crop Stage:

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	FLOWERING	HEAVY

RATING INFORMATION number 01 OF 03 TOTAL RATINGS

Rated By: FAY, FELLOWS Date: 7-11-86
Crop Stage:
Rating Method: 0=NO CONTROL 100= COMPLETE KILL

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	SEED FILL	HEAVY

RATING INFORMATION number 02 OF 03 TOTAL RATINGS

Rated By: FAY, MCKONE Date: 8-22-86
Crop Stage:
Rating Method: 0=NO CONTROL 100= COMPLETE KILL

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	SENESCENCE	MODERATE

EXPERIMENT NO.: 85015005

TITLE: HERBICIDES FOR LEAFY SPURGE CONTROL.
BRASS LANTERN ESTATES
BOZEMAN, MONTANA

CROP INFORMATION

Crop: RANGE	Seeding Method
Variety:	Seeding Depth:
Planted:	Row Width:
Experimental Design: RCB	Seeding Rate:
Replications: 3	Plot Size: 7 FT X 25 FT

SOIL INFORMATION

Soil Type: GRAVELLY LOAM	Previous Crop: RANGE
Organic Matter: 3% pH: 8.0	Fertilizer Used: NONE

HERBICIDE APPLICATION TREATMENT 1-24

Date: 6-28-85	Surfactant Used: NONE
Mixed By: FAY	In Trt:
Applied By: DAVIS	Surfactant Rate:
Propellant: CO2	Sprayer: BACKPACK
Pressure: 40 PSI	Volume: 25 GPA
Time: 2:30 P.M.	Nozzles: 8002
Cloud Cover:	Rel. Humidity: 19%
Wind Speed: 0-4 MPH	Air Temperature: 86 F
Wind Direction: NORTH	Soil Temp.: 2"91 F 4"
Note:	

Crop Stage: RANGE

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	EARLY SENESCENCE	HEAVY

RATING INFORMATION number 01 OF 03 TOTAL RATINGS
Rated By: DAVIS Date: 7-29-85
Crop Stage: RANGE
Rating Method: 0=NO CONTROL 100= COMPLETE KILL

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	SEED-FILL	HEAVY

RATING INFORMATION number 02 OF 03 TOTAL RATINGS
Rated By: FAY Date: 6-12-86
Crop Stage: RANGE
Rating Method: 0=NO CONTROL 100= COMPLETE KILL

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	EARLY FLOWER	HEAVY

RATING INFORMATION number 03 OF 03 TOTAL RATINGS
Rated By: DAVIS   Date: 6-19-87
Crop Stage:
Rating Method: 0=NO CONTROL 100= COMPLETE KILL

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	MID BLOOM	MODERATE

SUMMARY

DPD ester, sold by Westchem, did not provide effective control one year after application.

FILE NAME:86020001.EXP   INTERIM   PRINTED:01/07/88

M O N T A N A   S T A T E   U N I V E R S I T Y

TESTING DPD FOR CONTROL OF LEAFY SPURGE

EXPT. LOCATION:WHITEHALL, MT
RESEARCH BY:FAY/DAVIS   INITIATED:06/20/86   COMPLETED:06/19/87

TRT. NO.	PESTICIDE NAME	FORMU.	LBai/A	APPLI-CATION TYPE	% LEAFY SPURGE 7/11/86	% LEAFY SPURGE 8/22/86	% LEAFY SPURGE 6/19/87
01	DPD ESTR	EC 4.0	2.0	FLOWR	87	97	62
	LI - 700		2qt/ 100gl	FLOWR			
02	DPD ESTR	EC 4.0	4.0	FLOWR	99	99	47
	LI - 700		2qt/ 100gl	FLOWR			
03	DPD ESTR	EC 4.0	2.0	FLOWR	63	66	47
	LI - 700		2qt/ 100gl	FLOWR			
	TORDON	SC 2.0	.25	FLOWR			
04	DPD ESTR	EC 4.0	2.0	FLOWR	94	100	54
	LI - 700		2qt/ 100gl	FLOWR			
	BANVEL	SC 4.0	.5	FLOWR			
05	DPD ESTR	EC 4.0	4.0	FLOWR	99	100	83
	LI - 700		2qt/ 100gl	FLOWR			
	TORDON	SC 2.0	.25	FLOWR			
06	TORDON	SC 2.0	1.0	FLOWR	79	89	98
07	CONTROL				33	33	23
	LSD(0.05) =				58	59	43
	STANDARD DEVIATION =				33	33	24
	COEFF. OF VARIABILITY =				41	40	41

EXPERIMENT NO.: 86020002

TITLE: HERBICIDES FOR LEAFY SPURGE CONTROL.
RAY GILLESPIE FARM, WHITEHALL, MT.

CROP INFORMATION

Crop: PASTURE
Variety:
Planted:
Experimental Design: RCB
Replications: 3

Seeding Method
Seeding Depth:
Row Width:
Seeding Rate:
Plot Size: 7 FT X 25 FT

SOIL INFORMATION

Soil Type: GRAVELLY LOAM
Organic Matter: 3%   pH: 7.0

Previous Crop: PASTURE
Fertilizer Used: NONE

HERBICIDE APPLICATION   TREATMENT 1-14

Date: 6-17-86
Mixed By: DAVIS
Applied By: COBLE
Propellant: CO2
Pressure: 40 PSI
Time: 9:30 A.M.
Cloud Cover:
Wind Speed: 0 MPH
Wind Direction:
Note:

Surfactant Used: X-77
In Trt: 1-9,12,13
Surfactant Rate: 0.25%
Sprayer: BACKPACK
Volume: 14.5 GPA
Nozzles: 8002
Rel. Humidity: 40%
Air Temperature: 83 F
Soil Temp.: 2"66 F   4"62 F

Crop Stage:

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	FLOWERING	MODERATE

RATING INFORMATION number 01 OF 03 TOTAL RATINGS

Rated By: FAY, FELLOWS   Date: 7-11-86
Crop Stage:
Rating Method: 0=NO CONTROL 100= COMPLETE KILL

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	SEED FILL	MODERATE

RATING INFORMATION number 02 OF 03 TOTAL RATINGS

Rated By: FAY, MCKONE   Date: 8-22-86
Crop Stage:
Rating Method: 0=NO CONTROL 100= COMPLETE KILL

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	SENESCENCE	MODERATE

RATING INFORMATION number 03 OF 03 TOTAL RATINGS
Rated By: DAVIS   Date: 6-19-87
Crop Stage:
Rating Method: 0=NO CONTROL 100= COMPLETE KILL

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	MID BLOOM	MODERATE

SUMMARY

Oust, Escort, and Krenite did not provide effective control one, two or twelve months after application.

EXPT. LOCATION: WHITEHALL, MT
RESEARCH-BY: FAY/DAVIS   INITIATED: 06/17/86   COMPLETED: 06/19/87

TRT. NO.	PESTICIDE NAME	FORMU.	LBai/A	APPLI-CATION TYPE	%LEAFY SPURGE 7/11/86	% SEED CONTROL 7/11/86	% LEAFY SPURGE 8/22/86	% LEAFY SPURGE 6/19/87							
01	OUST	DF 75%	.7 oz	FLOWR	10	92	3	0							
02	OUST	DF 75%	1.5oz	FLOWR	17	98	5	2							
03	ESCORT	DF 60%	.3 oz	FLOWR	3	74	2	0							
04	ESCORT	DF 60%	.6 oz	FLOWR	7	83	5	2							
05	OUST ESCORT	DF 75% DF 60%	.75oz .3 oz	FLOWR FLOWR	7	92	0	0							
06	OUST ESCORT	DF 75% DF 60%	.75oz .6 oz	FLOWR FLOWR	10	97	3	3							
07	OUST ESCORT	DF 75% DF 60%	1.0oz .3 oz	FLOWR FLOWR	15	100	10	10							
08	OUST ESCORT	DF 75% DF 60%	1.0oz .6 oz	FLOWR FLOWR	17	93	2	0							
09	OUST ROUNDUP	DF 75% SC 4.0	1.0oz 1.0qt	FLOWR FLOWR	32	85	11	7							
10	KRENITE	SC 4.0	1.0gl	FLOWR	18	78	8	10							
11	KRENITE	SC 4.0	2.0gl	FLOWR	36	100	21	43							
12	OUST KRENITE	DF 75% SC 4.0	1.5oz 1.0gl	FLOWR FLOWR	40	100	18	30							
13	OUST 2,4-D AM	DF 75% SC 4.0	1.0oz 4.0oz	FLOWR FLOWR	82	95	81	52							
14	TORDON	EC 2.0	1.0lb	FLOWR	50	73	84	89							
15	CONTROL				0	0	0	0							
	LSD(0.05) =				16	20	10	11							
	STANDARD DEVIATION =				10	12	6	7							
	COEFF. OF VARIABILITY =				42	14	36	39							

EXPERIMENT NO.: 86020003

TITLE: BANVEL AND TORDON COMBINATIONS FOR LEAFY SPURGE CONTROL.
RAY GILLESPIE FARM, WHITEHALL, MT.

CROP INFORMATION

Crop: PASTURE	Seeding Method
Variety: `	Seeding Depth:
Planted:	Row Width:
Experimental Design: RCB	Seeding Rate:
Replications: 3	Plot Size: 7 FT X 25 FT

SOIL INFORMATION

Soil Type: GRAVELLY LOAM	Previous Crop: PASTURE
Organic Matter: 3% pH: 7.5	Fertilizer Used: NONE

HERBICIDE APPLICATION TREATMENT 1-14

Date: 6-17-86	Surfactant Used: NONE
Mixed By: LINDQUIST	In Trt:
Applied By: FELLOWS	Surfactant Rate:
Propellant: CO2	Sprayer: BACKPACK
Pressure: 40 PSI	Volume: 12 GPA
Time: 9:30 A.M.	Nozzles: 8002
Cloud Cover:	Rel. Humidity: 40%
Wind Speed: 0 MPH	Air Temperature: 83 F
Wind Direction:	Soil Temp.: 2"66 F 4"62 F
Note:	

Crop Stage: PASTURE

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	FLOWERING	HEAVY

RATING INFORMATION number 01 OF 03 TOTAL RATINGS
Rated By: FAY, FELLOWS Date: 7-11-86
Crop Stage:
Rating Method: 0=NO CONTROL 100= COMPLETE KILL

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	SEED-FILL	MODERATE

RATING INFORMATION number 02 OF 03 TOTAL RATINGS
Rated By: FAY, MCKANE Date: 8-22-86
Crop Stage:
Rating Method: 0=NO CONTROL 100= COMPLETE KILL

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	SENESCENCE	MODERATE

RATING INFORMATION number 03 OF 03 TOTAL RATINGS
Rated By: DAVIS Date: 6-19-87
Crop Stage:
Rating Method: 0=NO CONTROL 100= COMPLETE KILL

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	MID BLOOM	MODERATE

SUMMARY

Combinations of Banvel and Tordon, Banvel-2,4-D, Tordon-2,4-D, or EH 680 did not provide effective spurge control one year after application.

EXPT. LOCATION:GILLESPIE FARM, WHITEHALL, MT
RESEARCH BY:FAY/DAVIS INITIATED:07/11/86 COMPLETED:06/19/87

TRT. NO.	PESTICIDE NAME	FORMU.	LBai/A	APPLI-CATION TYPE	% LEAFY SPURGE 7/11/86	% LEAFY SPURGE 8/22/86	% LEAFY SPURGE 6/19/87
01	BANVEL	SC 4.0	2.0	FLOWR	20	10	7
02	BANVEL	SC 4.0	4.0	FLOWR	47	35	12
03	TORDON	SC 2.0	.25	FLOWR	15	7	7
04	TORDON	SC 2.0	.50	FLOWR	33	37	33
05	TORDON	SC 2.0	1.0	FLOWR	62	62	78
06	BANVEL	SC 4.0	1.0	FLOWR	57	65	65
	TORDON	SC 2.0	.25	FLOWR			
07	BANVEL	SC 4.0	1.0	FLOWR	80	88	65
	TORDON	SC 2.0	.50	FLOWR			
08	BANVEL	SC 4.0	.50	FLOWR	34	25	30
	TORDON	SC 2.0	.25	FLOWR			
09	BANVEL	SC 4.0	.5	FLOWR	52	57	62
	TORDON	SC 2.0	.5	FLOWR			
10	BANVEL	SC 4.0	.5	FLOWR	83	94	50
	2,4-D AM	SC 4.0	1.0	FLOWR			
11	TORDON	SC 2.0	.25	FLOWR	72	98	45
	2,4-D AM	SC 4.0	1.0	FLOWR			
12	EH 680	SC 2.0	1.0PT	FLOWR	85	81	28
13	EH 680	SC 2.0	2.0PT	FLOWR	85	87	33
14	EH 680	SC 2.0	3.0PT	FLOWR	98	97	35
15	CONTROL				0	0	0
				LSD(0.05) =	11	22	13
				STANDARD DEVIATION =	6	13	8
				COEFF. OF VARIABILITY =	12	24	21

EXPERIMENT NO.: 86020004

TITLE: COMBINATIONS WITH OUST FOR LEAFY SPURGE CONTROL.
RAY GILLESPIE FARM
WHITEHALL MONTANA.

CROP INFORMATION

Crop: PASTURE	Seeding Method
Variety:	Seeding Depth:
Planted:	Row Width:
Experimental Design: RCB	Seeding Rate:
Replications: 3	Plot Size: 7 FT. X 25 FT.

SOIL INFORMATION

Soil Type: GRAVELLY LOAM	Previous Crop: PASTURE
Organic Matter: 3% pH: 7.5	Fertilizer Used: NONE

HERBICIDE APPLICATION TREATMENTS 1-4

Date: 6-17-86	Surfactant Used: X-77
Mixed By: LINDQUIST	In Trt: 1-4
Applied By: FELLOWS	Surfactant Rate: 0.25%
Propellant: CO2	Sprayer: BACKPACK
Pressure: 40 PSI	Volume: 12 GPA
Time: 9:30 AM	Nozzles: 8002
Cloud Cover:	Rel. Humidity: 40%
Wind Speed: 0 MPH	Air Temperature: 83 F
Wind Direction:	Soil Temp.: 2"66 F 4"62 F
Note:	

Crop Stage: PASTURE GRASSES, 12 INCHES TALL

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	FLOWERING	HEAVY

RATING INFORMATION number 01 OF 03 TOTAL RATINGS
Rated By: FAY, FELLOWS Date: 7-11-86
Crop Stage:
Rating Method: 0=NO CONTROL 100= COMPLETE KILL

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	SEED FILL	HEAVY

RATING INFORMATION number 02 OF 03 TOTAL RATINGS
Rated By: FAY, MCKONE Date: 8-22-86
Crop Stage:
Rating Method: 0=NO CONTROL 100= COMPLETE KILL

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	RIPE	HEAVY

RATING INFORMATION number 03 OF 03 TOTAL RATINGS
Rated By: FAY, MCKONE Date: 6-15-87
Crop Stage:
Rating Method: 0=NO CONTROL 100= COMPLETE KILL

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	MID BLOOM	MODERATE

SUMMARY

Oust alone and in combination with 2,4-D, Banvel and Tordon did not provide effective spurge control one year after application.

FILE NAME:86020004.EXP INTERIM PRINTED:01/07/88

M O N T A N A S T A T E U N I V E R S I T Y

COMBINATIONS WITH OUST FOR LEAFY SPURGE CONTROL.

EXPT. LOCATION:GILLESPIE FARM, BOZEMAN, MT
RESEARCH BY:FAY/DAVIS INITIATED:06/17/86 COMPLETED:06/15/87

TRT. NO.	PESTICIDE NAME	FORMU.	LBai/A	APPLI-CATION TYPE	% LEAFY SPURGE 7/11/86	%CONTRL SEEDPRO 7/11/86	% LEAFY SPURGE 8/22/86	% LEAFY SPURGE 6/15/87	%INJURY GRASSES 6/15/87
01	OUST	DF 75%	1.0oz	SPOST	15	100	0	40	5
02	OUST	DF 75%	1.0oz	SPOST	99	98	97	79	10
	2,4-D AM	SC 4.0	1.0	SPOST					
03	OUST	DF 75%	1.0oz	SPOST	28	57	28	88	10
	BANVEL	SC 4.0	2.0	SPOST					
04	OUST	DF 75%	1.0oz	SPOST	30	40	21	85	10
	TORDON	SC 2.0	.25	SPOST					
05	CHECK				0	0	0	0	0
				LSD(0.05) =	12	11	11	9	14
				STANDARD DEVIATION =	6	6	6	4	8
				COEFF. OF VARIABILITY =	18	10	20	7	110

EXPERIMENT NO.: 8602006

TITLE: STARANE COMBINATIONS FOR LEAFY SPURGE CONTROL.
GILLESPIE FARM, WHITEHALL, MT.

CROP INFORMATION

Crop: PASTURE
Variety:
Planted:
Experimental Design: RCB
Replications: 3

Seeding Method
Seeding Depth:
Row Width:
Seeding Rate:
Plot Size: 7 FT X 25 FT

SOIL INFORMATION

Soil Type: GRAVELLY LOAM
Organic Matter: 3%   pH: 7.5

Previous Crop: PASTURE
Fertilizer Used: NONE

HERBICIDE APPLICATION   TREATMENT 1-10

Date: 6-17-86
Mixed By: DAVIS
Applied By: COBLE
Propellant: CO2
Pressure: 40 PSI
Time: 10:30 A.M.
Cloud Cover:
Wind Speed: 0 MPH
Wind Direction:
Note:

Surfactant Used: X-77
In Trt: 9,10
Surfactant Rate: 0.25%
Sprayer: BACKPACK
Volume: 14.5 GPA
Nozzles: 8002
Rel. Humidity: 40%
Air Temperature: 83 F
Soil Temp.: 2"66 F   4"62 F

Crop Stage:

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	FLOWERING	HEAVY

HERBICIDE APPLICATION   TREATMENT 11-20

Date: 7-29-86
Mixed By: RON WOOD
Applied By: DAVIS
Propellant: CO2
Pressure: 40 PSI
Time: 10:30 A.M.
Cloud Cover:
Wind Speed: 3-5 MPH
Wind Direction: SOUTH
Note:

Surfactant Used: X-77
In Trt: 19,20
Surfactant Rate: 0.25%
Sprayer: BACKPACK
Volume: 14 GPA
Nozzles: 8002
Rel. Humidity: 50%
Air Temperature: 84 F
Soil Temp.: 2"70 F   4"65 F

Crop Stage:

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	L. FLOWER, SEED-FILL	HEAVY

HERBICIDE APPLICATION TREATMENT 21-30

Date: 9-17-86
Mixed By: TOWNSEND
Applied By: DAVIS
Propellant: CO2
Pressure: 40 PSI
Time: 12:00 P.M.
Cloud Cover:
Wind Speed: 3-6 MPH
Wind Direction: NORTH
Note:

Surfactant Used: LI-700
In Trt: 29,30
Surfactant Rate: 0.25%
Sprayer: BACKPACK
Volume: 15 GPA
Nozzles: 8002
Rel. Humidity: 32%
Air Temperature: 73 F
Soil Temp.: 2"60 F 4"55 F

Crop Stage: PASTURE

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	SENESCENCE	HEAVY

RATING INFORMATION number 01 OF 03 TOTAL RATINGS

Rated By: FAY, FELLOWS Date: 7-11-86
Crop Stage:
Rating Method: 0=NO CONTROL 100= COMPLETE KILL

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	SEED-FILL	HEAVY

RATING INFORMATION number 02 OF 03 TOTAL RATINGS

Rated By: FAY, MCKONE Date: 8-22-86
Crop Stage:
Rating Method: 0=NO CONTROL 100= COMPLETE KILL

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	RIPE	HEAVY

RATING INFORMATION number 03 OF 03 TOTAL RATINGS

Rated By: FAY Date: 6-15-87
Crop Stage:
Rating Method: 0=NO CONTROL 100= COMPLETE KILL

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	FLOWERING	HEAVY

SUMMARY

This experiment was established in 1986 to compare applications made on June 17, July 29, and September 17. Oust, and Oust with Tordon was only effective by June 15, 1987 when applied in mid-September. Tordon and Starane were not very effective when applied alone at 0.5 lb/acre at any date of application. The Starane-Tordon combinations were effective when applied in June (treatments 2 and 3), late July at the highest rate (treatment 13) and the two highest treatments (treatments 22 and 23) on September 17. Further work needs to be done with rates and dates. We will continue to monitor in 1988.

FILE NAME:86020006.EXP INTERIM PRINTED:01/07/88

MONTANA STATE UNIVERSITY

STARANE COMBINATIONS FOR LEAFY SPURGE CONTROL

EXPT. LOCATION:GILLESPIE FARM, WHITEHALL, MT
RESEARCH BY:FAY/DAVIS INITIATED:06/17/86 COMPLETED:06/15/87

TRT. NO.	PESTICIDE NAME	FORMU.	LBai/A	APPLI-CATION TYPE	% LEAFY SPURGE 7/11/86	% LEAFY SPURGE 8/22/86	% LEAFY SPURGE 6/15/87	% GRASS INJURY 6/15/87							
01	STARANE	SC 1.67	.25	FLOWR	70•	88	78	2							
	TORDON	EC 2.0	.25	FLOWR											
02	STARANE	SC 1.67	.25	FLOWR	80	97	86	0							
	TORDON	EC 2.0	.5	FLOWR											
03	STARANE	SC 1.67	.25	FLOWR	82	94	93	3							
	TORDON	EC 2.0	1.0	FLOWR											
04	STARANE	SC 1.67	.25	FLOWR	91	92	41	0							
	2,4-D AM	SC 4.0	1.0	FLOWR											
05	STARANE	SC 1.67	.5	FLOWR	98	88	49	0							
	2,4-D AM	SC 4.0	1.0	FLOWR											
06	STARANE	SC 1.67	.5	FLOWR	89	95	58	0							
	2,4-D AM	SC 4.0	2.0	FLOWR											
07	STARANE	SC 1.67	.5	FLOWR	91	91	58	3							
08	TORDON	EC 2.0	.5	FLOWR	23	10	69	0							
09	OUST	DF 75.0	1 oz	FLOWR	10	0	15	0							
10	OUST	DF 75.0	1 oz	FLOWR	16	5	23	7							
	TORDON	EC 2.0	.125	FLOWR											
11	STARANE	SC 1.67	.25	FLOWR	NA	99	64	0							
	TORDON	EC 2.0	.25	FLOWR											
12	STARANE	SC 1.67	.25	FLOWR	NA	100	79	0							
	TORDON	EC 2.0	.5	FLOWR											
13	STARANE	SC 1.67	.25	FLOWR	NA	100	99	2							
	TORDON	EC 2.0	1.0	FLOWR											
14	STARANE	SC 1.67	.25	FLOWR	NA	100	45	0							
	2,4-D AM	SC 4.0	1.0	FLOWR											

MONTANA STATE UNIVERSITY

STARANE COMBINATIONS FOR LEAFY SPURGE CONTROL

TRT. NO.	PESTICIDE NAME	FORMU.	LBai/A	APPLI-CATION TYPE	% LEAFY SPURGE 7/11/86	% LEAFY SPURGE 8/22/86	% LEAFY SPURGE 6/15/87	% GRASS INJURY 6/15/87
15	STARANE	SC 1.67	.5	FLOWR	NA	100	52	0
	2,4-D AM	SC 4.0	1.0	FLOWR				
16	STARANE	SC 1.67	.5	FLOWR	NA	100	60	0
	2,4-D AM	SC 4.0	2.0	FLOWR				
17	STARANE	SC 1.67	.5	FLOWR	NA	98	43	0
18	TORDON	EC 2.0	.5	FLOWR	NA	86	62	0
19	OUST	DF 75.0	1 oz	FLOWR	NA	7	53	25
20	OUST	DF 75.0	1 oz	FLOWR	NA	18	93	15
	TORDON	EC 2.0	.125	FLOWR				
21	STARANE	SC 1.67	.25	FLOWR	NA	NA	60	3
	TORDON	EC 2.0	.25	FLOWR				
22	STARANE	SC 1.67	.25	FLOWR	NA	NA	90	2
	TORDON	EC 2.0	.5	FLOWR				
23	STARANE	SC 1.67	.25	FLOWR	NA	NA	98	15
	TORDON	EC 2.0	1.0	FLOWR				
24	STARANE	SC 1.67	.25	FLOWR	NA	NA	15	0
	2,4-D AM	SC 4.0	1.0	FLOWR				
25	STARANE	SC 1.67	.5	FLOWR	NA	NA	48	0
	2,4-D AM	SC 4.0	1.0	FLOWR				
26	STARANE	SC 1.67	.5	FLOWR	NA	NA	45	15
	2,4-D AM	SC 4.0	2.0	FLOWR				
27	STARANE	SC 1.67	.5	FLOWR	NA	NA	17	0
28	TORDON	EC 2.0	.5	FLOWR	NA	NA	67	2
29	OUST	DF 75.0	1 oz	FLOWR	NA	NA	96	33
30	OUST	DF 75.0	1 oz	FLOWR	NA	NA	98	43
	TORDON	EC 2.0	.125	FLOWR				
31	CONTROL				0	0	0	0
32	CONTROL				0	0	0	0
				LSD(0.05) =	7	7	33	12
				STANDARD DEVIATION =	4	4	20	7
				COEFF. OF VARIABILITY =	21	9	35	130

EXPERIMENT NO.: 86020010

TITLE: TESTING FALL APPLIED DPD ESTER FOR LEAFY SPURGE CONTROL. GILLESPIE FARM, WHITEHALL, MONTANA.

CROP INFORMATION

Crop:
Variety:
Planted:
Experimental Design: RCB
Replications: 3

Seeding Method
Seeding Depth:
Row Width:
Seeding Rate:
Plot Size: 7 FT. X 25 FT.

SOIL INFORMATION

Soil Type: GRAVELLY LOAM
Organic Matter: 3%   pH: 7.0

Previous Crop: PASTURE
Fertilizer Used: NONE

HERBICIDE APPLICATION   TREATMENTS 1-6

Date: 9-17-86
Mixed By: TOWNSEND
Applied By: DAVIS
Propellant: CO2
Pressure: 40 PSI
Time: 12:00 NOON
Cloud Cover:
Wind Speed: 3-6 MPH
Wind Direction: NORTH
Note:

Surfactant Used: LI-700
In Trt: 1-5
Surfactant Rate: 2 QT./100 GAL
Sprayer: BACKPACK
Volume: 15 GPA
Nozzles: 8002
Rel. Humidity: 32%
Air Temperature: 73 F
Soil Temp.: 2"60 F   4"55 F

Crop Stage: PASTURE

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	SENESCENCE	MODERATE

RATING INFORMATION number 01 OF 01 TOTAL RATINGS

Rated By: FAY, MCKONE   Date: 6-15-87
Crop Stage: PASTURE
Rating Method: 0=NO CONTROL 100= COMPLETE KILL

Weeds Present	Stage of Growth	Population Density
LEAFY SPURGE	FLOWERING	MODERATE

SUMMARY

A phenoxy product sold by Westchem, DPD ester, applied in September, 1986 did not provide effective leafy spurge control the following year.

FILE NAME:86020010.EXP INTERIM PRINTED:01

MONTANA STATE UNIVERSITY

TESTING FALL APPLIED DPD ESTER FOR LEAFY SPURGE CONTROL

EXPT. LOCATION:GILLESPIE FARM, WHITEHALL, MT

RESEARCH BY:FAY/DAVIS INITIATED:06/15/87 COMPLETED:06/15/

TRT. NO.	PESTICIDE NAME	FORMU.	LBai/A	APPLI-CATION TYPE	% LEAFY SPURGE 6/15/87	% GRASS INJURY 6/15/87
01	DPD ESTR	EC 4.0	2.0	FALL	45	0
	LI-700 S UR	F 2	QT/10 0 GAL			
02	DPD ESTR	EC 4.0	4.0	FALL	50	0
	LI-700 S UR	F 2	QT/10 0 GAL			
03	DPD ESTR	EC 4.0	2.0	FALL	59	0
	TORDON	EC 2.0	.25	FALL		
	LI-700 S UR	F 2	QT/10 0 GAL			
04	DPD ESTR	EC 4.0	2.0	FALL	47	0
	BANVEL	EC 2.0	.5	FALL		
	LI-700 S UR	F 2	QT/10 0 GAL			
05	FDP ESTR	EC 4.0	2.0	FALL	73	0
	TORDON	EC 2.0	.25	FALL		
	LI-700 S UR	F 2	QT/10 0 GAL			
06	TORDON	EC 2.0	1.0	FALL	98	0
	LI-700 S UR	F 2	QT/10 0 GAL			
07	CONTROL				0	0
	LI-700 S UR	F 2	QT/10 0 GAL			
	LSD(0.05) =				27	NA
	STANDARD DEVIATION =				15	NA
	COEFF. OF VARIABILITY =				29	NA

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Published by: Great Plains Agricultural Council: Leafy Spurge Symposium.

Sulfometuron applied alone and with auxin herbicides for leafy spurge control

RODNEY G. LYM and CALVIN G. MESSERSMITH

Sulfometuron is an analog of chlorsulfuron but with slightly less soil residual and a different weed control spectrum. Sulfometuron currently is used for grass suppression along roadsides and also has controlled some broadleaf weeds including leafy spurge. The purpose of this experiment was to evaluate sulfometuron alone and in combination with auxin herbicides for leafy spurge control.

The experiment was established in cropland severely infested with leafy spurge near Hunter, ND. Spring and fall treatments were applied on June 27 and September 4, 1985, respectively. Leafy spurge was 26 to 36 inches tall and beginning seed set in June while fall regrowth following a summer dormancy had begun when treatments were applied in September. The herbicides were applied with a tractor-mounted sprayer delivering 8.5 gpa at 35 psi. All plots were 10 by 30 feet in a randomized complete block design with four replications. As leafy spurge control declined, a retreatment of picloram at 0.25 lb/A was applied on August 26, 1986, as a split-block treatment to the back one-third of each plot to evaluate sulfometuron as a pretreatment to picloram. Evaluations were based on percent stand reduction as compared to the control.

Leafy spurge growth stopped following application of sulfometuron alone, regardless of application date. Plants treated with sulfometuron alone in June were not controlled visibly but had chlorotic leaves when evaluated in August and root bud elongation was inhibited. Leafy spurge top growth was killed when treated with sulfometuron plus an auxin herbicide and root bud growth was inhibited. Leafy spurge root buds were white and short on plants treated with sulfometuron, compared to the pink elongated buds on untreated plants. Sulfometuron plus an auxin herbicide provided better leafy spurge control than sulfometuron alone, and long-term control was better when sulfometuron was mixed with picloram than with 2,4-D or dicamba (Table). Leafy spurge control declined rapidly between the June and August 1986 evaulations.

Leafy spurge control increased to a maximum of 100% following retreatment with picloram at 0.25 lb/A (Table). Control averaged 81 and 67% in August 1987, when picloram was applied to plants originally treated with sulfometuron in the spring and fall, respectively. Control increased following the picloram retreatment as the sulfometuron rate increased following spring but not fall treatments. The best long-term control was sulfometuron spring-applied with either picloram or metsulfuron followed by the picloram retreatment which averaged 94 and 93%, respectively. The optimum herbicide application rates and date and the effectiveness of various retreatments must be evaluated further to determine if sulfometuron plus an auxin herbicide can provide cost-effective leafy spurge control. (Published with approval of the Agric. Exp. Stn., North Dakota State Univ., Fargo 58105).

Table. Leafy spurge control with sulfometuron applied either alone or with various auxin herbicides (Lym And Messersmith).

Application date/ treatment	Rate	Aug 1985	May 1986	Aug 1986	May 1987 Single	May 1987 Retreat.[a]	August 1987 Single	August 1987 Retreat.[a]
	(oz/A)	(% control)						
June 27, 1985								
Sulfometuron	1	0	6	0	0	87	5	63
Sulfometuron	1.5	0	63	25	12	88	17	85
Sulfometuron	2	0	36	6	3	87	10	82
Sulfometuron+2,4-D	1+16	95	76	26	8	84	24	64
Sulfometuron+dicamba	1+32	96	85	40	35	98	55	86
Sulfometuron+picloram	1+8	70	96	59	51	100	67	94
Sulfometuron+metsulfuron	2+0.5	0	60	24	0	98	5	93
Control	…	0	0	0	0	63	0	55
LSD (0.05)		25	22	26	25	31	20	31
September 4, 1985								
Sulfometuron	0.5	…	16	0	0	54	0	40
Sulfometuron	1	…	95	7	23	77	21	56
Sulfometuron+2,4-D	1+16	…	99	17	3	92	8	72
Sulfometuron+dicamba	1+32	…	97	23	15	91	13	73
Sulfometuron+picloram	1+8	…	99	74	33	83	38	83
Sulfometuron+2,4-D	0.5+16	…	95	24	21	87	26	62
Sulfometuron+dicamba	0.5+32	…	97	51	19	83	19	84
Sulfometuron+picloram	0.5+8	…	99	40	17	86	27	71
Sulfometuron+metsulfuron	2+0.5	…	88	13	0	83	0	62
DPX-LS300	1	…	44	6	4	76	4	49
Control	…	…	0	0	0	73	0	38
LSD (0.05)			26	30	36	29	32	NS

[a]Picloram at 0.25 lb/A applied as a split-block to the back one-third of each plot on August 26, 1986.

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Published by: Great Plains Agricultural Council: Leafy Spurge Symposium.

Evaluation of sulfometuron and other sulfonylurea herbicides for leafy spurge control[1]

RODNEY G. LYM and CALVIN G. MESSERSMITH

Previous research at North Dakota State University has shown that sulfometuron delays, and sometimes stops, bud growth on leafy spurge roots. A herbicide that prevents or delays bud regrowth should improve long-term control since leafy spurge reestablishes by growth from the root buds following top growth control. The purpose of these experiments was to evaluate sulfometuron alone and in combination with auxin herbicides applied throughout the growing season for leafy spurge control. Also, DPX-L5300, chlorsulfuron, and fosamine were evaluated for leafy spurge control.

All herbicides were applied with a tractor-mounted sprayer delivering 8.5 gpa at 35 psi. All plats were 10 x 30 ft in a randomized complete block design. The sulfometuron experiment establishment dates in 1986 and leafy spurge growth stages were: June 5 near Hunter, ND, at the true flower stage; July 22 and August 27 near Chaffee, ND, at the mature seed and fall regrowth stages, respectively; September 3 near Valley City, ND, well branched and in the fall regrowth stage; and September 15 near Dickinson, ND, in the fall regrowth stage with most leaves chlorotic or bright red. As leafy spurge control declined, a retreatment of picloram at 4 oz/A was applied 12 months after the original treatment as a split-block treatment to the back one-third of each plot at Hunter and Chaffee. Evaluations were based on percent stand reduction as compared to the control.

No treatment applied in June near Hunter provided satisfactory leafy spurge control 2 months after treatment (MAT) (Table 1). There was 10% or less grass injury with all treatments. These plots were cultivated by the landowner and were not evaluated further. Similar sulfometuron plus auxin herbicide treatments applied in July near Chaffee provided 82 to 100% top growth control I MAT. Sulfometuron alone did not provide satisfactory leafy spurge control. When evaluated in May 1987, grass injury tended to increase as the sulfometuron rate increased and was higher when sulfometuron was applied with picloram or dicamba compared to sulfometuron alone. When evaluated in August 1987, control was similar when sulfometuron was applied either alone or with an auxin herbicide prior to the picloram retreatment (62%) compared to no prior treatment (48%), although there was a trend for improved control when a treatment preceded picloram application.

[1]Published with approval of the Agric. Exp. Stn., North Dakota State Univ., Fargo 58105.

Table 1. Leafy spurge control by sulfometuron with auxin herbicides applied in June at Hunter or July at Chaffee (Lym and Messersmith).

		Location and evaluation date						
		Hunter		Chaffee				
		Aug 86		Aug 86	May 87		Aug 87	
Treatment	Rate	Control	Grass injury	Control	Control	Grass injury	Control	Retreat-ment[a]
	(oz/A)	(%)						
Sulfometuron + picloram	0.25 + 4	19	10	–	–	–	–	–
Sulfometuron + dicamba	0.25 + 8	0	10	–	–	–	–	–
Sulfometuron + 2,4-D	0.5 + 8	5	0	–	–	–	–	–
Sulfometuron + picloram	0.5 + 8	41	0	100	40	11	15	52
Sulfometuron + dicamba	0.5 + 16	1	10	83	5	0	7	54
Sulfometuron + 2,4-D	1 + 8	0	10	97	18	3	8	53
Sulfometuron + picloram	1 + 8	40	10	99	60	20	16	54
Sulfometuron + picloram	1 + 16	9	0	–	–	–	–	–
Sulfometuron + dicamba	1 + 16	–	–	82	47	11	14	76
Sulfometuron + picloram	2 + 32	–	–	99	97	30	60	66
Sulfometuron + dicamba	2 + 128	–	–	100	96	49	59	69
Sulfometuron + picloram + 2,4-D	0.5+ 4 + 16	18	10					
Sulfometuron	1	–	–	31	18	10	7	66
Sulfometuron	2	–	–	13	16	15	8	72
Control	0	0	0	0	0	0	0	48
LSD(0.05)		27	NS	15	32	21	22	NS

[a] Picloram at 4 oz/A applied as a split-block to the back one-third of each plot on June 29, 1987.

Leafy spurge control tended to be better when sulfometuron plus an auxin herbicide was applied in August or September (Table 2) compared to June or July (Table 1). However, grass injury also was higher. Long-term leafy spurge control tended to be higher as the sulfometuron rate increased up-to 2 oz/A but the dicamba, 2,4-D, and picloram rate had little effect on control over the ranges evaluated. Sulfometuron + picloram at 2 + 8 to 16 oz/A provided the best long-term leafy spurge control 12 MAT (averaged 93% over the Valley City and Dickinson locations). However, grass injury averaged 42 and 77% 12 MAT at the two locations, respectively (Table 2).

DPX-L5300 alone or applied with 2,4-D or dicamba did not provide long -term leafy spurge control (Table 3). DPX-L5300 + picloram at 1 + 8 oz/A Provided 77 and 21% leafy spurge control 3 and 12 MAT, respectively, averaged over locations and was similar to sulfometuron + picloram at 1 + 8 oz/A. However, no DPX-L5300 treatment injured grass. Chlorsulfuron applied with an auxin herbicide did not provide satisfactory leafy spurge control. Sulfometuron applied with amitrole, fluroxypyr, and picloram all resulted in similar leafy spurge control. Fosamine provided inconsistent leafy spurge control even when applied at 96 oz/A.

Table 2. Sulfometuron with auxin herbicides applied in August or September for leafy spurge control (Lym and Messersmith).

		Location and evaluation date									
		Chaffee			Valley City			Dickinson			
		May 87		Aug 87	May 87		Aug 87	June 87		Sept 87	
Treatment	Rate	Control	Grass Injury	Control	Control	Grass Injury	Control	Control	Grass Injury	Control	Grass Injury
	(oz/A)	(%)									
Sulfometuron + 2,4-D	0.5 + 16	–	–	–	41	0	11	–	–	–	–
Sulfometuron + 2,4-D	0.5 + 32	–	–	–	57	0	9	55	61	23	23
Sulfometuron + picloram	0.5 + 8	89	35	15	96	7	39	–	–	–	–
Sulfometuron + picloram	0.5 + 12	–	–	–	98	3	68	97	71	67	26
Sulfometuron + picloram	0.5 + 16	–	–	–	99	4	81	–	–	–	–
Sulfometuron + dicamba	0.5 + 16	68	8	16	–	–	–	–	–	–	–
Sulfometuron + 2,4-D	1 + 8	35	83	1	–	–	–	–	–	–	–
Sulfometuron + 2,4-D	1 + 16	–	–	–	90	5	26	–	–	–	–
Sulfometuron + 2,4-D	1 + 32	–	–	–	93	6	41	–	–	–	–
Sulfometuron + picloram	1 + 8	95	46	32	99	8	85	–	–	–	–
Sulfometuron + picloram	1 + 12	–	–	–	99	6	88	–	–	–	–
Sulfometuron + picloram	1 + 16	–	–	–	99	8	86	–	–	–	–
Sulfometuron + dicamba	1 + 16	81	36	17	–	–	–	–	–	–	–
Sulfometuron + 2,4-D	2 + 16	–	–	–	97	34	68	75	73	26	33
Sulfometuron + 2,4-D	2 + 32	–	–	–	99	29	73	78	70	29	33
Sulfometuron + picloram	2 + 8	–	–	–	99	49	97	95	89	83	60
Sulfometuron + picloram	2 + 12	–	–	–	99	41	9S	99	94	90	80
Sulfometuron + picloram	2 + 16	–	–	–	99	37	98	99	98	93	91
Sulfometuron + picloram	2 + 32	94	56	70	–	–	–	–	–	–	–
Sulfometuron + dicamba	2 + 128	95	53	56	–	–	–	–	–	–	–
Picloram	16	–	–	–	99	0	63	–	–	–	–
Fosamine	64	43	15	9	–	–	–	–	–	–	–
Fosamine	96	56	13	20	–	–	–	–	–	–	–
LSD (0.05)		29	19	28	12	21	22	20	29	22	24

Table 3. DPX-L5300 and chlorsulfuron with auxin herbicides for leafy spurge control (Lym and Messersmith).

		Location and evaluation date						
		Chaffee				Dickinson		
		Aug 86		May 87	Aug 87	Sept 86	June 87	Aug 87
Treatment	Rate	Leafy spurge	Grass injury	Leafy spurge	Leafy Spurge	Leafy Spurge	Leafy spurge	Leafy spurge
	(oz/A)	(% control)						
DPX-L5300	1	0	0	0	0	21	0	0
DPX-L5300	2	0	0	0	0	8	0	0
DPX-L5300 + 2,4-D	1 + 16	3	0	0	0	42	3	0
DPX-L5300 + picloram	1 + 8	67	0	36	20	87	5	15
DPX-L5300 + dicamba	1 + 16	3	0	8	3	42	0	0
Chlorsulfuron + 2,4-D	0.5 + 16	0	0	0	0	57	0	0
Chlorsulfuron + picloram	0.5 + 8	42	10	9	0	63	3	10
Chlorsulfuron + dicamba	0.5 + 16	3	10	3	0	37	0	0
Sulfometuron + amitrole	1 + 32	11	20	6	0	27	6	6
Sulfometuron + fluroxypyr	1 + 16	49	40	30	12	97	15	0
Sulfometuron + picloram	1 + 8	59	30	40	13	–	–	–
Fosamine + X-77 surf.	32 + 0.5%	–	–	–	–	62	14	a
Fosamine + X-77 surf.	64 + 0.5%	–	–	–	–	10	11	0
Fosamine + X-77 surf.	96 + 0.5%	–	–	–	–	68	52	10
LSD (0.05)		18	18	21	11	40	12	NS

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Fluroxypyr for leafy spurge control

RODNEY G. LYM and CALVIN G. MESSERSMITH

Fluroxypyr is a picolinic acid herbicide similar to picloram but with less soil residual and a different weed control spectrum. The purpose of this experiment was to evaluate fluroxypyr for leafy spurge control as a single application treatment, applied with auxin herbicides, and in a repetitive treatment program.

The experiment was established on a dense stand of leafy spurge near Dickinson, ND, on July 14, 1986. Previous research had indicated the optimum application time for leafy spurge control with fluroxypyr was post seed-set. The herbicides were applied using a tractor-mounted sprayer delivery 8.5 gpa at 35 psi. The retreatments were applied as a split-block treatment. The original whole plots were 15 × 56 ft and the retreatment subplots were 10 x 15 ft with three replications. Evaluations were based on percent stand reduction as compared to the control.

Fluroxypyr at 0.5 and 1 lb/A provided an average of 90 and 41% leafy spurge control 2 and 11 months after treatment (MAT), respectively (Table). Control was similar when fluroxypyr at 0.25 or 0.5 lb/A was applied alone or with dicamba, picloram, or 2,4-D. Picloram at 1 lb/A provided 73% leafy spurge control 11 MAT which was the expected level of control from this treatment based on long-term evaluations at North Dakota State University. No single treatment provided satisfactory control 14 MAT.

Leafy spurge control, when averaged over retreatments, increased to an average of 73% regardless of the original fluroxypyr treatment and was similar to the picloram treatments (Table). The best retreatments were picloram alone at 0.5 lb/A, picloram + fluroxypyr at 0.25 + 0.25 lb/A, and + picloram + 2,4-D at 0.25 + 1 lb/A which averaged 94, 89, and 86% control, respectively. In comparsion, fluroxypyr at 0.5 lb/A applied as a retreatment averaged only 69% control.

In general, fluroxypyr alone and applied with dicamba, picloram, and 2,4-D provided similar control to picloram + 2,4-D at 0.25 + 1 lb/A both in the year of treatment and following various retreatments (Table). For example, fluroxypyr at 0.5 lb/A applied twice provided 83% leafy spurge control compared to 89% with picloram + 2,4-D at 0.25 + 1 lb/A applied twice. The picloram + 2,4-D treatment was the most cost-effective treatment in a long-term leafy spurge research program conducted in North Dakota. Thus fluroxypyr applied once provided less leafy spurge control than picloram at similar rates, but fluroxypyr may be useful in a retreatment program especially in areas where picloram cannot be used. (Published with approval of the Agric. Exp. Stn., North Dakota State Univ., Fargo 58105).

Table. Leafy spurge control with fluroxypyr alone and in combination with auxin herbicides (Lym and Messersmith).

Treatment	Rate	Evaluation date		Retreatment/rate (lb/A)/evaluated Sept 87							
		Sept 86	June 87	Fluro. 0.5	Pic. 0.25	Pic. 0.5	Fluro.+ Pic. 0.25+ 0.25	Fluro.+ Pic. 0.5+.25	Pic.+2.4-D 0.25+1	Control	Mean
	(lb/A)	(% control)									
Fluroxypyr	0.5	88	34	83	78	98	96	85	89	0	75
Fluroxypyr	1	92	47	70	88	89	87	78	86	13	73
Fluroxypyr+picloram	0.25+0.25	95	27	64	84	96	91	78	93	10	74
Fluroxypyr+picloram	0.5+0.25	98	40	63	71	98	93	87	94	16	74
Fluroxypyr+2,4-D	0.5+1	94	27	72	72	93	80	77	84	5	69
Fluroxypyr+dicamba	0.25+0.25	96	13	64	88	94	86	88	70	8	71
Picloram+2,4-D	0.25+1	99	25	79	91	97	85	77	89	3	75
Picloram	1	81	73	74	76	87	89	60	81	17	69
Control		0	0	51	68	96	90	56	86	0	64
Mean				69	80	94	89	76	86	8	
LSD (0.05)		13	28	whole plot = NS; subplots = 8; whole plot × subplot = 32							

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Leafy spurge control under trees and along waterways

RODNEY G. LYM and CALVIN G. MESSERSMITH

Leafy spurge is difficult to control with herbicides near trees or open water such as ponds, ditches, and rivers because of potential damage to desirable vegetation or water contamination. However, these areas provide a constant source of seed for infestation of nearby and downstream areas if no control measures are initiated. The purpose of these experiments was to evaluate several herbicides for both leafy spurge control and potential to damage desirable vegetation.

Three experiments for leafy spurge control under trees were established in a shelter belt located in a waterfowl rest area near Valley City, ND. The plots were located in a dense stand of leafy spurge growing under mature ash and elm trees that had been planted five ft apart in 12-foot rows. The herbicides were applied either with a hand-held single-nozzle sprayer delivering 40 gpa or with the controlled droplet applicator (CDA) which applied approximately 4 gpa. The hand-held sprayer treatments were applied as a pre-measured amount of herbicide:water per plot to assure the correct rate and three passes were made across each plot to assure adequate coverage. The CDA treatments covered each plot only once. The experiment starting dates and leafy spurge stage at treatment were: June 26, 1986, flowering and beginning seed set; September 3, 1986, post-seed set and chlorotic leaves; and June 16, 1987, yellow bract to flowering growth stage. There were four replications per treatment in a randomized complete block design and the plots were 12 by 24 feet. Evaluations were based on percent stand reduction as compared to the control.

Initial leafy spurge control was poor when glyphosate was applied alone, regardless of rate or treatment date (Table 1). Control improved to over 90% 12 months after treatment (MAT) following a June but not September application. Grass injury was nearly 100% with all glyphosate treatments.

Sulfometuron alone did not control leafy spurge satisfactorily (Table 1). However, control at 12 MAT increased by an average of 10 and 35% when applied with glyphosate in the spring and fall, respectively, compared to glyphosate alone. Leafy spurge control averaged 97% with sulfometuron + 2,4-D at 1 or 2 + 17 oz/A but grass injury was over 50%. Picloram, applied with the CDA at a picloram:water concentration of 1:7, provided nearly 100% leafy spurge control with no grass injury. Several ash trees had some leaf curling but no visible permanent damage from this treatment.

Table 1. Leafy spurge control under trees (Lym and Messersmith).

Application date and treatment	Rate	Evaluation date: Aug 86 Control	May 87 Control	May 87 Grass injury	Aug 87 Control	Aug 87 Grass injury
	(oz/A)	(%control)				
June 26, 1986						
Glyphosate	8.5	9	92	88	79	–
Glyphosate	17	41	96	98	94	–
Sulfometuron	0.5	15	0	0	29	–
Sulfometuron	1	9	0	0	19	–
Sulfometuron	2	9	28	15	19	–
Sulfometuron+glyphosate	0.5 + 8.5	13	98	98	90	–
Sulfometuron+glyphosate	1 + 8.5	13	96	99	95	–
Sulfometuron+glyphosate	2 + 8.5	24	99	96	85	–
Picloram (CDA)	1:7[a]	99	95	0	85	–
LSD (0.05)		19	8	14	23	–
September 3, 1986						
Glyphosate	17	–	65	99	54	–
Sulfometuron+glyphosate	2 + 17	–	99	99	89	–
Sulfometuron+2,4-D	2 + 17	–	69	66	51	–
Picloram (CDA)	1:7[a]	–	86	9	66	–
LSD (0.05)			26	17	31	–
June 16, 1987						
Glyphosate	8.5	–	–	–	13	98
Glyphosate	17	–	–	–	30	98
Sulfometuron+glyphosate	0.5 + 8.5	–	–	–	9	83
Sulfometuron+glyphosate	1 + 8.5	–	–	–	12	86
Sulfometuron+glyphosate	2 + 8.5	–	–	–	36	76
Sulfometuron+2,4-D	1 + 17	–	–	–	95	48
Sulfometuron+2,4-D	2 + 17	–	–	–	99	63
Picloram (CDA)	1:7a	–	–	–	96	0
LSD (0.05)					12	25

[a] Solution concentration picloram (Tordon 22K):water.

The experiment to evaluate leafy spurge control with herbicides that can be used near water was established on June 27, 1986 along a ditchbank in Fargo. The experimental design and application methods were similar to the tree experiment. All plots were treated with 2,4-D at 1 lb/A in June 1987 to control leafy spurge seedlings.

Amitrole at 4 lb/A provided 91 and 95% leafy spurge control 12 and 15 MAT, respectively, but there was 64% grass injury (Table 2). Increasing the application rate to 8 lb/A increased grass injury but not leafy spurge control. Unfortunately, amitrole, is no longer cleared for use near water. Fosamine provided 90% leafy spurge control 12 MAT but also 57% grass injury. No other fosamine treatment provided satisfactory control and evaluations varied considerably from plot to plot indicating this herbicide may provide inconsistent control. (Published with approval of the Agric. Exp. Stn., North Dakota State Univ., Fargo 58105).

Table 2. Leafy spurge control along ditchbanks (Lym and Messersmith).

		Control			
		Aug 86	May 87		Aug 87
Treatment	Rate	Control	Control	Grass injury	Control
	(lb/A)	(%)			
Amitrole	2	99	69	23	80
Amitrole	4	100	91	64	95
Amitrole	8	100	87	81	96
Fosamine	2	5	14	3	59
Fosamine	4	19	58	10	55
Fosamine	8	40	90	57	82
LSD (0.05)		19	17	42	28

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Leafy spurge control with picloram plus dicamba or various 2,4-D formulations

RODNEY G. LYM and CALVIN G. MESSERSMITH

Picloram remains the most effective herbicide for leafy spurge control. Previous research at North Dakota State University has shown picloram + 2,4-D at 0.25 + 1.0 lb/A applied annually to be more cost effective than picloram at 1 to 2 lb/A applied once. The purpose of these experiments was to compare the effect of dicamba and/or various 2,4-D formulations applied with picloram for leafy spurge control.

The initial 2,4-D formulation experiments were established on the Sheyenne National Grasslands near McLeod, ND, on June 15, 1984, and near Hunter, ND, on May 30, 1985. The herbicides were applied using a tractor-mounted sprayer delivering 8.5 gpa at 35 psi. All plots were 10 by 30 ft in a randomized complete block design with four replications. Evaluations were based on percent stand reduction as compared to the control.

Picloram plus 2,4-D mixed amine provided better leafy spurge control than picloram + 2,4-D alkanolamine (Table 1). Leafy spurge control from picloram + 2,4-D mixed amine at 0.25 + 1 lb/A was similar to control from picloram at 0.5 lb/A alone but picloram + 2,4-D is approximately 30% less expensive. Similarly, leafy spurge control from picloram plus dicamba was greater when applied with 2,4-D mixed amine than with the alkanolamine. Neither 2,4-D formulation alone controlled leafy spurge.

Picloram + dicamba + 2,4-D mixed amine provided 72% leafy spurge control 2 years after application at Hunter (Table 1). This level of control was similar to that attained with picloram at 2 lb/A in North Dakota but is 70% less expensive. Therefore, similar experiments were begun in 1986 to evaluate this combination treatment further. Experiments were established on June 11 and 18, near Dickinson and Valley City, respectively, and on August 28 on the Sheyenne National Grasslands and September 3 and 15 near Valley City and Dickinson, respectively.

Leafy spurge control was much lower at Dickinson than at Valley City or Sheyenne regardless of treatment (Table 2). The plots near Dickinson were on an abandoned mine site with a very dense leafy spurge stand. The soil drains quickly and generally was much drier than nearby areas. The combination of a dense stand and poor growing conditions may account for the poor leafy spurge control from both spring- and fall-applied treatments.

Table 1. Leafy spurge control with picloram applied with various formulations of 2,4-D (Lym and Messersmith).

Location/ application date		Months after treatment				
Treatment	Rate	3	12	15	24	27
	(lb/A)	(% control)				
Sheyenne, June 1984						
Picloram	0.25	76	23	4	1	–
Picloram	0.5	95	75	43	10	–
Picloram+2,4-D alkanolamine	0.25+1	78	14	6	3	–
Picloram+2,4-D mixed amine[a]	0.25+1	94	72	23	21	–
2,4-D mixed amine[a]	4	47	7	13	0	–
2,4-D alkanolamine	4	42	20	7	5	–
LSD (0.05)		15	25	15	12	–
Hunter, June 1985						
Picloram+dicamba +2,4-D mixed amine[a]	0.25+1+2	99	98	89	72	60
Picloram+dicamba +2,4-D alkanolamine	0.25+1+2	51	51	25	25	18
2,4-D mixed amine[a]	4	6	3	0	0	0
2,4-D alkanolamine	4	5	0	0	0	0
Picloram+dicamba	0.25+1	53	38	15	0	7
LSD (0.05)		15	15	15	15	20

[a] Mixed amine salts of 2,4-D (2:1 dimethylamine:diethanolamine)-EH736.

In general, leafy spurge control was similar with all 2,4-D formulation combinations in experiments begun in 1986 (Table 2). No treatment provided the long-term control obtained with the picloram + dicamba + 2,4-D mixed amine treatment applied at Hunter in 1985 (Table 1). Previous research at North Dakota State University has shown that the benefit of applying 2,4-D with picloram may not be apparent after one application. Likewise, subtle but consistent differences in control due to 2,4-D formulation may take several years to become obvious. Therefore, these treatments were reapplied in 1987 to evaluate the long-term effect of picloram combined with various 2,4-D formulations and dicamba on leafy spurge control. (Published with approval of the Agric. Exp. Stn., North Dakota State Univ., Fargo.)

Table 2. Leafy spurge control with Picloram applied with dicamba and various formulations of 2,4-D (Lym and Messersmith).

		Location/evaluation date (MAT)							
Original application date		Valley City			Dickinson			Sheyenne	
Treatment	Rate	3/9	12	15[a]	3/9	12	15	9	12
	(lb/A)	------------------------- (% control) -------------------------							
Spring 1986									
2,4-D mixed amine[b] +piclorant+dicamba	2+0.25+1	43	7	52	3	3	46	–	–
2,4-D mixed amine[b] +piclorant+dicamba	2+0.25+0.5	78	24	63	10	3	28	–	–
2,4-D mixed amine[b] +piclorant+dicamba	1+0.12+0.5	37	5	49	11	7	23	–	–
2,4-D alkanolamine[c] +picloram+dicamba	2+0.25+1	59	8	75	10	6	45	–	–
Picloram+dicamba	0.25+1	83	9	73	16	6	38	–	–
LSD (0.05)		40	19	43	NS	NS	NS	–	–
Fall 1986									
2,4-D mixed amine[b] +piclorant+dicamba	2+0.25+1	95	40	–	33	1	–	89	31
2,4-D alkanolamine[c] +picloram+dicamba	2+0.25+1	93	24	–			–	92	49
2,4-D mixed amine[b] +picloram+dicamba	4+0.5+2	99	80	–	61	12	–	95	56
2,4-D ester[d]+2,4-DP +dicamba+picloram	2+2+0.5+0.25	89	10	–	36	3	–	94	40
2,4-D ester[d]+2,4-DP +dicamba+picloram	2+2+0.5+0.5	99	54	–	50	6	–	98	71
2,4-D alkanolamine[c] +picloram+dicamba	4+0.5+2	97	36	–	60	8	–	96	55
Picloram+dicamba	0.5+2	98	45	–	76	18	–	94	58
Picloram	0.5	95	35	–	32	0	–	96	47
LSD (0.05)		5	31		NS	NS		8	NS

[a] Treatments reapplied June 1987.

[b] Mixed amine salts of 2,4-D (2:1 dimethylamine:diethanolamine)-EH736.

[c] 2,4-D alkanolamine.

[d] 2,4-D isooctyl ester:2,4-DP butoxyethanol ester:dicamba (4:4:1)-EH680.

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Picloram and 2,4-D combination treatments for long-term leafy spurge management

RODNEY G. LYM and CALVIN G. MESSERSMITH

Picloram is an effective herbicide for leafy spurge control, especially when applied at rates from 1 to 2 lb/A. However, the high cost of picloram at 2 lb/A makes it uneconomical to treat large acreages in pasture and rangeland weed control programs. Research by North Dakota State University has suggested that picloram at 0.25 to 0.5 lb/A applied annually will give satisfactory leafy spurge control after 3 to 5 years. The purpose of this experiment is to establish the number of annual applications of picloram needed to provide 90 to 100% control of leafy spurge and to investigate possible synergism between picloram and 2,4-D.

The experiment was established at three locations in North Dakota and began on 25 August 1981 at Dickinson, 1 September 1981 at Sheldon, and on 11 June 1982 at Valley City. The soil at Dickinson was a loamy fine sand with pH 6.6 and 3.6% organic matter, at Sheldon was a fine sandy loam with pH 7.7 and 2.1% organic matter, and at Valley City was a loam with pH 6.7 and 9.4% organic matter. Dickinson, located in western North Dakota, generally receives much less precipitation than the other two sites located in eastern North Dakota. All treatments were applied annually except 2,4-D alone which was applied biannually (both spring and fall). Picloram treatments were applied in late August 1981 and in June of 1982 through 1986. The Sheldon location was discontinued following the fall evaluations in 1985. Thus, the Dickinson site has received seven picloram and picloram plus 2,4-D treatments and 13 2,4-D treatments, while the Valley City site has received six and 12 treatments, respectively. The plots were 10 by 30 ft and each treatment was replicated four times in a randomized complete block design at all sites. Evaluations were based on percent stand reduction as compared to the control.

Picloram at 0.25, 0.38 and 0.5 lb/A provided 49, 69 and 77% leafy spurge control, respectively, 60 months after treatment (Table). Control had declined by approximately 9% compared to the previous year. 2,4-D alone provided an average of 47% control of leafy spurge after biannual applications for 6 years.

Leafy spurge control 60 months after treatment increased by an average of 26, 16, and 13% when 2,4-D at 1 to 2 lb/A was applied with picloram at 0.25, 0.38, or 0.5 lb/A respectively, when compared to the same picloram rate applied alone. Picloram at 0.5 lb/A plus 2,4-D provided an average of 90% leafy spurge control but had declined slightly compared to the previous year. The greatest enhancement with 2,4-D plus picloram seems to be with 2,4-D at 1.5 lb/A or less and picloram at 0.375 lb/A or less. In general, leafy spurge control has been similar at all sites and does not seem to be influenced by soil types, pH, or organic matter. However, leafy spurge control at Dickinson had declined in 1986 and 1987 compared to 1985 which probably was due to above average precipitation and excellent growing conditions in 1986 following several years of below average precipitation.

Picloram at 0.5 lb/A alone and all picloram at 0.38 or 0.5 lb/A plus 2,4-D treatments are near or have reached the target of 90% or better leafy spurge control. Some type of treatment will need to be continued to maintain control, but perhaps more economical treatments will sustain the target control level. (Published with approval of the Agric. Exp. Stn., North Dakota State Univ., Fargo 58105).

Table. Leafy spurge control from annual picloram or picloram plus 2,4-D treatments and biannual 2,4-D treatments at two locations in North Dakota (Lym and Messersmith).

		Site and 1987 evaluation date								
		Dickinson		Valley City		Months after treatment				
Herbicide	Rate	June	Sept	May	Aug	12[a]	24	36	48	60
	(lb/A)	(% control)								
Picloram	0.25	51	30	48	61	39	48	48	58	49
Picloram	0.38	65	51	74	79	65	62	52	77	69
Picloram	0.5	76	63	77	78	65	71	81	86	77
2,4-D bian	1	55	30	24	25	22	30	38	50	39
2,4-D bian	1.5	48	27	48	42	22	24	26	45	49
2,4-D bian	2	54	24	55	27	19	30	26	54	54
Pic+2,4-D	0.25+1	79	79	67	94	52	66	63	85	73
Pic+2,4-D	0.25+1.5	81	84	74	85	58	66	70	85	77
Pic+2,4-D	0.25+2	75	62	76	90	57	62	66	83	76
Pic+2,4-D	0.38+1	79	73	90	91	69	72	70	90	84
Pic+2,4-D	0.38+1.5	85	81	84	92	68	74	76	93	84
Pic+2,4-D	0.38+2	82	85	90	95	68	59	76	91	86
Pic+2,4-D	0.5+1	82	81	92	99	71	75	84	94	87
Pic+2,4-D	0.5+1.5	86	89	97	96	64	73	80	97	91
Pic+2,4-D	0.5+2	86	87	96	98	76	75	81	95	91
LSD (0.05)		20	19	20	19	18	14	19	14	14

[a] Mean values through 48 months after treatment include data from the Sheldon location which was discontinued after 1985.

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Leafy spurge control with low rate annual picloram and 2,4-D combination treatments

RODNEY G. LYM and CALVIN G. MESSERSMITH

Previous research at North Dakota State University has shown that annual treatments of picloram + 2,4-D for 3 to 5 years will give leafy spurge control similar to expensive high rate picloram treatments. Picloram + 2,4-D at 0.25 + 1 lb/A generally gives 20 to 30% better leafy spurge control than picloram at 0.25 lb/A alone, but the benefit of a herbicide combination declines as the picloram or 2,4-D rate increases. Picloram + 2,4-D at 0.5 + 1 lb/A tends to give only 5 to 10% better control than picloram at 0.5 lb/A alone. The purpose of this experiment was to evaluate long-term leafy spurge control from annual treatments of picloram + 2,4-D amine at relatively low application rates.

The experiment was established at four locations in North Dakota. Spring treatments were applied in June 1984 at Dickinson, Hunter, and Valley City, and the fall treatments were applied in September 1984 at Valley City and the Sheyenne National Grasslands near McLeod. The soil was a loamy fine sand at Dickinson a silty clay loam at Hunter, Sheldon and the Sheyenne National Grasslands, and a loam at Valley City. Dickinson, located in western North Dakota, generally receives much less precipitation than the other two sites located in eastern North Dakota. The spring treatments were applied annually in June in 1984 through 1987. The fall treatments were applied in September 1984 and 1985, but discontinued thereafter. The herbicides were applied with a tractor-mounted sprayer delivering 8.5 gpa at 35 psi. All plots were 10 by 30 feet in a randomized complete block design with four replications except at Hunter which had 8 by 25 feet plots and three replications. Evaluations were based on a visual estimate of percent stand reduction as compared to the control.

The results from the Dickinson location were different than the other sites and will be discussed separately. Picloram at 0.12, 0.25, 0.38, and 0.5 lb/A provided 2, 28, 63 and 67% leafy spurge control, respectively, as a spring applied treatment at Hunter and Valley City, but only 0, 1, 6, and 27% control, respectively, as a fall applied treatment at Sheyenne and Valley City, when evaluated 24 months following initial application (Table). The addition of 2,4-D to picloram tended to increase leafy spurge control slightly for spring- but not for fall-applied treatments. The slight increase in control was similar regardless of 2,4-D rate. The increased leafy spurge control obtained when 2,4-D was applied with picloram as a spring treatment was not found when similar treatments were fall applied. Leafy spurge generally begins regrowth in mid to late-July following a fall application and had become reestablished by the following fall. However, spring-applied treatments generally maintained control all season and regrowth was typically 0 to 3 inches tall when a killing frost occurred. This limited growth may predispose the plants to winter kill and allow gradually increased control. Thus, the fall treatments were discontinued.

Leafy spurge control generally was greater 36 months after the initial treatment than 24 months at Hunter and Valley City, but not Dickinson (Table). The reason for poor control at Dickinson compared to the other locations is not known. A similar experiment, begun in 1981 at Dickinson, resulted in annual increases in leafy spurge control. Dickinson has received above average precipitation for the last 36 months and the leafy spurge may be growing more vigorously than previously.

Leafy spurge control 36 months after treatment averaged 10, 40, 67 and 78% with picloram alone at 0.12, 0.25, 0.38 and 0.5 lb/A, respectively, and control increased slightly when picloram was applied with 2,4-D to an average of 22, 46, 66 and 89%, respectively. This increase is much less than previously reported when 2,4-D at 1 to 2 lb/A was applied with picloram. The 2,4-D application rate did not affect leafy spurge control; control averaged 56% over the picloram treatments regardless of the 2,4-D rate.

This experiment must be continued for several years to determine whether the presently used picloram at 0.25 to 0.5 lb/A + 2,4-D at 1 lb/A treatment is the most cost effective application rate for an annual leafy spurge control program or whether the picloram and/or 2,4-D rate can be reduced and still maintain acceptable control. (Published with approval of the Agric. Exp. Stn., North Dakota State Univ., Fargo.)

Table. Leafy spurge, control in 1968 from annual picloram or picloram plus 2,4-D amino treatments spring or fall applied since 1964 at four locations in North Dakota (Lym and Messersmith).

		Application time/location/evaluation date													
		Spring								Fall					
		Hunter-1987		Dickinson-1987		Valley City-1987		Mean[a]		Sheyenne-1987		Valley City 1986/1987			
Treatment	Rate	May 29	Aug 21	June 2	Sept 9	May 28	Aug 20	1986	1987	May 30	Aug 24	June 3	Aug 20	May 20	Mean[b]
	(lb/A)	(% control)													
Picloram	0.12	2	3	3	4	18	55	2	10	42	0	3	0	1	0
Picloram	0.25	17	27	6	13	62	62	28	40	67	0	25	1	0	1
Picloram	0.38	64	67	31	29	70	81	63	67	74	9	56	3	2	6
Picloram	0.5	74	79	9	33	81	82	67	78	89	16	92	38	43	27
Picloram + 2,4-D	0.12 + 0.12	3	22	6	21	40	57	30	22	72	0	32	8	17	4
Picloram + 2,4-D	0.12 + 0.25	3	12	3	6	24	55	4	14	62	8	12	0	0	4
Picloram + 2,4-D	0.12 + 0.5	7	10	13	23	54	61	10	31	67	2	7	0	0	1
Picloram + 2,4-D	0.25 + 0.12	40	73	10	20	67	70	26	54	70	5	19	1	0	3
Picloram + 2,4-D	0.25 + 0.25	42	55	28	45	44	71	21	43	64	0	18	1	0	1
Picloram + 2,4-D	0.25 + 0.5	30	25	22	29	51	73	29	41	58	2	35	6	6	4
Picloram + 2,4-D	0.38 + 0.12	45	69	13	27	64	81	50	55	81	15	56	11	14	13
Picloram + 2,4-D	0.38 + 0.25	84	87	22	40	73	82	70	79	75	6	48	3	4	4
Picloram + 2,4-D	0.38 + 0.5	52	44	36	64	80	88	63	66	89	18	64	3	4	10
Picloram + 2,4-D	0.5 + 0.12	94	92	40	54	92	86	87	93	78	15	75	8	8	11
Picloram + 2.4-D	0.5 + 0.25	87	90	27	66	85	83	74	86	93	22	89	18	19	20
Picloram + 2.4-D	0.5 + 0.5	79	80	40	73	95	94	80	87	94	18	81	15	7	17
Picloram + 2,4-D	0.25 + 1.0	22	40	23	43	73	82	46	48	92	12	63	6	7	9
LSD (0.05)		26	31	18	23	30	19	23	20	28	NS	31	15	18	11

[a]Average control at Hunter and Valley City 24 and 36 months following the original 1984 treatment date.

[b]Average control 24 months following the original 1984 treatment data, fail treatments discontinued after 1985.

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Leafy spurge control with resulting forage production from several herbicide treatments

RODNEY G. LYM and CALVIN G. MESSERSMITH

An experiment to evaluate long-term leafy spurge control and forage production was established at two sites in North Dakota in 1983. The predominate grasses were bluegrass (*Poa* spp.) with occasional crested wheatgrass, smooth brome, big bluestem, or other native grasses. The treatments were selected based on previous research conducted at North Dakota State University and included 2,4-D at 2 lb/A, picloram + 2,4-D at 0.25 + 1 lb/A, picloram at 2 lb/A, and dicamba at 8 lb/A, and were applied in August 1983 or June 1984 as fall or spring treatments. The 2,4-D at 2 lb/A and picloram plus 2,4-D treatments were applied annually, while the picloram alone and dicamba treatments were reapplied when leafy spurge control declined to 70% or less. Thus, picloram at 2 lb/A was reapplied at Valley City in August 1985 and at Dickinson in June and August 1986. Dicamba at 8 lb/A was reapplied in June 1985 and 1986 at both locations as spring treatments and at Dickinson in September 1985 and at both locations in 1986 as a fall treatment. The plots were 15 by 50 ft with four replications in a randomized complete block design at each site. Forage yields were obtained by harvesting a 4 by 25 ft section with a rotary mower in July 1984, 1985, 1986, and 1987. Sub-samples were taken by hand along each harvested strip and separated into leafy spurge and forage so the weight of each component in the mowed sample could be calculated. The samples were oven dried and reported with 12% moisture content. Economic return was estimated by converting forage production to animal unit days (AUD) and then to pounds of beef at $0.60/lb minus the cost of the herbicide and estimated application cost, i.e. 2,4-D = $2.00/lb ae, dicamba = $11.75/lb ae, picloram = $40.00/lb ae, and application = $2.05/A. The cost of treatments applied in fall 1987 is not subtracted from the net return.

Most treatments resulted in less economic gain at Dickinson than Valley City despite excellent leafy spurge control from several treatments. Dickinson generally receives 5 to 6 inches less precipitation annually than Valley City. Total forage production averaged after 4 yr across all treatments was 4820 lb/A at Dickinson and 7968 lb/A at Valley City (Table). Leafy spurge control from 2,4-D at 2 lb/A was not satisfactory from spring or fall applications at either site. However, 2,4-D provided short-term control resulting in an economic gain of $82/A and $57/A at Valley City and of $35/A and $45/A at Dickinson as spring and fall applied treatments, respectively. Leafy spurge control with picloram + 2,4-D at 0.25 + 1 lb/A averaged over both locations was 76% in 1987 (Table) as a spring applied treatment which was an increase from 44% control in 1985 (data not shown). Above average precipitation was received at both locations in 1986 allowing vigorous leafy spurge regrowth. Leafy spurge control was poor with picloram + 2,4-D at 0.25 + 1 lb/A fall applied, but forage production (averaged across locations) of 6190 lb/A was only slightly less than the spring average of 6867 lb/A.

Picloram at 2 lb/A spring applied provided 83% leafy spurge control at Valley City 48 months after application but only 64% control 15 months after a second application at Dickinson (Table). Dicamba generally gave good leafy spurge control as a fall but not as a spring applied treatment. All treatments have reduced leafy spurge production compared to the control except the fall application of 2,4-D at 2 lb/A at Valley City. (Published with approval of the Agric. Exp. Stn., North Dakota State Univ., Fargo.)

Table. Leafy spurge control, forage production and estimated net return from several herbicide treatments at two sites in North Dakota.

Original treatment date		Re-treatment time				1987 Control		Yield[a]			Total
Herbicide	Rate	Herbicide	Rate	Year	Cost	June	Aug	Forage	Leafy spurge	Utili- zation	Net return[b]
	(lb/A)		(lb/A)		($/A)	----- (%) -----		------ (lb/A) ------		(AUD)	($/A)
								Valley City			
Spring 1984		**Spring**									
2,4-D	2	2,4-D	2[c]	84-87	24	10	18	7089	3676	177	82
Picloram + 2,4-D	0.25 +1	Picloram + 2,4-D	0.25[c] +1[c]	84-87	56	59	86	8143	1936	204	66
Picloram	2	...	...	...	82	84	83	9073	1417	227	54
Dicamba	8	Dicamba	8[d]	85,86	288	86	63	8740	1918	219	-157
Fall 1983		**Fall**									
2,4-D	2	2,4-D	2[c]	84-87	24	3	0	5424	5155	136	57
Picloram + 2,4-D	0.25 +1	Picloram + 2,4-D	0.25 +1[c]	84-87	56	93	16	8096	2918	202	65
Picloram	2	Picloram	2[d]	85	164	100	99	9142	261	229	-27
Dicamba	8	Dicamba	8[d]	86	192	99	88	8680	688	217	-27
		Control				0	0	7321	6053	0	
LSD (0.05)						15	10	1843	1624		
								Dickinson			
Spring 1984		**Spring**									
2,4-D	2	2,4-D	2[c]	84-87	24	9	18	3934	472	98	35
Picloram + 2,4-D	0.25 +1	Picloram + 2,4-D	0.25 +1[c]	84-87	56	63	65	5591	146	142	28
Picloram	2	Picloram	2[d]	86	164	96	64	5917	108	148	-75
Dicamba	8	Dicamba	8[d]	85,86	288	77	49	4601	210	115	-219
Fall 1983		**Fall**									
2,4-D	2	2,4-D	2[b]	84-87	24	11	4	4585	1350	115	45
Picloram + 2,4-D	0.25 +1	Picloram + 2,4-D	0.25 +1[c]	84-87	56	34	8	4283	1329	107	8
Picloram	2	Picloram	2[d]	86	164	99	85	5445	54	136	-82
Dicamba	8	Dicamba	8[d]	85,86	288	97	82	5277	57	132	-209
		Control				0	0	3749	2417	0	
LSD (0.05)						11	12	1063	687		

[a]Total production of 1984 through 1987 harvest.

[b]Total net return for 1984 through 1987. Fall 1987 treatment cost is not subtracted from net return.

[c]Annual retreatment.

[d]Applied when control declines to less than 70%.

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Leafy spurge control following an eight-year management program

RODNEY G. LYM and CALVIN G. MESSERSMITH

An experiment to evaluate long-term leafy spurge management was established at four sites (Sheyenne National Grassland near McLeod, Sheldon and two near Valley City) in North Dakota in 1980. All sites were established in early June except one site at Valley City which was established in September 1980. The herbicides applied in 1980 included 2,4-D as liquid and picloram as liquid (2S) and granular (2%G) formulations, and picloram applied using the roller and pipe-wick applicators. The conventional broadcast treatments were applied using a tractor-mounted sprayer delivering 8 gpa water at 35 psi. A granular applicator was used to apply the picloram 2%G treatments. Solution concentration in the roller was 0.25 lb/gal; this is the same solution concentration as picloram at 2 lb/A sprayed at 8.5 gpa. The solution concentration was increased for the pipe-wick applicator to picloram at 0.5 lb/gal because the pipe-wick applied about half the total volume per acre as the roller applicator. The roller and pipe-wick applicator height was adjusted to treat the top one-half of the tallest leafy spurge stems. The additive in the roller and pipe-wick treatments was a 5% (v:v) oil concentrate (83% paraffin based petroleum oil plus 15% emulsifier). The plots were 15 by 150 feet and treatments were replicated twice at each site in a randomized complete block design. Each plot was divided into six 7.5 by 50 feet subplots and retreatments of 2,4-D, picloram 2S, dicamba or no treatment were applied in June 1981 except the fall Valley City site which was retreated in August 1981.

Original 1980 whole plot treatments were reapplied in 1982 with several of the treatments changed (see Table). A carpet applicator was substituted for the roller applicator. The carpet applicator was designed by Magnolia Spray Equipment Corp., Jackson, MS, and consists of a 1 by 8 feet carpet attached to a rectangular spray box. The herbicide solution was sprayed onto the backside of the carpet through nozzles inside the spray box. Excess solution was returned to the spray tank. The picloram solution on the carpet applicator was 0.25 lb/gal and 0.4 lb/gal for two and one pass applications, respectively. The granular picloram treatments were replaced by picloram applied with the pipe-wick or carpet applicator with two passes, the second pass in the opposite direction to the first. Dicamba at 8 lb/A spray applied replaced the picloram plus oil concentrate pipe-wick applied treatment. The whole plots were retreated in 1982 with the original treatment except picloram at 2 lb/A was reapplied to the control subplot only since subplots receiving annual retreatments maintained satisfactory leafy spurge control. The experimental site at the Sheyenne National Grasslands was treated in the fall of 1982 to establish an equal number of spring and fall treatment sites. Subplot retreatments were applied again in 1983 through 1987. Evaluations are based on visual percent stand reduction as compared to the control.

In general, leafy spurge control was higher from spring-applied treatments compared to similar fall-applied treatments (Table). Previous research at North Dakota State University has shown spring- or fall-applied treatments to give similar leafy spurge control; however, in this study the fall treatments were applied to leafy spurge plants that had been harvested for yield in July of each year through 1984. Thus, the plants were shorter and in the vegetative growth stage compared to the normal fall growth stage. This reduced the plant leaf area treated and may have resulted in less herbicide uptake and translocation. Even though the plants were not mowed after 1984, the control in 1987 averaged 15% higher for spring- compared to fall-applied treatments, respectively. There was a 23% difference between the two averages in 1986 (data not shown). Thus, control from the fall-applied treatment is gradually increasing.

Picloram (2S) at 1 and 2 lb/A had provided the best long-term leafy spurge control regardless of retreatment in previous evaluations (Table). However, picloram at 1 and 2 lb/A without an annual retreatment (i.e. retreatment control) only provided 27% control when averaged over rate and application date in 1987 but control increased to 84 and 59% for spring and fall, respectively, when averaged over annual retreatments with dicamba at 2 lb/A and picloram + 2,4-D at 0.25 + 1 lb/A. Thus, when higher rates of picloram are applied every few years, there is little advantage in using more than 1 lb/A initially when annual retreatments are applied.

Dicamba at 8 lb/A alone spring applied averaged 4% control, but control increased to 80 and 96% with retreatments of dicamba at 2 lb/A or picloram + 2,4-D at 0.25 + 1 lb/A, respectively (Table). Leafy spurge control from fall-applied dicamba at 8 lb/A also averaged 4% and increased to an average of 68% following retreatments of dicamba at 2 lb/A and 50% following retreatments of picloram at 0.25 lb/A or picloram + 2,4-D at 0.25 + 1 lb/A.

Annual application of 2,4-D, the most economical treatment in the study, provided 3 and 22% leafy spurge control as a fall- and spring-applied treatments, respectively (Table). Leafy spurge control was increased to 96% when the 2,4-D original treatment was retreated with picloram + 2,4-D at 0.25 + 1 lb/A annually in the spring, but the same fall-applied treatment provided only 31% control.

The annual retreatments averaged across all whole plot treatments, that provided the highest leafy spurge control was picloram + 2,4-D at 0.25 + 1 lb/A in the spring (93%) and dicamba at 2 lb/A in the fall (69%) (Table). Annual retreatments of dicamba at 1 lb/A averaged only 38 and 45% leafy spurge control as a spring- or fall- applied treatment averaged over whole plot treatments, respectively. Leafy spurge control was increased 31% when 2,4-D was added to picloram at 0.25 lb/A compared to picloram at 0.25 lb/A alone as an annual treatment spring-applied, but not when fall-applied. Thus, the most practical retreatments when considering both cost and control were picloram at 0.25 lb/A alone in the fall or picloram + 2,4-D at 0.25 + 1 lb/A spring-applied, but dicamba at 2 lb/A would be the retreatment of choice where picloram could not be applied such as in areas with a water table 10 feet or less below the surface.

No treatment using a reduced-volume applicator (i.e., carpet, pipewick, roller) maintained satisfactory control alone. The reduced volume applicators would not have an economic advantage if several annual retreatments were required for satisfactory leafy spurge control. Several herbicide treatment alternatives provided 90% or more leafy spurge control 7 years after the initial treatment, but no treatment program had eradicated leafy spurge. (Published with approval of the Agric. Exp. Stn., North Dakota State Univ., Fargo.)

Table. Leafy spurge control in North Dakota following an eight-year management program (Lym and Messersmith).

Whole plot						Retreatment subplot 1981, 1983-87/Rate, lb/A						
Treatment[a] 1980	Rate	Soln conc	Treatment[a] 1982	Rate	Soln conc[b]	2,4-D 1.0	Dicamba 1.0	Dicamba 2.0	Picloram 0.25	Picloram +2,4-D 0.25+1.0	Control 0	Mean
	(lb/A)	(lb/gal)		(lb/A)	(lb/gal)	(% control)						
Spring applied												
2,4-D	2.0	0.24	2,4-D	2.0	0.24	22	40	64	55	96	0	47
Picloram 2%G	1.0	–	Picloram (carpet-2 pass)	–	0.25	72	20	70	69	96	0	54
Picloram 2%G	2.0	–	Picloram (wick-2 pass)	–	0.5	81	45	79	75	98	59	73
Picloram 2S	1.0	0.13	Picloram 2S	1.0	0.13	73	29	87	65	89	23	61
Picloram 2S	2.0	0.25	Picloram 2S[b]	2.0	0.25	59	72	73	68	95	15	64
Picloram (Roller)	–	0.25	Picloram (carpet)	–	0.25	48	25	80	42	93	5	49
Picloram+oil conc. (Roller)	–	0.25	Picloram (carpet)	–	0.25	49	53	77	79	97	23	63
Picloram (Wick)	–	0.5	Picloram (wick)	–	0.5	13	14	60	30	83	0	33
Picloram+oil conc. (Wick)	–	0.5	Dicamba	8.0	1.0	57	42	80	67	96	4	57
Control	–	–	Control	–		20	28	65	63	95	0	39
Mean						51	38	74	62	93	13	55

LSD (0.05): whole plot = 13; subplot = 10; whole plot × subplot 30.

Whole plot						Retreatment subplot 1981, 1983-87/Rate, lb/A						
Treatment[a] 1980	Rate	Soln conc	Treatment[a] 1982	Rate	Soln conc[b]	2,4-D 1.0	Dicamba 1.0	Dicamba 2.0	Picloram 0.25	Picloram +2,4-D 0.25+1.0	Control 0	Mean
	(lb/A)	(lb/gal)		(lb/A)	(lb/gal)	(% control)						
Fall applied												
2,4-D	2.0	0.24	2,4-D	2.0	0.24	3	27	53	42	31	0	26
Picloram 2%G	1.0	–	Picloram (carpet-2 pass)	–	0.25	6	56	75	39	63	7	41
Picloram 2%G	2.0	–	Picloram (wick-2 pass)	–	0.5	19	44	57	57	48	14	40
Picloram 2S	1.0	0.13	Picloram 2S	1.0	0.13	15	46	75	45	48	26	43
Picloram 2S	2.0	0.25	Picloram 2S[b]	2.0	0.25	28	65	80	60	70	44	58
Picloram (Roller)	–	0.25	Picloram (carpet)	–	0.25	9	28	69	47	42	8	34
Picloramr+oil conc. (Roller)	–	0.25	Picloram (carpet)	–	0.25	38	60	82	56	66	24	54
Picloram (Wick)	–	0.5	Picloram (wick)	–	0.5	8	41	70	44	30	14	34
Picloranr+oil conc. (Wick)	–	0.5	Dicamba	8.0	1.0	11	41	68	54	46	4	37
Control	–	–	Control	–	–	0	42	62	40	36	0	31
Mean						14	45	69	48	48	15	40
LSD (0.05): whole plot = 17; subplots = 14; whole plot x subplot 28.												

a Spray applied except the treatments identified as roller wick or carpet applicator applied.
b Applied to control subplot only.

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Spring or fall applied granular picloram and dicamba for leafy spurge control

RODNEY G. LYM and CALVIN G. MESSERSMITH

Granular and liquid formulations of picloram and dicamba were compared for leafy spurge control in two experiments established in 1980 on June 25 and September 3 near Valley City. Eight experiments to compare picloram 2% and 10%G formulations were established on September 14, 1982, and June 10, 1983, near Sheldon; September 9, 1982, June 21, 1983, and June 13 and September 11, 1984, near Dickinson; and June 14 and September 18, 1984, in the Sheyenne National Grasslands. Blank pellets were included in the experiments conducted at Sheldon so the number of pellets applied per plot was similar to improve uniformity of distribution of the picloram 10%G formulation. All experiments were in a randomized complete block design with four replications and were 10 by 30 ft plots. The granules were applied uniformly by hand, while the liquid formulations were applied with a tractor-mounted sprayer delivering 8.5 gpa at 35 psi. Evaluations were based on percent stand reduction compared to the control. A significant interaction between site and treatments occurred, so experimental sites will be discussed individually.

Leafy spurge control with picloram and dicamba was better from fall than spring applied treatments at Valley City, especially when evaluated 24 to 60 months after treatment (Table 1). The control averaged across all treatments after 24, 48, and 60 months was 54, 22, and 13% for spring applications and 78, 62, and 26% for fall applications, respectively. Fall applied dicamba at 8 lb/A and picloram at 2 lb/A as liquids provided similar control after 5 years, but control with granular picloram was better than with granular dicamba. Dicamba and picloram applied in the spring of 1980, generally did not give satisfactory leafy spurge control by 1982 and 1983, respectively. The exception was picloram at 2 lb/A which provided satisfactory control until 1984. Only fall applied picloram 2%G at 1.5 and 2 lb/A provided satisfactory leafy spurge control after 48 months at 83 and 86%, respectively, but no treatment provided satisfactory control 60 months after application.

Picloram 2%G and 10%G at equal rates generally provided similar leafy spurge control at both Sheldon and Dickinson (Table 2). Fall applications of picloram 2%G and 10%G at all application rates, except 2.0 lb/A, provided better leafy spurge control after 9 months than spring applications after 3 months. This difference could be due to insufficient moisture to completely disperse the granules following the June application, because the treatments generally were similar 12 and 24 months after application. Leafy spurge control in 1985 at Sheldon was similar to control in 1984. However, the treatments at Dickinson did not provide satisfactory leafy spurge control in 1985, so specific evaluations were not taken. The soil at Sheldon is very sandy compared to the mostly clay soil at Dickinson which may have allowed deeper picloram movement in the soil profile and thus better long-term leafy spurge root control at Sheldon than Dickinson.

Leafy spurge control with picloram at 1 and 2 lb/A was similar for the 2%G and 10%G when blanks were added, but was much worse with 10%G than 2%G pellets without blanks (Table 2). The picloram 2%G and 10%G pellets were similar in size and 80% fewer pellets per acre are applied with picloram 10%G than with 2%G. Thus, uniform distribution with hand-held application equipment was difficult which probably accounted for the decreased control. Visible grass injury was negligible with either picloram formulation. In general, leafy spurge control with picloram at 2 lb/A declined more rapidly when the liquid (2S) formulation was used compared to 2%G or 10%G.

Similar experiments were begun in 1984 using a new formulation of picloram 10%G with smaller pellets which resulted in more pellets per square foot than the previous 10%G formulation at similar rates. Picloram 2%G and 10%G gave similar leafy spurge control at all application rates except 0.5 lb/A (Table 3). Blanks were not mixed with the new 10%G formulation, but a uniform distribution still was obtained. Control was much lower at Dickinson than at Sheyenne which again probably was due to deeper picloram movement in the sandy soil at Sheyenne than in the clay soil at Dickinson. Unlike previous experiments, spring application of picloram granules provided better leafy spurge control than fall applications when evaluated 12 months after treatment. Fall precipitation was below normal and the soil was very dry until late October in 1984. The dry soil conditions after application apparently caused generally poor long-term control despite adequate moisture in 1985. Picloram at 2 lb/A maintained an average of 92 and 70% control 36 months after treatment as a spring and fall applied treatment, respectively, regardless of formulation.

Granular and liquid formulations of dicamba, and picloram generally provided similar control at comparable rates. Picloram 2%G and 10%G provided similar leafy spurge control either when blanks were included with the 10% pellets or when the number of 10% pellets per square foot was increased by use of a smaller pellet. Generally spring and fall treatment provided similar long-term control except when application was made during very dry conditions. Picloram granules provided better long-term control in sandy compared to clay soils. (Published with the approval of the Agric. Exp. Stn., North Dakota State Univ., Fargo.)

Table 1. Spring and fall applied granular picloram and dicamba for leafy spurge control at Valley City, ND.

		Application and evaluation date																	
		Spring treatment (25 June 1980)									Fall treatment (3 Sept 1980)								
Herbicide	Rate	6-81	9-81	6-82	9-82	6-83	9-83	6-84	9-84	6-85	6-81	9-81	6-82	9-82	6-83	9-83	6-84	9-84	6-85	8-85
	(lb/A)	(% control)																		
Picloram 2%G	1	97	80	53	25	44	22	10	8	3	95	86	84	55	76	52	51	52	18	10
Picloram 2%G	1.5	98	89	87	22	77	38	29	26	11	99	100	100	96	98	97	87	83	59	48
Picloram 2%G	2	99	98	90	53	85	72	56	62	28	100	100	99	100	100	98	93	86	68	63
Dicamba 5%G	4	74	55	9	3	4	0	4	0	0	94	74	43	31	31	29	18	20	17	9
Dicamba 5%G	6	82	54	25	3	16	5	4	3	1	96	99	89	58	55	55	41	40	22	6
Dicamba 5%G	8	91	75	45	19	29	6	5	6	0	99	100	98	83	84	78	66	67	39	20
Picloram 2S	2	100	99	98	90	94	79	64	71	54	100	100	100	100	98	94	79	78	50	28
Dicamba 4S	8	94	74	28	12	42	13	7	5	4	99	99	100	97	92	83	69	72	47	33
LSD (0.05)		9	14	21	17	20	11	11	12	20	3	10	22	29	24	24	29	23	26	23

Table 2. Leafy spurge control using Picloram 2%G and 10%G of similar size.

Picloram Formulation		Evaluation date									
		1983		1984		1985		1983		1984	
	Rate	June	Aug	June	Aug	June	Aug	June	Aug	June	Aug
	(lb/A)	(% control)									
		Sheldon						Dickinson			
Applied Fall 1982											
2%G+blanks	0.5	66	26	8	21	11	16	38	5	18	5
2%G+blanks	1	86	41	29	33	31	18	69	15	42	13
2%G+blanks	1.5	87	67	48	48	47	24	90	37	71	51
2%G	2	99	76	80	66	71	44	96	53	79	64
10%G+blanks	0.5	39	11	3	31	0	0	34	9	19	0
10%G+blanks	1	83	60	52	56	39	30	84	21	45	36
10%G+blanks	1.5	81	60	43	58	54	38	88	35	55	47
10%G+blanks	2	87	63	77	56	65	45	89	40	75	64
10%G	1	53	26	11	13	18	13	--	--	--	--
10%G	2	89	61	45	45	52	57	--	--	--	--
Liquid (2S)	2	94	67	55	44	30	35	94	42	60	41
LSD (0.05)		16	30	19	23	24	25	18	28	30	33
Applied Spring 1983											
2%G+blanks	0.5	--	28	27	10	21	8	--	38	28	12
2%G+blanks	1	--	38	58	13	55	14	--	57	53	43
2%G+blanks	1.5	--	86	95	36	92	50	--	62	83	60
2%G	2	--	97	94	69	93	62	--	76	89	65
10%G+blanks	0.5	--	26	11	6	18	4	--	25	20	2
10%G+blanks	1	--	54	61	16	52	28	--	32	42	23
10%G+blanks	1.5	--	74	70	26	58	35	--	78	75	56
10%G+blanks	2	--	92	92	56	92	56	--	63	76	70
Liquid (2S)	2	--	93	79	39	76	57	--	96	94	51
LSD (0.05)			22	14	14	23	15		23	19	29

Table 3. Leafy spurge control using picloram 2%G, 10%G, and 2S as spring or fall applied treatment.

Picloram formulation	Rate	1984 Aug	1985 June	1985 Aug	1986 June	1986 Aug	1987 May	1987 Aug	1984 Aug	1985 June	1985 Sept
	(lb/A)	------	------	------	------	(% control)	------	------	------	------	------
Applied Spring 1984					Sheyenne				Dickinson		
2%G	0.5	83	89	53	56	34	27	37	0	0	0
2%G	1	96	99	83	79	54	51	48	38	48	8
2%G	1.5	96	100	97	95	91	79	73	43	62	13
2%G	2	98	100	98	98	94	94	86	83	88	53
10%G	0.5	64	75	19	4	4	4	2	3	0	4
10%G	1	95	99	84	86	82	68	58	31	43	23
10%G	1.5	97	99	94	93	86	68	59	56	45	16
10%G	2	97	99	94	94	86	91	76	72	56	31
Liquid (2S)	2	98	100	99	98	94	92	76	98	80	28
LSD (0.05)		8	10	16	17	24	27	28	23	24	21
Applied Fall 1984											
2%G	0.5	--	94	57	76	7	4	4	--	71	16
2%G	1	--	100	91	91	74	64	71	--	85	39
2%G	1.5	--	100	96	98	83	77	79	--	97	56
2%G	2	--	100	97	97	86	76	67	--	98	81
10%G	0.5	--	82	42	43	6	9	1	--	46	15
10%G	1	--	96	81	66	52	33	33	--	79	36
10%G	1.5	--	99	91	89	81	64	72	--	91	45
10%G	2	--	99	91	96	73	68	70	--	95	68
Liquid (2S)	2	--	100	99	97	88	74	73	--	99	47
LSD (0.05)		--	6	16	14	26	28	24	--	9	17

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Dicamba combinations for leafy spurge shoot control

M. A. FERRELL and T. D. WHITSON

Leafy spurge is a major broadleaf, perennial weed problem in rangeland. This research was conducted in Crook County, WY, to compare the efficacy of dicamba combinations, with picloram and 2,4-D LVE, on leafy spurge.

Plots were established May 14, 1986 to a dense stand of leafy spurge in a rangeland setting. The leafy spurge was in the prebud stage-of-growth. Perennial grasses 4 to 6 inches tall were present as an understory. Herbicides were applied with a 6-nozzle knapsack spray unit with a carrier volume of 40 gpa delivered at 40 psi pressure through 8004 flat fan nozzles. Weather conditions were as follows: air temp. 45º F, relative humidity 60%, wind SW at 5 mph, sky cloudy, and a soil temp. – 0 inch 60º F, 1 inch 54º F, 2 inch 50º F, 4 inch 50º F. Soil was silt loam (22% sand, 58% silt and 20% clay) with 1.8% organic matter and 6.3 pH. Plots were 9 by 30 feet and arranged in a randomized complete block design with four replications.

Visual evaluations were made May 14, 1987. Picloram at 2.0 lb ai/A was the only effective treatment. Combinations of dicamba with picloram and 2,4-D LVE were not effective in controlling leafy spurge. (Wyoming Agric. Exp. Sta., Laramie, WY 82071, SR 1517.)

Leafy spurge shoot control.

Treatment[1]	Rate lb ai/A	Percent control[2]
dicamba	0.5	0
dicamba	1.0	0
dicamba	2.0	0
dicamba	4.0	53
dicamba + picloram	0.5 + 0.125	0
dicamba + picloram	1.0 + 0.25	18
picloram	0.5	42
picloram	1.0	65
picloram	2.0	96
dicamba + 2,4-D LVE	1.0 + 1.0	47
dicamba + 2,4-D LVE	1.0 + 3.0	45
LSD (0.05) =		19
CV =		36

[1]Treatments applied May 14, 1986; surfactant, X-77, added to all treatments at 0.5 v/v.
[2]Visual evaluations July 7, 1987.

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Leafy spurge control with fall applications of sulfometuron

M. A. FERRELL and T. D. WHITSON

Leafy spurge is a major broadleaf, perennial weed problem in rangeland. This research was conducted in Crook County, WY, to compare the efficacy of fall applications of sulfometuron on leafy spurge.

Plots were established September 16, 1986 to a dense stand of leafy spurge in a rangeland setting. Leafy spurge was mature and had shed most of its seed. Perennial grasses 1 to 2 feet tall were present as an understory. Herbicides were applied with a 6-nozzle knapsack spray unit with a carrier volume of 40-gpa delivered at 40 psi pressure through 8004 flat fan nozzles. Weather conditions were as follows: air temp. 53º F, relative humidity 80%, wind S at 5 mph, sky cloudy, soil temp. – 0 inch 55º F, 1 inch 57º F, 2 inch 57º F, 4 inch 57º F. Soil was a silt loam (22% sand, 58% silt and 20% clay) with 1.8% organic matter and 6.3 pH. Plots were 9 by 30 feet and arranged in a randomized complete block design with four replications.

Percent leafy spurge control, suppression, and grass suppression were evaluated visually on July 8, 1987. No treatment provided satisfactory control when evaluated 10 months after application. Picloram applied at 2.0 lb ai/A normally provides 90% control or better one year after application, however, in this particular study control was variable, ranging from 50 to 90% control in individual plots. All treatments containing sulfometuron resulted in suppression of leafy spurge, with sulfometuron + glyphosate resulting in the highest suppression, at 81%. All treatments containing sulfometuron at the 0.0468 lb ai/A rate and higher also resulted in grass suppression. Sulfometuron + glyphosate resulted in the highest percentage of grass suppression at 89%. Due to the suppressive nature of sulfometuron, its use as a setup treatment needs to be studied. (Wyoming Agric. Exp. Sta., Laramie, WY 82071, SR 1518).

Leafy spurge shoot control.

Treatment[1]	Rate lb ai/A	Percent control[2] 1987	Percent suppression[2] 1987	Percent grass suppression[2] 1987
sulfometuron	.0313	0	10	0
sulfometuron	.0468	3	30	20
sulfometuron	.0938	13	35	28
sulfometuron + 2,4-D LVE	.0313 + 1.0	10	38	0
sulfometuron + 2,4-D LVE	.0625 + 1.0	24	54	20
sulfometuron + picloram	.0313 + .125	13	33	10
sulfometuron + picloram	.0625 + .125	60	75	23
sulfometuron + glyphosate	.0625 + .75	49	81	89
fosamine	1.0	0	0	0
fosamine	2.0	0	0	0
sulfometuron + fosamine	.0938 + 1.0	13	51	11
picloram	.125	0	0	0
picloram	2.0	70	0	0
LSD (0.05) =		16	18	18
CV =		61	88	42

[1]Treatments applied September 16, 1986; surfactant, X-77, added to all treatments at 0.5% v/v.
[2]Visual evaluations July 8. 1987.

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Leafy spurge control with spring applications of sulfometuron

M. A. FERRELL and T. D. WHITSON

Leafy spurge is a major broadleaf, perennial weed problem in rangeland. This research was conducted in Crook County, WY, to compare the efficacy of spring applications of sulfometuron on leafy spurge.

Plots were established May 14, 1986 to a dense stand of leafy spurge in a rangeland setting. The leafy spurge was in the prebud stage. Perennial grasses 4 to 6 inches tall were present as an understory. Herbicides were applied with a 6-nozzle knapsack spray unit with a carrier volume of 40 gpa delivered at 40 psi pressure through 8004 flat fan nozzles. Weather conditions were as follows: air temp. 45º F, relative humidity 60%, wind SW at 5 mph, sky cloudy, soil temp. – 0 inch 60º F, 1 inch 54º F, 2 inch 50º F, 4 inch 50º F. Soil was a silt loam (22% sand, 58% silt and 20% clay) with 1.8% organic matter and 6.3 pH. Plots were 9 by 30 feet and arranged in a randomized complete block design with four replications.

Percent leafy spurge control and grass suppression were evaluated visually on August 13, 1986 and July 7, 1987. With the exception of metsulfuron, all treatments exhibited varying degrees of control three months after application, with sulfometuron + 2,4-D LVE and picloram providing good control (see table). Evaluations were taken 14 months after herbicide applications and it was found that sulfometuron + 2,4-D LVE provided poor weed control while picloram provided fair weed control. However, treatments containing sulfometuron did exhibit some suppression of leafy spurge with no grass suppression 14 months after treatment application. (Wyoming Agric. Exp. Sta., Laramie, WY 82071, SR 1519.)

Leafy spurge shoot control.

Treatment[1]	Rate lb ai/A	Percent control[2] 1986	Percent control[2] 1987	Percent grass suppression[2] 1986	Percent grass suppression[2] 1987
sulfometuron	.0468	53	0	83	0
sulfometuron	.0938	55	0	91	0
metsulfuron	.0188	0	0	0	0
metsulfuron	.0375	0	0	0	0
sulfometuron + metsulfuron	.0468 + .0188	58	0	85	0
sulfometuron + metsulfuron	.0468 + .0375	59	0	90	0
sulfometuron + metsulfuron	.0625 + .0188	55	0	90	0
sulfometuron + metsulfuron	.0625 + .0375	60	0	90	0
sulfometuron + glyphosate	.0625 + .75	53	0	98	8
fosamine	1.0	3	0	0	0
fosamine	2.0	5	0	0	0
sulfometuron + fosamine	.0938 + 1.0	59	0	85	0
sulfometuron + 2,4-D LVE	4.0	87	34	69	0
picloram	2.0	87	60	0	0
LSD (0.05) =		8	3	11	ns
CV =		14	33	15	599

[1] Treatments applied May 14, 1986; surfactant, X-77, added to all treatments at 0.5% v/v.

[2] Visual evaluations August 13, 1986 and July 7, 1987.

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Initial control of leafy spurge with various formulations of 2,4-D

M.A. FERRELL and T.D. WHITSON

Leafy spurge is a major broadleaf, perennial weed problem in rangeland. This research was conducted in Crook County, WY, to compare the efficacy of various formulations of 2,4-D on leafy spurge.

Plots were established May 28, 1987 on a dense stand of leafy spurge in a rangeland setting. The leafy spurge was in full bloom. Perennial grasses 6 to 8 inches tall were present as an understory. Herbicides were applied with a 6-nozzle knapsack spray unit with a carrier volume of 30 gpa delivered at 45 psi pressure through 8004 flat fan nozzles. Weather conditions were as follows: air temp. 63º F, relative humidity 74%, wind W at 5 mph, sky cloudy, soil temp. 0 inch 75º F, 1 inch 70º F, 2 inch 70º F, 4 inch 65º F. Soil was a silt loam (22% sand, 58% silt and 20% clay) with 1.8% organic matter and 6.3 pH. Plots were 10 by 27 feet and arranged in a randomized complete block design with four replications.

Visual evaluations were made July 7, 1987, 40 days after treatment application. The 2,4-D butoxyethyl ester + 2,4-D amine formulation provided better initial control especially at the 1.0 lb ai/A rate than did the other 2,4-D formulations. As rates increased, however, there was less difference between the 2,4-D formulations. (Wyoming Agric. Exp. Sta., Laramie, WY 82071, SR 1520.)

Leafy spurge control.

Treatment[1]	Rate lb ai/A	Percent initial control[2] 1987
2,4-D alkanolamine	1.0	54
2,4-D isoctyl ester	1.0	74
2,4-D amine + 2,4-D butoxyethyl ester	1.0	80
2,4-D alkanolamine	1.5	69
2,4-D isooctyl ester	1.5	78
2,4-D amine + 2,4-D butoxyethyl ester	1.5	81
2,4-D alkanolamine	2.0	80
2,4-D isooctyl ester	2.0	81
2,4-D amine + 2,4-D butoxyethyl ester	2.0	85
picloram	2.0	73
LSD (0.05)		17
CV		14

[1]Treatments applied May 28, 1987.

[2]Visual evaluations July 7, 1987.