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Future directions of leafy spurge in the Great Plains

DONALD E. ANDERSON

Administrative Advisor to GPC-14

My comments are directed to an evaluation of general research directions needed to generate an effective Leafy spurge control research program in the Great Plains Region and some ideas on the role of GPC-14 as a vehicle to help coordinate the efforts of state, federal and private organizations involved in the work. Because of the great economic significance of Leafy spurge in several states of the Northern Great Plains, significant research resources will need to be committed to find satisfactory solutions to control of this persistent pest. An estimated 2.3 million acres of land are infested with Leafy spurge in the Central states, and that number grows each year as the pest spreads.

Areas of research emphasis

There are three areas of research concentration needed to wage war on spurge. First and possibly most important is a strong research effort into the basic physiology of the plant. This is a difficult and complex task because of the large number of genetic variants of the plant. Numerous basic questions regarding the morphology, the anatomy and the physiology of the plant remain unanswered. Plant scientists have referred to spurge as the "ideal" weed because it is a prolific seed producer, and it easily regenerates from shoots or root fragments. Because the plant tends to defy conventional weed control systems, it is important to understand the biological processes of the plant in order to devise an effective control procedure.

The other two needed research areas are control of the spurge plant through biological and/or chemical control systems. It is known that spurge was introduced into North America from Europe. It is perplexing that our ancestors did not bring along the natural enemies of spurge when they brought the seed. We believe that natural enemies (insects and disease) have effectively controlled the spurge plant in Europe to the extent that it is of little economic significance. It seems logical that we should pursue biological control mechanisms to the extent possible if we are to gain some measure of control in North American. Along with biological control, we need to continue research on chemical control to develop more effective systems of control. There is considerable agreement that a coordinated effort of biological and chemical control will be needed to achieve long run solutions to the problem.

The role of GPC-14

It is important that we strive to make the research efforts in North America complimentary, and that we work hard not to reinvent the wheel in several research programs. GPC-14 was identified as the vehicle to develop communication among scientists working on Leafy spurge control. It is through meetings such as this and the publication of newsletters, annual reports and program proceedings that this communication will get the job done. I am urging the GPC-14 to continue reporting research efforts and defining the progress they have made through annual reporting sessions. As we look to the future, we need to make a sincere effort to establish a good level of scientific communication with our colleagues in Canada and Europe. GPC-14 symposiums should include invited papers on current work in Canada and Europe in future sessions.

I want to commend Dr. Alley and his colleagues for the outstanding program they have assembled for this meeting. I am sure that this will be a productive session and that the beauty of the Sundance area will add positively to our memory of this session.

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Leafy spurge symposium: Future directions of leafy spurge research from a university viewpoint

A. F. GALE

State Agriculture Program Leader, University of Wyoming, Laramie

I have been asked to substitute on the original program today to talk about the "Future Directions of Leafy Spurge Research from a University Viewpoint" ...Actually, you will be hearing an Extension person's viewpoint of the University's viewpoint of the future directions of leafy spurge research.

Leafy spurge's introduction into Wyoming is unknown; however, it was identified in Park County in 1944 and in Crook County in 1946. It is currently found in all 23 Wyoming counties.

The latest leafy spurge survey (1981) indicates that there are 38,442 acres on private land, 7,176 acres on state land, and 3,000 acres on federal land for a total of 48,168 acres in Wyoming.

It is estimated that leafy spurge is currently found on 2.5 million acres of rangeland in the United States and Canada. Maybe we are fortunate in Wyoming to only have 48,000 plus acres, as some of our neighboring states are estimating considerably greater acreages. For example, estimates of acreage being reported in some neighboring states are over 800,000 acres in North Dakota; Montana 500,000 acres; Nebraska 105,000 acres; and 60,000 acres in South Dakota.

I have very briefly outlined that problem; now, let's think in terms of research. As everyone present at this meeting knows, research takes dollars and research scientists with time available and the interest in conducting the research.

The USDA has recognized that leafy spurge is a very serious problem and has directed $200,000 for research efforts. The Old West Regional Commission also budgeted $125,000 for research efforts to be shared among five states with serious leafy spurge problems: Montana received $34,000; North Dakota $32,000; Wyoming $24,198; South Dakota $16,000; and Nebraska $15,000. Industry has also supplied large amounts of monies in the form of grants for research.

The Wyoming State Legislature, recognizing the significance of the leafy spurge problem in Wyoming, enacted the Leafy Spurge Act in 1978. During the last three bienniums, monies have been appropriated amounting to $4.3 million to assist landowners with the financial burden of controlling leafy spurge. George Hittle will be discussing this program during this morning's session. At this time, $10,000 has been made available to the College of Agriculture from a Wyoming Department of Agriculture grant to assist with leafy spurge.

I have been asked to discuss future directions of leafy spurge from a University viewpoint. Ladies and gentlemen, there have been considerable strides made with our research program but we have a long way to go. I relate this fact to approximately three summers ago when a very energetic and aggressive graduate student by the name of Ron Vore returned to Laramie after evaluating and soil sampling the research plots at Sundance. Ron appeared very dejected and disheartened. When asked what his problem was, he informed us that the trials that had shown complete leafy spurge vegetative control for two years had live roots and shoots 12 to 16 inches below the soil surface. Essentially, what he was telling us is that our hopes to obtain one treatment eradication with existing chemicals had just gone down the tube. Also, that additional research would need to be conducted to develop economical and effective retreatments.

I have serious concerns when I think about future leafy spurge research. Where are the research funds going to come from? As most of you know, the Old West Regional Commission has been dissolved. The USDA is having budget problems and the state budgets are not all that rosy, even in Wyoming. We never know when industry grant funds may cease to exist.

With these circumstances existing, I feel Universities in states having problems must identify leafy spurge research as a high priority and go forward to request funds to carry out the vitally needed research for our producers and preserve our land resources.

I am sure, as the program proceeds, you will note not only the contribution research has made but also that a great deal of work is needed. Thanks for the opportunity to express my views.

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Legislative viewpoint

JERRY GEIS

Senator, Washakie-Hot Springs Counties

I want to thank you for inviting me here to speak to this fine group. I see some of my colleagues back there, former House member Harold Hellbaum, and a good friend of mine Marlene Simons. So we've got a few people that are interested in agriculture and taking care of noxious weeds.

When I first heard about leafy spurge was back in 1975 when I was a "green horn" Legislator. They sent me to Cheyenne, Wyoming, after stumbling around I finally found the Capitol and was assigned to the Appropriations Committee. The reason I was assigned to this committee was because no one else wanted to serve on that committee because you really catch hell on that one.

Everybody comes to you needing dollars for this and dollars for that, you begin to wonder where the State of Wyoming is going to get that much money. Somehow, somewhere we always come up with enough money to handle our programs.

In 1976 the Department of Agriculture came to the Appropriations Committee stating they had a problem with leafy spurge and showed us some pictures of it. That is the first time I had ever seen leafy spurge. I knew what Cocklebur looked like and a few others, but I never knew what leafy spurge looked like.

We couldn't get our committee members to buy the program that year, so in 1977 when Senator Novotany, was Chairman of the Appropriations Committee, he and I flew over here with George Hittle, Harold Alley and a few others. We really took a hard look at the Leafy spurge problem in Crook County, we knew we had a problem and we knew we had to go back and fight harder to get the money., We found out that Sheridan County and Carbon County also had a lot of leafy spurge so we hit every county that we could think of that we could get some support from the Legislators that had problems with Leafy spurge.

So then we came in with a program we added it to the Department of Agriculture budget first, they kicked it out of there, so we then introduced a separate bill to handle the Leafy spurge program. We appropriated 1.4 million dollars, it was in and was out, finally it was right down to the final wire, we did pass the first appropriations bill for leafy spurge for 1978 of 1.4 million dollars. We set up a six year program, we thought that with the state's help within six years we could control leafy spurge. We knew we would have to do one application then we would have to come back and hit the hot spots. We found out a lot about leafy spurge and I think it is going to be an on going fight, probably never getting rid of leafy spurge but if we can control it, put the land back into production, I feel it is worth the money the state has put out to handle the leafy spurge program. After they researched it they found out that there is leafy spurge in every county in the state. We found out we had a lot more acres than they thought when they originally started the program. I think if you are going to get a program and you are going to go to your State Legislators with it you need to know the total number of acres you have. You really have got to get your local weed and pest districts lobbying for the program. Then go to the state with it, go to the State Department of Agriculture and then really work out a good plan.

There are statutes we have now that the district has agreed to assess the additional mill levy for leafy spurge. They then take it and use it for control of leafy spurge and the state will match it plus some other funds. I think in the future if the state doesn't have the money they had in the past, it is going to be up to the local people and ranchers to provide more funds. We may have to in the future change the statutes and maybe assess a full statewide mill levy to have enough of a weed and pest program to handle the noxious weeds. It can be handled and Legislators feel it is a pretty large program, tell them the truth and you can sell them. We had our biggest problems selling it to our Legislators that live in our bigger towns like Casper, Laramie and Cheyenne, they couldn't see why we should be out helping agriculture again.

I have toured the area three times since 1977 and am very impressed with the program.

I feel it is a privilege to be in agriculture, and that's why I am one of the leaders in helping to use the money to make the State of Wyoming a better state, make it more productive and make a better agriculture program out of it.

Thank you.

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Wyoming's Leafy Spurge Program Coordinator's viewpoint: Fiction, theory or fact

GEORGE F. HITTLE

Weed and Pest Coordinator, Wyoming Department of Agriculture, Presentation, Leafy Spurge Symposium, Sundance, WY June 21, 1983

Webster's New Collegiate Dictionary defines the following terms as:

1. "Fiction as something invented by the imagination or feigned. Feigned being defined as not genuine or real;"
2. "Theory as the analysis of a set of facts in their relation to one another, an idea or hypothetical set of facts, an unproved assumption;"
3. "Fact is a thing done, an actual occurrence, a piece of information presented as having objective reality."

All three terms apply to the program. The program was designed on imagination based on an idea or scientific set of facts and then an actual occurrence.

The term "jargon has been applied, which is defined as unintelligible or meaningless talk or any talk or writing which one does not understand." Some examples (which are not in chronological order):

1. Aerial application has proved unsuccessful;
2. Mickey Mouse chemicals;
3. We have been criticized by other states, which is a case of one does not understand;
4. The university research work is not worth a damn;
5. If the law was implemented in the manner intended rather than being manipulated, everything would be okay;
6. The department should depend upon the integrity of the people carrying out the program;
7. You name it, we have heard about it; most which is not defined in the dictionary.

I'm not going into any more jargon or I'll place myself into the above classification.

In discussing "theory, as the analysis of a set of facts," we had to look at our "capabilities," which is defined in part as a "quality, ability, etc. that can be developed or used", once we determined our capabilities, interaction had to occur which involved many organizations, such as:

1. University of Wyoming;
2. Acceptance by Wyoming Weed and Pest Council, State Board of Agriculture, Weed and Pest Control Districts and Landowners;
3. Support of private organizations and industry;
4. Last but not least, support of our Governor and State Legislature.

Many questions needed answering and several factors had to be considered before initiating the program:

1. Recognition of the problem, which included surveys, plant behavior and priority of control;
2. Did we have the knowledge required for implementing a control program?
3. Can we formulate and initiate a large scale program on Leafy Spurge?
4. Can this be accomplished without jeopardizing other noxious weed and pest programs already in effect?
5. Can the landowners, district and state afford to invest in a Leafy Spurge program?

The decision was made and H.B. 53 was introduced by State Representatives Kenneth Gropp and J. L. Graham. On March 8, 1978 Governor Herschler signed into law a six year act, that is now known as "Wyoming's Leafy Spurge Control Act of 1978."

The State Evaluation Committee Report is available. The report deals with "fact," which is a piece of information presented as having objective reality. The report gives you detailed information about the program.

Beyond a doubt we are at the crossroad of the program. "Crossroad" being defined as "where a decision must be made." Decisions that have been made or will have to be made are:

1. State legislature extended the Leafy Spurge Act to June 30, 1990;
2. Reevaluation and direction of the program;
   a. Research. b. Education. c. Control Methods.
3. Cost evaluation, past, present and future;
4. Management systems need implementing;
5. Regenerate some enthusiasm and participation;
6. Term of maintenance program, past versus present and future;
7. Compliance section in the law will have to be tested in court;

8. Greater demand for federal participation on lands administered by federal agencies.

Interaction programs need to be intensified and accelerated to keep pace with the ongoing control programs. Various organizations will be requested for more input into the program.

Another positive aspect is the herbicide monitoring program. Based on available toxicity data and water quality criteria the herbicide concentrations do not constitute dangerous or harmful concentrations to humans or to the environment.

"Fiction, Theory or Fact," you as individuals can draw your own conclusions.

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Leafy spurge viewpoint from Weed and Pest supervisor

ROBERT R. BENJAMIN

Supervisor, Sheridan County Weed & Pest Control District

I am glad to be here today and have an opportunity to speak.

When Tom Whitson called me and asked if I would speak on a County Supervisors viewpoint of a Leafy Spurge Control Program, several things came to mind and Tom made a few suggestions.

The two main things I want to cover briefly, is if we could go back to the beginning, how would you set up a County Leafy Spurge Control Program, and second, I will give you a brief overview of what the Leafy Spurge Control Program has done in our county and where we are trying to improve it.

But before getting into this I would like to pass along a little story concerning leafy spurge.

In Sheridan County we have a leafy spurge fieldman and when I first met him several years ago, he was taking me around and showing me some spurge. One day we were out by his place and we stopped in. He was showing me some weeds he had and his horse, now Chuck was quite a cowboy and roper, and he explained to me that "Bob, when I retire, me and that horse are gonna grow old together". Well I thought that was pretty nice.

While I was working up this speech it came to me that coordinating a county leafy spurge program had saved me a great expense. I didn't need to buy a horse to grow old with, coordinating a leafy spurge program will do that for me.

With that in mind, if I were to start over I believe a new program should be centered around two things, information and education.

You need to inform and educate yourself first to leafy spurge, its identification and its characteristics, also you need to learn about all control measures that are available, such as chemical, mechanical, biological. Second you need to educate and inform all the residents in the county about leafy spurge.

In starting a new program you will need to sit down and design a program for your county.

One of the first priorities will be to come up with an inventory of the acres of leafy spurge you have.

If we did go back I would recommend that an inventory be broken down as to where the spurge is located, such as what percent is located in range lands, crops, riparian, etc. Where the spurge is located and how much you have will dictate your total costs.

The inventory is one area our program had some problems. Estimating a particular weed species infestation within a county is a hard and difficult job to undertake. You will probably revise your estimate several times as we did.

Along the inventory lines a good management tool is the use of a helicopter to survey your Leafy spurge with.

In setting up your program, there is a need to develop some type of written cooperative agreement between the landowner and the Weed and Pest District. It should outline the work to be done over an estimated period of time. The agreement should also specify the type of control practices, especially chemical types and when and what rates it will be applied at. Who is going to do the work and estimate as to the acres of leafy spurge.

It is at your first contact getting people signed up, that you can collect some of your acreage data on an individual basis.

During these contacts it is important to explain to the landowner, that he is entering into a control program, not an eradication. People have signed up on a three-four year program and thought in this amount of time they would be rid of their spurge.

We need to educate the people to the idea that once they have leafy spurge, they stand a good chance of always having it.

I think it can be explained simply that a landowner may have 500 acres of spurge and need 500 gallons of chemical to treat it for the first year. He may need 250 gallons the second and eventually only need 1 gallon, but he needs to check that 500 acres each year and all of his land each year from now on.

I mentioned earlier education of yourself and those with the spurge, also you need to consider educational programs and materials for people not infested. This will enable them to be aware of leafy spurge so that small outbreaks can be identified and worked on immediately.

One of the best products to do this with is the 3" x 5" leafy spurge color post card put together by the Wyoming Weed & Pest Council. It shows the plant in bloom, the roots and flowering head along with a descriptive write-up on the back.

Along the education line you can utilize the standard ways, newspaper articles, visual aids, handouts, plant mounts. Our winter meetings have a portion of the slide show just for leafy spurge.

Last summer we grew leafy spurge in a greenhouse and along with a write-up put the potted plants in town at the Co-ops, seed stores, etc. It’s a good idea, but you need to remember to remove the plants before they go to seed, or you might get the comment, “Looks like the Weed & Pest hasn’t got enough leafy spurge, they are growing it in the seed store”.

One problem you might encounter with people is that how can one plant create such a county or statewide stir.

We've had this stuff for 30 years, what's the excitement now? In these types of contact you need to have some good information lined up.

Sometimes pictures will work, or showing the person what spurge can really do, will help.

Two of our harder cooperators to sign up made trips to Montana last summer and both saw what leafy spurge can become. Both came back and signed up on the program and are two of our most active spurge fighters.

Funding for a program is a key factor, this is going to involve coordination and cooperation with County Commissioners, State Legislators, state agencies and federal agencies.

There are many stumbling blocks and at times the red tape and problems can seem impossible, but they can be overcome.

In looking at our program I feel since 1978 our program has been successful in stopping the rapid spread of Leafy spurge and reduced the amount of acres visibly infested with Leafy spurge.

One of the more exciting things for us in leafy spurge has been our trial of one quart of Tordon 22K, put on with four and three fourths gallons of water per acre with a helicopter. This treatment was done once in the spring and once in the fall.

We have achieved a good kill on the spurge and the native grasses have responded to the lighter rates of Tordon. With this treatment we are blanket spraying areas with visible leafy spurge and areas known to have had leafy spurge in the past.

Failure wise, we have had some of the more common problems, chemicals applied wrong, either in amounts per acre or timing, funding shortages, people who were reluctant to sign up and cooperate.

Three of the major areas our program has had problems with and we are working at to correct are: First, we did not do a good enough job informing the people that this was a control program. People signed up with the idea they could spray three or four times and be done.

Second, whenever you sign someone up on a cooperative agreement they should fully understand the agreement.

Last, this item came out to me last summer as I was driving by a pasture in August where the leafy spurge had been sprayed recently with a ground rig and a handgun. It appeared to me that the spraying had done a good job of killing the spurge, but in walking around the area something seemed wrong. It then struck me that this cooperator had done a good job on his spurge but left twice the Canada thistle in the pasture unsprayed getting ready to go to seed.

In talking to other people it became apparent that some people were fighting leafy spurge and neglecting the other weeds.

I realize this is a leafy spurge symposium, but I feel it is important that we impress upon people the total weed control concept, because we are all in the weed control business.

In closing I would like to say that from a County Supervisor's viewpoint we have completed a lot of the easy leafy spurge work and are now entering into the hard work of the continuous retreat and watching for the treating those small isolated spurge patches.

With that I would like to thank you for the opportunity to speak here today, and I hope I have given you some food for thought.

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Leafy spurge from rancher's viewpoint

JESS DRISKILL

Rancher, Devils Tower, Wyoming

I am going to talk to you in three different stages. The past, what leafy spurge was on our ranch; where we are at the present time; where I think the future goes and what I think we are going to have to have in the future to maintain some kind of control.

From a ranchers point of view the leafy spurge program in the state of Wyoming has been a ranch saver. Without that program we basically would not have a ranch today, that's all there is to it. When we look back in the past our ranch is a real old timer in this county, it was one of the very first ones.

We are also an old timer as far as spurge is concerned, my grandad told me that one of the old homesteader wives had spurge planted in her flower garden. This was in 1910.

About 1950 it spread on down the creek and long about the 50's it was beginning to become a serious enough problem that we had 1,000 acres that was badly enough infested that it was beginning to interfere with our carrying capacity and at that time about the only chemical you had available to you was 2,4-D and my grandad started aerially spraying a little over 1,000 acres a year with 2,4-2. Needless to say this completely demuted the creek of all deciduous trees. You will see this tomorrow when you go in, and that is one thing that I want you to be aware of. The older tree kills that you will see as you tour tomorrow are primarily due to 2,4-D and not due to Tordon. I don't mean we haven't killed trees with Tordon, because we sure as hell have and killed a lot of them. But we have a lot of trees left. Pine trees seem to be about as susceptible as anything and we have killed quite a lot of them.

To get back to where we were on the spraying program, I moved out on that ranch to take over the management of it in 1972. We continued the aerial application of 2,4-D and some Tordon and it was costing us 5 or 6 thousand dollars a year to do this spraying. The big ranch was run down and I thought there was a lot of things maybe we needed to do worse, so I missed a year. I'll tell you when I missed that year, I became immediately aware of the importance of continuing a treatment program on spurge. It didn't look like there was any way that we could still handle any part of it and I went down to talk to Dr. Alley. He came up; he had been made aware of this by his predecessor at the University of Wyoming of the spurge problem we had on Left Creek. He had been on the property in the middle 50's and had taken a look at it, but had not been back since. He was really amazed how the spurge had spread and intensified on the creek. I ask Harold at that time, I said, if I put $10,000 a year on this program will I get some kind of control. He said, "Jess if you put $10,000 a year you'll never have control." So through his help and many other people, we started working on awareness and working on a program trying to get some help.

Subsequently we did in 1978. A Legislature enactment of a spurge bill. You'll see tomorrow that we have pretty damn good control. To be right honest with you, those of you who are not familiar with what happened through the treatment program, will not really believe we have a spurge problem out there. I don't think I have a single acre that doesn't have a spurge plant on it. So we still have to cover the same amount of acres all of the time. The money involved is just mind-boggling if you are involved in areas of infestation. I'm probably going to catch a little hell from some of the professionals, maybe some of the lawmakers and some others as far as the way I figure the cost of this thing. But as far as I'm concerned, from the rancher's point of view, it is what you have got to figure to be realistic. When we entered into this program we worked really hard in conjunction with our weed supervisor in establishing a spurge inventory on our ranch. I feel we were extremely accurate, I think we did a good job of it. I would not deny that during the program that I accumulated more spurge because we all know how it grows and spreads. But by the same token, if you are in a serious infestation, it's not conceivable that you're going to make an initial treatment all in one year, it is going to be an on going situation that takes two or three years to get an initial treatment.

When I put my figures together on our initial inventory the total dollars' that have been expended on our ranch have exceeded $216 per acre to get right up to where we are today.

Now you look at it today and don't have much spurge and the carrying capacity is back up, but at one time when the program started in 1977, our carrying capacity was cut by at least 40% possibly as much as 50%. Today we are back to at least 100% carrying capacity and contrary to what George thinks, I'm glad we are back there again.

Our grass is really good and this in spite of a drier growing season we have ever witnessed, and that's going to be hard for you to realize because our county is good and I don't deny that, but from the 15th of May until the 15th of April we had no measurable precipitation on our ranch, which is a critical time. Good subsoil moisture and nice cool weather saved our life.

It is not conceivable that man or that landowner can control that spurge, not initially, not now, not in the future. There is no conceivable way. So be aware that what has been alluded to here is sure right. It is not the awareness of the people here in this room but the awareness of the people that think we don't have a spurge problem.

People don't realize what is going to happen if you let spurge grow. And the decision as to whether you control or don't control, it is basically up to these people because the landowner cannot afford it – no way. People that are on the outside don't know about it are the ones that are going to make it able for us to secure money to have control.

If we don't convince them that it is their decision and that we need the money we're not going to get it. They have got to make up their minds, do they want to abandon that land or do they want to let spurge go, or do they want to save it, because the landowner can't afford to do it. It is just as simple as that.

I hope that you all take time to take a real good look at the pictures in back of the room or you will not have any idea of what's been done if you don't look to see what it was like before. I hope you will take into consideration that how many live trees we have left, and also think about that pine trees coming back, they regenerate so fast in this country. We've got one County Commissioner who says it is the second worst weed. We grow pine trees like you wouldn't believe, so 10 years from now nobody is ever going to know we killed pine trees.

I'd like everybody to leave here with the thought you are going to make everybody you meet aware of the spurge program, because it's the decision of the other people, it is not those of us that knows spurge or are concerned with it, it's not even our decision. Because there is no way we are going to generate that money without their help.

Thank you.

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Leafy spurge viewpoint from Weed and Pest District board member

JOHN DORRANCE

Rancher and District Board of Directors, Hulett, Wyoming

It is very hard for me to separate being a rancher from being a weed and pest board member. Because I got on the Weed and Pest Board, and because of my leafy spurge problem. I don't think I'd be on it if I didn't have leafy spurge; I wouldn't care about it and I wouldn't be on the board. I probably have the second worst infestation in the county and always will, it is there to stay, it is not going to go anywhere. So I got on the Weed and Pest to eradicate leafy spurge in Crook County. I am proud of our county, we didn't eradicate, but we did control it. Now I think we are the control capital of Wyoming, maybe of the world, who knows. The Russians might beat us, but they've got a problem.

Now what I'd like to do is take you through some figures and kind of tell you where we have gone and mostly where we are going to go. What you must realize is that we've been through three weed and pest supervisors and they have all been good men and they have all done a good job. We don't have a big fancy outfit, we don't have gobs of pickups and we don't spend a lot of money on administrative costs. Our administrative costs are running, for the whole program, $32,693 if the federal government could administrate at $2,100,000 program for that we probably would be really on the move by now.

So we aren't very fancy, but you will see that we got the job done despite some obstacles. Some of the acres we thought we had 9,600 cases of spurge to be treated, actually what we have treated initially has been closer to 13,000 acres. About 11,946 acres of private land, 200 acres BLM, and 1,500 plus acres state land, 1.5 acres of Roping Club. Some figures aren't included in this, we've got the Devils Tower National Monument, and there was spurge all over it and tomorrow you will see that there is very little spurge in that park.

The BLM – that's a bad one, they don't like treating their acres, we wrote nasty letters, they have told us to go fly a kite. We have gotten together and we are getting the job done together.

The state, the state sometimes doesn't have enough money, but they have come up with the money to treat their land too, so we are getting the problem solved there.

Other people in the county, we yell and scream at, so far that is all that has been necessary to get the problem solved.

Now I'd like to talk about the cost to do this. The cost is $2,100,000, figures out to about $154 an acre, the USDA says you can go out and buy farm land in Wyoming for $160 an acre, so what we have done here is we've kept it from spreading, we haven't been eradicating it, we have kept it from spreading so we've probably kept that land that is worth $160 an acre worth the $160 an acre.

What we have done is drawn a line around our problem area and fighting the battle in just one spot rather than the whole state. I hope we can continue to do that.

Here is how the cost breaks down as far as what we have recorded. The landowner had to pay 20% of that, and comes to about $368,245. The county mill and vehicle fee is $325,501, the Wyoming Department of Agriculture came up with $1,147,477, the BLM came up with $30,000 and the Commission of Public Lands for the state school land came up with $227,722. Now that is a lot of money.

I think you will see tomorrow, we are proud of it, because it is the landowners who do it, we don't have fancy crews and we don't need weed and pest supervisors on ground applications, it is put on by the individual landowner. Maybe that is why we have kept the cost so low.

What I'd like to bring up here is the herbicide cost and the application cost. I think it would be of interest as this was touched on by Jess and I have some figures here to show when we initially started, herbicide costs were around $200,000 for the initial 2,206 acres treated. Application costs, a percentage ratio, of around $30,000 that was about 15%. Now on the first retreat herbicide costs dropped to $65,700 and application costs increased proportionally 28%. On the second retreat herbicide costs again dropped to $57,000 and total application costs increased again, as a percent, and there up to 35%.

So you can see that what we have been saying is that if you have one acre of leafy spurge you are always going to have one acre of leafy spurge. You are going to have to go over that whole area. Now if you can do it out in the open with a helicopter or an airplane that is fine, I happen to have pine trees straight up and down, that means a man with a backpack and that is expensive. So far we have been able to manage and kill the weeds.

Basically that is all I have to say, I could talk forever as a rancher but I'm suppose to be here as a Weed and Pest board member.

Again, I'd like to say that we are controlling the weeds, and we being the whole county, everybody out there is doing it, that has it and if they aren't they should because we'll get after them if they don't do it.

I am real proud of the county, I'm proud of our Weed and Pest Department, and I hope we can continue doing what we have done so far.

Thanks

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Update on leafy spurge control in North Dakota – 1983

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Economical control of leafy spurge has been a major goal of the leafy spurge program in North Dakota. Annual application of picloram plus 2,4-D at 0.25 plus 1.0 lb/A for two years has resulted in greater forage production and similar leafy spurge control compared to picloram applied once at 2.0 lb/A after three years (Table 1). Dicamba at 2.0 lb/A has given fair forage production, but only 39% leafy spurge control. Dicamba has generally given better leafy spurge control in western compared to eastern North Dakota. Annual applications of 2,4-D have not resulted in long-term leafy spurge control, but does kill the top growth long enough to allow increased forage production.

Application of picloram using a pipe-wick has given good leafy spurge control while using only 20 to 40% as much picloram as a broadcast spray at 2.0 lb/A. The wick used consisted of 0.75 inch PVC pipe with 0.12 inch holes drilled every two inches and covered by 0.5 inch poly-foam overlayed with canvas. The wicking material was wrapped around 75% of the pipe circumference and attached to the PVC pipe with contact cement. The design consisted of 1) two 6-foot bars, one foot apart rectangular shaped (2-bar applicator); 2) three 6-foot bars, one foot apart rectangular shaped (3-bar applicator); 3) two 6-foot bars one foot apart with three interconnecting diagonal bars so each leafy spurge stem was treated by the front, diagonal and rear bar (diagonal applicator). Picloram at 1:3 (picloram: water) (v:v) was applied using the wicks either with one pass or two passes; the second pass was in the opposite direction to the first pass. Picloram applied using two passes resulted in better leafy spurge control than a single pass regardless of applicator type (Table 2). Picloram application with the diagonal wick resulted in better leafy spurge control than either the 2-bar or 3-bar rectangular design and was rated 98% control 22 months after treatment.

In a similar experiment picloram applied using the 2-bar wick in the fall resulted in much better leafy spurge control than a mid-summer treatment (Table 3). Data from similar experiments in 1980 and 1981 also indicated picloram applied with the wick applicator resulted in better leafy spurge control as a fall treatment rather than a spring or early summer treatment.

In 1981 and 1982 leafy spurge root samples were taken weekly to a six inch depth from early April to late October. Analysis of the soluble sugars indicated sucrose as the major carbohydrate present with a slight amount of glucose and fructose also present. The soluble carbohydrate reached maximum levels in late fall just prior to freeze up and constituted 16% of the leafy spurge root material on a dry weight basis. Large fluctuations in the free carbohydrate levels were observed during mid-summer in both growing seasons. These fluctuations were found to vary inversely with the average weekly high temperature and similarly to the average weekly low temperature with a correlation coefficient of -0.80 ($P = 0.01$) and 0.80 ($P = 0.01$), respectively. Carbohydrate levels decreased as the average weekly temperature increased; conversely root carbohydrate levels increased as the average weekly temperature decreased. Such large fluctuations in carbohydrate movement could affect herbicide translocation and thus leafy spurge control. Root samples are being taken twice weekly in 1983 so that a more precise prediction of periods of increased carbohydrate and perhaps herbicide translocation to the root system can be made.

Table 1. Leafy spurge control from various annual herbicide treatments or a single application of picloram.

Herbicide	Rate	Control 1982	Control 1983	Total forage production	Net return[1]
	(lb/A)	(%)	(%)	(lb/A)	($/A)
Annual treatments (1981-82)					
Picloram	0.25	14	50	4,090	23
Picloram + 2,4-D	0.25+1.0	20	68	4,086	19
Dicamba	2.0	5	39	3,501	-12
2,4-D	2.0	4	22	3,349	15
Single application (1980)					
Picloram	2.0	84	76	2,548	-72
Control		...	...	2,114	
LSD (0.05)		24	16	448	

[1] Economic return estimated by converting forage production to hay at $48/T minus herbicide and application cost. 2,4-D at $2.17/lb, dicamba at $10-30/lb, picloram at $40.00/lb. Application cost at $2.05/A.

Table 2. Leafy spurge control with picloram using several wick applicators with treatments applied on 10 August 1981.

Applicator	No. passes	Picloram concentration[a]	Control 1982 June	Control 1982 August	Control 1983 June
			(%)		
2-Bar	1	1:3	77	36	48
2-Bar	2	1:3	88	77	76
3-Bar	1	1:3	75	15	30
3-Bar	2	1:3	92	80	86
Diagonal	1	1:3	71	56	53
Diagonal	2	1:3	100	99	98
LSD (0.05)			21	25	25

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

Table 3. Leafy spurge control with picloram applied using the wick applicator in mid-summer or early fall.

Applicator	No. passes	Picloram concentration[a]	Control June 1983
Applied 8 July 1982			%
2-Bar	1	1:7	12
2-Bar	1	1:3	24
Applied 27 August 1982			
2-Bar	1	1:7	85
2-Bar	1	1:3	88
LSD (0-05)			17

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

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Leafy spurge rust found in southeastern North Dakota

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A rust fungus, tentatively identified as *Uromyces* sp., was found at two locations in Ransom and Sargent counties in late May 1983. The rust appeared to cause a systemic infection. It was present in young buds below the soil surface and formed distinct pycnia on the lower surface of infected leaves. Within 1-2 weeks after emergence of pycnia-bearing leaves, numerous aecia formed on the lower leaf surface intermixed with the pycnia. The infection caused extreme stunting of plants, accompanied by thickening of the dwarfed leaves and sometimes a flattening of the stems in cross section. Above ground portions of infected plants nearly always died within 3-4 weeks after emergence. Viability of below ground portions of the plant is yet to be determined. Aeciospores from infected plants were inoculated onto the suspected alternate host, alfalfa, and there resulted in the formation of uredia and urediospores. The potential of this indigenous pathogen as a biocontrol agent for leafy spurge is being evaluated.

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The nutritional value of leafy spurge as a forage component for ewes and lambs

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Research begun in the summer of 1982 is being continued on the Ray Gillespie ranch 6 miles south of Whitehall, Montana to determine the nutritional value of leafy spurge as a forage component for ewes and lambs. Since previous research, conducted by Montana State University graduate assistant Barb Landgraf, showed that after a 2 to 3 week adjustment period sheep would selectively consume 40 to 50% of their diet as leafy spurge, it was suggested that the nutritional benefits of this weed be explored by further monitoring sheep as they selectively graze leafy spurge.

Nine 1.8 ha pastures, each containing 5 lamb/ewe pairs, have been divided into three treatments: 1) leafy spurge controlled with chemicals, 2) light levels of leafy spurge (about 10% of the plant composition), and 3) heavy levels of leafy spurge (about 20% or more of the plant composition). Ten utilization cages have been placed in each pasture to determine species selected (grasses, forbs, or spurge) and to estimate diet intake by use of the paired plot technique. In addition, lamb production will be measured by recording lamb weight gains once every 2 weeks, and ewe performance will be estimated by monitoring lambing records of those ewes grazing leafy spurge.

Preliminary data have shown that lambs eating leafy spurge have gained up to 5 pounds more during the 9-week data collecting period than those lambs grazing only native grasses. In addition, the lambing records of those ewes grazing leafy spurge during the summer of 1982 have not shown any birthing difficulties, abnormalities, or abortions as a result of eating leafy spurge. However, since data from the summer of 1983 have yet to be collected and combined with these results, it would be presumptious to make any conclusions concerning these preliminary findings at this point in time.

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Herbicide applicators for All Terrain Vehicles

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Leafy spurge is routinely found in rough terrain which is inaccessible to conventional herbicide application equipment. Ranchers are currently treating spurge in these problem areas by hand application of chemicals which prevents accuracy. All Terrain Vehicles (A.T.V.) equipped with herbicide applicators may provide better weed control in problem areas.

A granular spreader was fabricated for the A.T.V. This design utilizes a conventional garden spreader. The ground drive mechanism is converted to a rear wheel drive mechanism and the spreader is bolted to the rear A.T.V. rack. The drive mechanism can be engaged or disengaged by a spring lever. The spreader is easily calibrated.

A controlled droplet applicator (C.D.A.) was mounted on the A.T.V. using two C.D.A. sprayer heads (Micron Company) fastened to a 6-foot section of pipe which was clamped to the rear rack of the A.T.V. A 2-gallon hand pump sprayer tank served as the reservoir. Each flow line to the C.D.A. heads included a 7-pound check valve, a pressure regulator, and a gate valve. A 6-volt battery supplied power to the C.D.A. motors.

A front mounted rope wick was fabricated for the A.T.V. This design utilizes wick rope, inserts, and rubber stoppers from a kit available from the Monsanto Chemical Company. The wicks are supported in a wedge shape and interconnected to form a manifold. The wick bar is bolted to the front forks of the A.T.V. This mount is hinged at the forks to allow for height adjustment. A 2-gallon sprayer tank feeds the wick by gravity flow.

By using components currently available, herbicide applicators can easily be made for A.T.V's. These accessories can provide access and accuracy in chemically treating problem areas.

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Update on leafy spurge research at Montana State University

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None of the new herbicides that have been tested have controlled leafy spurge regrowth after one year. Rather than review screening trials, this report will cover three unique experiments. These experiments are currently in progress, so only methods and some preliminary results will be discussed.

The first experiment investigates the cultural practice of pulling leafy spurge to control stem regrowth. Leafy spurge pulls easily from the ground and the root sustains a significant amount of damage. To quantify the amount of root damage and the energy required to pull leafy spurge, measurements were taken on the stem diameter, root diameter, length of root material pulled, and the foot-pounds required to pull each plant from the ground. With a pull of 4 to 6 ft lbs, 2.4 to 4.8 cm of root material was removed. A timing experiment was established to determine if there is an optimum time to pull leafy spurge so that there is minimal regrowth. Plots were hand pulled every 2 weeks throughout the growing season in 1982. Plots pulled on June 30, 1982 produced the best control of regrowth with 94% control on Sept. 1, 1982 and 35% control the following year on June 12, 1983. Percent control was determined by measuring stems/ft^2. Visual ratings on June 12, 1983 were 80 to 90% control since the regrowth was not vigorous.

Effect of "solarization" on leafy spurge growth was measured. Clear and black plastic was laid out on March 22, 1983 after the snow disappeared from the study site. Soil temperatures were measured at 5 and 10 cm depths. Air temperature and stems/ft^2 were measured on each treatment once a week. Temperatures at both depths were significantly greater under clear plastic than with no plastic on all measurement dates except when snow covered the plots.

The number of stems/ft^2 was directly correlated with increased temperatures. An extreme proliferation of stems (166/ft^2) was observed under clear plastic with 82º F at 5 cm and 72º F at 10 cm on May 27, 1983. On the same date plots with no plastic produced 56 stems/ft^2 with temperatures of 60º F and 53º F at 5 and 10 cm depths, respectively. With the high temperatures under the clear plastic stems died while the number of stems under the black plastic and or no plastic continued to increase. The plastic will be removed in late June and soil temperatures and stem counts will be measured to determine if the control treatments with no plastic will eventually produce the same number of stems/ft^2 which emerged under clear plastic. Temperatures on the plots that were covered with plastic will be monitored to see if the decreasing soil temperatures will recreate an optimum at which root buds will be induced to grow.

We have examined the constituents of the leafy spurge plant in an attempt to develop a use for the plant. The oil fraction of the plant may have value due to its high caloric value. However, the extraction process and feasibility of a centralized facility to produce these oils for fuel is not economically attractive at present. The high caloric characteristic can most effectively be used by utilizing the entire plant biomass for fuel to heat farms and ranch buildings on a localized basis. Technologies for harvesting and burning crop residues are available. Leafy spurge could be easily adapted and provide much greater energy per area of land per year than other alternative fuels.

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Leafy Spurge Awareness Program in Montana, part II

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A statewide Extension program was reinitiated through the Plant and Soil Science Department at Montana State University in the spring of 1983. The purpose of the program is to increase public awareness of leafy spurge and knapweed, Montana's two most important range weeds.

The objectives of the program are to disseminate current information on the spread and control of these weeds. Mass media techniques, a newsletter on leafy spurge and knapweed, herbicide demonstration plots, and tours and meetings will be utilized to reach as wide an audience as possible. Road signs, bumper stickers, and postcards will also be used to increase weed awareness.

An integrated approach will be utilized to attack Montana's leafy spurge and knapweed problem. This will involve close cooperation between research scientists, chemical companies, and county, state, and federal entities. The use of farm flocks for control of leafy spurge will be promoted by working closely with the sheep industry, sheep extension specialist, and Montana Wool Growers Association.

A leafy spurge and knapweed ransom program will be initiated on a county basis through the county Extension agents, vocational agriculture instructors, and weed supervisors. The purpose of this program will be to increase weed awareness among youth groups and help map county weed infestations.

A program evaluation will be conducted using a questionnaire developed in the summer of 1983. Two populations will be sampled; those attending the weed tours and those who have not attended the tours. Two counties will be sampled for both spurge and knapweed. The results should indicate the effectiveness of our Extension program.

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Soil residue and leafy spurge root studies

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Plant Science Dept., University of Wyoming, Laramie. Paper Presentation at 1983 Leafy Spurge Symposium, Sundance, WY

The weed science community has as yet to come firmly to grips with the control of underground portions of perennial weeds. It is questioned by some as being necessary to develop such data in terms of controlling these problem plants. Developing root control data may prove unnecessary but control of the root system is necessary in terms of a weed control program. In light of increasing the knowledge level we have of perennial weeds and developing effective weed control programs, studies of root control are needed. Also, resultant root control from a treatment may be of little value to the land manager or weed control supervisor. But because of the root systems contribution to survival, spread and regeneration, development of treatment programs must take root control into account.

As in out-of-sight, out-of-mind, root control has not been extensively regarded as a critical factor in weed control. This is evident by the minimal amount of reference to the root system of perennial weeds in weed control publications. However, root control is a facet of weed science instruction as "in order to combat creeping perennial weed infestations, seed production must be stopped and vegetative propagation must be curtailed by killing both the above-and below-ground portions of the plant" (2). Leafy spurge root control was referred to by Baker, while researching treatment efficacy, when he reported "no attempt was made to check root kills..." (3). This reference, made almost 30 years ago reflects an early understanding of the contribution the root system makes in perennial weed control. It has also been observed that field bindweed roots remained abundant and appeared viable after several years of top growth removal (1).

As a result of minimal information concerning root control evaluation, sampling and analysis technology previously was not available. With evaluations requiring soil sampling, methods to extract, transport and process samples needed to be developed. A discussion of the sampling methods developed to evaluate root control, some of the recent data from these studies and herbicide residue data will be presented in this paper. Also, an attempt to correlate some of the means will be included.

A repetitive herbicide treatment experiment was established in 1978 to provide an area of study for developing a workable leafy spurge control program. Part of this study was to evaluate control of the root or underground portion of the plant. Earliest evaluations, made in 1979, were simple judgment values based on ease of crown pull. Also, percent live roots was determined at each sample site to a depth of 6 to 8 inches. Resistance to pull and percent live roots increased as percent shoot control decreased (9). When these data were analyzed a correlation coefficient of 0.86 resulted revealing a strong correlation of the data. In 1980, root control was randomly evaluated at this site by means of determining the depth to live root tissue at an existing leafy spurge crown. As percent shoot control increased, average depth to live root tissue increased. A correlation coefficient of 0.61 was computed from comparison of these data (5). Later in 1980 a core sampling technique was attempted to further evaluate root control. Samples were extracted with a core tool to depths of 32 inches. Each sample was screened on site and root segments counts and weights taken. Root counts and weight were reduced as compared to the check in all original and retreatment combination plots (6). The following correlations were computed from the data: root weight to root counts -0.81; root weight to shoot counts -0.61; root counts to shoot counts -0.83; root counts and root weight to shoot counts -0.84. In 1981, a soil sampling core bit powered by a hydraulic motor mounted on a small back-hoe was used to sample soil for root control. Samples were bagged and transported to Laramie. Samples were washed in a screen with the remaining roots weighed. Again, from selected original and retreatment combination plots, root weights were reduced as compared to the check (7). A correlation coefficient of 0.74 resulted from analysis of the data. This study was continued in 1982 with a correlation coefficient of 0.73 resulting from comparison of root weights and shoot counts (8).

In 1980, evaluations of herbicides on leafy spurge control were expanded to an additional three locations in Wyoming. This was done to expand the root control study effort, include location and differing soil type effect and also to samples for herbicide residues in the soil profile. Data generated from these sites in 1981 and 1982 are presented in Tables 1, 2 and 3 with Table 4 a compilation of the resulting correlation coefficients. Data presented include shoot counts and percent control of leafy spurge top growth, root weights and the concentration of dicamba and picloram one and two years after application.

Shoot count data (Table 1) shows a reduction of leafy spurge shoots in all plots with percent control ranging from 70 to 100, as compared to the check one year after treatment. However, in the following year control has decreased in all treatment areas except, for picloram at 2.0 lb a.i./A at two locations.

Root weights from the three locations (Table 2) were highly variable as compared to the check, and from year to year. The most consistent reduction in the root system appears to be provided by picloram when the two years data are reviewed. In some cases the data suggest a stimulation in below-ground tissue development.

Residue analysis (Table 3) was restricted in 1982 to picloram due to the known soil persistence of dicamba and picloram, and sampling and analysis expense. In 1982, two years following application of picloram, soil residue had fallen in all locations and for both rates of application. The residue data presented are representative of the entire soil sample profile from the soil surface to a depth of 24 inches. These data are somewhat in contrast with the report by Grover and Bowes in that they reported residues in the top 7.5 cm (3 inches) of soil. They reported the critical level of picloram to prevent leafy spurge re-establishment from seed to be about 50 ppb (4) . From the data presented in Table 3 are compared to shoot control in Table 1, the residue levels found in 1982 throughout the top 24 inches of soil appear to be under the critical level to prevent re-establishment of leafy spurge from root regeneration and seed germination.

In reviewing the correlation coefficients presented in Table 4, root weight to shoot count were poorly correlated for all locations over two years. Only moderate or good correlations resulted in comparing residue to shoot counts and residue to root weight.

Through the efforts to develop a measurement technique to determine root control as it relates to shoot control, not only is the sample method important but also the analysis is critical. Numerous sample numbers are necessary to reduce variance and offer a valid statistical test. This presents a problem in time, expense and transport. Coupled with the difficulty in root separation and measurement, there are many problems yet to be solved. A more realistic approach than weight measurement of root biomass may be a reversion to an evaluation of root viability at various soil depths. Where evaluations are limited to a select few treatment areas, a more positive correlation may be developed between shoot and root control. It is apparent that a soil residue maintenance of both dicamba and picloram is necessary for longevity of leafy spurge control. From these and other data, an annual application of 0.5 lb a.i./A may be providing a soil residual at an adequate level to maintain excellent shoot control. However, the resulting reduction in the root system remains to be unearthed.

Table 1: Leafy spurge shoot control one and two years after treatment with dicamba and picloram.

Location	Treatment[1]	Rate (lb ai/A)	Shoot Counts/sq ft. 1981	1982	% Control 1981	1982
Crook	dicamba	6.0	15.8	3.6	80	67
(80-226)	dicamba	8.0	0.5	2.0	99	82
	picloram	1.0	0.1	1.2	99	89
	picloram	2.0	0	0	100	100
	Check	--	80.0	10.9	0	0
Johnson	dicamba	6.0	10.7	4.7	76	0
(80-229)	dicamba	8.0	12.9	5.6	70	0
	picloram	1-.0	0.4	3.0	99	32
	picloram	2.0	0.4	1.0	99	77
	Check	--	43.7	4.4	0	0
Fremont	dicamba	6.0	6.7	5.0	92	73
(80-227)	dicamba	8.0	3.6	2.0	95	89
	picloram	1.0	3.2	3.9	96	79
	picloram	2.0	0.3	0	99	100
	Check	--	79.4	18.3	0	0

[1]Herbicides in 1980 applied as granular formulation

Table 2: Leafy spurge root evaluations one and two years after treatment with dicamba and picloram.

Location	Treatment[1]	Rate (lb ai/A)	Root wt (oz/cu. ft)	
			1981	1982
Crook	dicamba	6.0	6.94	0.56
(80-226)	dicamba	8.0	4.14	0.70
	picloram	1.0	3.20	1.12
	picloram	2.0	3.36	0.81
	Check	--	3.62	1.00
Johnson	dicamba	6.0	8.34	3.35
(80-229)	dicamba	8.0	8.64	2.28
	picloram	1.0	8.87	1.06
	picloram	2.0	8.16	2.30
	Check	--	10.03	2.70
Fremont	dicamba	6.0	5.72	--
(80-227)	dicamba	8.0	7.25	--
	picloram	1.0	6.24	--
	picloram	2.0	5.66	--
	Check	--	5.90	--

[1] Herbicides applied as granual formulation in 1980

Table 3: Concentrations of dicamba and picloram, one and two years after application, in three Wyoming soils.

Location	Treatment[1]	Rate (lb ai/A)	PPM	
			1981	1982
Crook	dicamba	6.0	1.020	-
(80-226)	dicamba	8.0	0.086	-
	picloram	1.0	0.468	0.044
	picloram	2.0	0.647	0.073
Johnson	dicamba	6.0	0.081	-
(80-229)	dicamba	8.0	0.119	-
	picloram	1.0	0.100	0.082
	picloram	2.0	0.497	0.119
Fremont	dicamba	6.0	0.348	-
(80-227)	dicamba	8.0	0.592	-
	picloram	1.0	0.112	-
	picloram	2.0	0.088	-

[1] Herbicides applied as granual formulation in 1980

Table 4: Correlation coefficients from comparisons of shoot count, root weight and herbicide residue means.

Location	Year[1]	Root wt: Shoot cnts	Residue: Shoot cnts	Residue: Root wt.
Crook	1981	0.04	0.46	0.64
Fremont		0.21	0.50	0.74
Johnson		0.88	0.48	0.52
Crook	1982	0.22	0.96	0.52
Johnson		0.36	0.95	0.43
	Ave	0.34	0.67	0.57

[1] Plots were established in 1980

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The activity of selected mixtures of plant growth regulators and herbicides on leafy spurge

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Paper presented by the 39th Annual Weed & Pest Conference, Douglas, Wyoming, November, 1983

Regeneration of leafy spurge from viable root buds is a major problem encountered in its control. While certain herbicides have been shown to be effective in controlling shoot growth they appear to not be as effective in destroying the root systems from which new shoots can develop.

Growth regulators were researched to assess their potential value for increased herbicide activity, stimulation of dormant buds and effects upon vegetative growth. It is hoped that such research will lead to the discovery of a growth regulator that will effectively control Leafy spurge by itself or have a synergistic effect when used in combination with an herbicide, thus providing more effective and inexpensive control.

An initial growth regulator screening study was conducted at the University of Wyoming Plant Science greenhouse in order to select growth regulators that showed activity on leafy spurge.

The growth regulators used in the initial screening study were 2,4-D amine, applied at rates of 1/16 lb. a.i., 1/8 lb. a.i., and 1/4 lb. a.i. per acre; Fruitone-N (1-naphthaleneacetic acid) applied at rates of 3, 6, and 12 grams a.i./A; ABG-3034 a cytokinin applied at rates of 3, 6, and 12 grams/A; Roundup (glyphosate) applied at rates of 1/32 lb. a.i., 1/16 lb. a.i., and 1/8 lb. a.i. per acre; PP333 an antigibberellin applied at rates of 3, 6, and 12 grams a.i./A; Cytex, a mixed cytokinin liquid concentrate extracted from marine algae tissue, applied at rates of 1, 2, 4, gallons a.i. per acre; and Pro-Gibb (gibberellic acid) applied at rates of 3, 6 and 12 grams a.i./A.

The herbicides used in the initial screening study were Banvel (dicamba) applied at a rate of 1.0 lb. a.i. per acre and Tordon (picloram) applied at a rate of 0.25 lb. a.i. per acre.

Leafy spurge plants were established from cuttings of stock plants, which included 20 mm of shoot and 30 mm of root, with individual cuttings planted in containers 6 inches in diameter by 7 inches in height. The plants were grown in a greenhouse at a temperature of 22 degrees C and were watered once daily. Growth to 8 inches took approximately 4 months at which time the plants were treated.

The experiment was a completely randomized design with two replications. Treatments were applied with a hand operated spray atomizer. A fine mist spray with pre-measured solutions of growth regulators and herbicides were applied singularly and in combination of the desired rates on June 12, 1982. The treatments were first evaluated on August 11, 1982, 60 days after treatment, with the evaluations-based on visual damage and fresh weight of the shoots. The visual evaluation showed a highly significant difference between treatments, with the Pro-Gibb + picloram treatment showing the greatest activity. There were no significant differences between treatments based on the fresh weight of the shoots. However, the treatment with the lowest shoot weight was picloram applied by itself at 0.25 lb. a.i./A.

After the first evaluation the spurge plants were allowed to regrow for 58 days and were evaluated on October 8, 1982, 118 days after the start of the experiment. The final evaluation was based on the height of the longest shoot, number of shoots per container, visual evaluation, shoot weight, and root weight. A statistical analysis showed no significant differences between treatments for any of the evaluations. However, treatments containing gibberellin and cytokinin resulted in the greatest activity on Leafy spurge growth and were selected for further study.

The growth regulators selected for additional study were Pro-Gibb (gibberellic acid) which was applied at rates of 3, 6, and 12 grams a.i./A and Cytex (mixed cytokinins) applied at rates of 1, 2 and 4 gallons/A.

The herbicides used were Tordon at a rate of 1/8 lb. a.i./A and Banvel applied at a rate of 0.5 lb. a.i./A. As in the previous screening study herbicides were applied at less than normal rates to observe any increased activity caused by the growth regulators.

Leafy spurge plants were established as in the earlier screening study. How ever, after approximately 5 months of growth in the greenhouse they were transferred to growth chambers with conditions set at 14 hours of daylight at 27º C and 10 hours of dark at 10º C, with an average relative humidity of approximately 40 percent. Plants were moved from the greenhouse to the growth chambers in order to stimulate growth and stabilize growth conditions. The experiment involving growth regulators selected from the previous screening study was a randomized complete block design with five replications. Treatments were applied on January 15, 1983 with a hand operated spray atomizer in the same fashion as for the previous screening study. Immediately prior to treatment the height of the main shoot and number of shoots per container were recorded, for comparison at the conclusion of the experiment.

The experiment was concluded on March 4, 1983, 49 days following treatment, and evaluated with respect to the following parameters:

1) The number of buds on the crown;
2) a visual evaluation with 1 indicating no damage and 5 indicating a completely dead plant;
3) difference in plant height from time of treatment to time of evaluation;
4) weight of shoots dried at 60º C;
5) the number of buds per cm of root, which was determined by taking counts on the primary roots and dividing by the root length;

6) length of the longest primary root;
7) weight of the roots dried at 60º C;
8) and the difference in the number of shoots per container from time of treatment to time of evaluation.

Evaluation of the data indicate cytokinin at 2 gal/A significantly increased the number of crown buds when compared to the check. Whereas, gibberellin at 3 and 6 grams/A, gibberellin at 6 and 12 grams/A + picloram at 0.125 lb/A and cytokinin at 1 and 2 gal/A + picloram at 0.125 lb/A significantly decreased the number of crown buds when compared to the check. However, when the treatments containing growth regulators + picloram were compared to picloram alone there was no significant decrease in the number of crown buds.

With the exception of treatments where gibberellin and cytokinin were applied alone all treatments exhibited significant visual damage such as yellowing and twisting of stems and leaves, with the cytokinin at 4 gal/A + picloram showing the greatest visual damage than picloram applied alone at 0.125 lb. a.i./A. At the time of the evaluation no plants were completely dead.

Treatments showing a significant increase in plant height were gibberellin at 6 and 12 g/A and cytokinin at 1 gal/A. Cytokinin at 4 gal/A + picloram was the only treatment that significantly reduced plant height when compared to the check. Once again, however, it did not significantly reduce plant height when compared to picloram alone.

Treatments resulting in a significant decrease in shoot weight were gibberellin at 3, 6, and 12 grams/A + picloram with cytokinin at 1, 2, and 4 gal /A + picloram showing the greatest significant difference when compared to the check. None of the treatments significantly increased shoot weight. As before, the treatments did not significantly decrease shoot weight when compared to picloram applied alone.

The treatment showing the greatest reduction in the number of buds/cm of root was cytokinin at 1 gal/A + picloram. However, due to the wide variation of the number of buds/cm of root within treatments the reduction was not significant from any other treatment.

There were no significant differences between treatments for root length.

There were also no significant differences between treatments for root weight.

Although there was a wide difference in the number of shoots between treatments these differences were not significant due to the wide variation of shoot numbers within treatments.

Although cytokinin and gibberellin did increase the activity of the herbicides, especially picloram, in reducing shoot weight and vegetative growth they did not aid in reducing root growth and had no significant effect on the number of root buds. Even in the treatments where the growth regulators did increase the activity of the herbicides the increase was not significantly better than where the herbicides were used alone.

Results of these data would indicate Cytex (mixed cytokinins) and Pro-Gibb (gibberellic acid) are ineffective in aiding picloram and dicamba in controlling regeneration of Leafy spurge from viable root buds when used at the rates evaluated.

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A summary of original and three repetitive herbicide treatments for control of leafy spurge (*Euphorbia esula* L.)

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Leafy spurge (*Euphorbia esula* L.) is a competitive and aggressive perennial which is very difficult and expensive to control. Its deep, tenacious root system with the capacity to sprout from root segments and underground buds along with the potential of the seed remaining viable for up to eight years is indicative of its persistent nature.

The weed has spread in recent years from small isolated areas to where it is reported to infest 2.5 million acres in the United States and Canada. It is found from the best agriculture land to rocky slopes and hillsides of low productive rangeland sites. Infestations range from solid stands where all other vegetation is virtually eliminated to isolated infestations which serve as a source of seed for spread and subsequent infestation of additional areas.

An extensive repetitive herbicide treatment program for leafy spurge control was initiated in 1978 and the effects of original and retreatments on leafy spurge shoot and root control has been evaluated since the initiation of the study.

Initial herbicide treatments were made on May 25, 1978 in a randomized complete block design. Plots were 11 ft by 132 ft per treatment with two replications. The original treatments consisted of dicamba (3,6-dichloro-o-anisic acid) at 4.0 and 8.0 lb ai/A, picloram (4-amino-3,5,6 trichloropicolinic acid) at 0.5, 1.0 and 2.0 lb ai/A of the picloram K salt and 2% bead formulation, picloram/2,4-D amine (1.0 lb picolinic acid + 2 lb 2,4-D amine/gal) at 0.5 + 1.0, 1.0 + 2.0 and 2.0 + 4.0 lb ai/A and an untreated check.

The soil at the experimental site was classified as a sandy loam (65.4% sand, 23.2% silt, 11.4% clay with 1.5% organic matter and a 7.7 pH).

Repetitive herbicide treatments have been applied in the years of 1979, 1980, 1981 and 1982. Plot size was 11 ft by 22 ft per repetitive treatment. Repetitive treatments were applied over the initial treatments creating a split block design. Each treatment was random and replicated twice. Retreatments were dicamba at 2.0 lb ai/A, dicamba/2,4-D amine at 1.0 + 2.0 lb ai/A, 2,4-D amine at 2.0 lb ai/A and picloram at 0.5 and 1.0 lb ai/A.

Four square foot quadrats were located at random within each original and retreatment plot. Live, aboveground leafy spurge shoots have been recorded each year over the life of the study. Percent shoot control was determined by using the formula:

$$\text{Percent control} = 1 - \frac{\text{Counts per ft}^2 \text{ in treatment}}{\text{Counts per ft}^2 \text{ in check}} \times 100$$

The percentage leafy spurge shoot control resulting from the original treatments are presented in Table 1 and Figure 1. The original treatment of picloram K salt and 2% beads applied at the rate of 2.0 lb ai/A in 1978 were maintaining 90 to 85% leafy spurge shoot control, respectively, four years following treatment. These percentages have decreased from 99% shoot control as evaluated one year following application. The 1.0 lb ai/A of picloram K salt was maintaining 78% shoot control in 1982, a decline from 97% in 1979. Lower rates of picloram, picloram/2,4-D and the dicamba treatments are maintaining from 0 to 61% shoot control.

The effectiveness of the various original treatments which received the different repetitive treatments are presented in Tables 2 through 7. The most effective original plus a repetitive treatment was where picloram was a component of each of the treatments. Picloram applied at 0.5 lb ai/A in 1978 and retreated with 0.5 lb ai/A in 1979, 1980, and 1981 gave 98% shoot control when evaluated in 1982. The higher rates resulted in 99 to 100% shoot control (Table 2).

Picloram as an original treatment and retreated for three successive years with dicamba, dicamba/2,4-DA or 2,4-DA were not as effective, especially at the lower application rates of picloram (Table 3).

Outstanding leafy spurge shoot control can be obtained with dicamba if the retreatment is picloram (Table 4). From 98 to 100% shoot control was obtained with the original dicamba treatment which was retreated for three successive years with picloram at 0.5 and 1.0 lb ai/A. The high rates of dicamba required for initial control are more damaging to the associated grass species than rates of picolinic acid that gives equivalent leafy spurge shoot control.

The retreatments of 2,4-D amine, dicamba/2,4-DA or dicamba were not as effective as retreatments as picolinic acid (Tables 3, 5, 7).

Data indicate that a maintenance or repetitive herbicide treatment would not have to be initiated for three years where the 2.0 lb ai/A of picolinic acid was utilized as a treatment. Where dicamba or the lower rates of picolinic acid were utilized retreatments would have to be initiated earlier. With dicamba retreatments would have to be on a year to year basis to maintain shoot control.

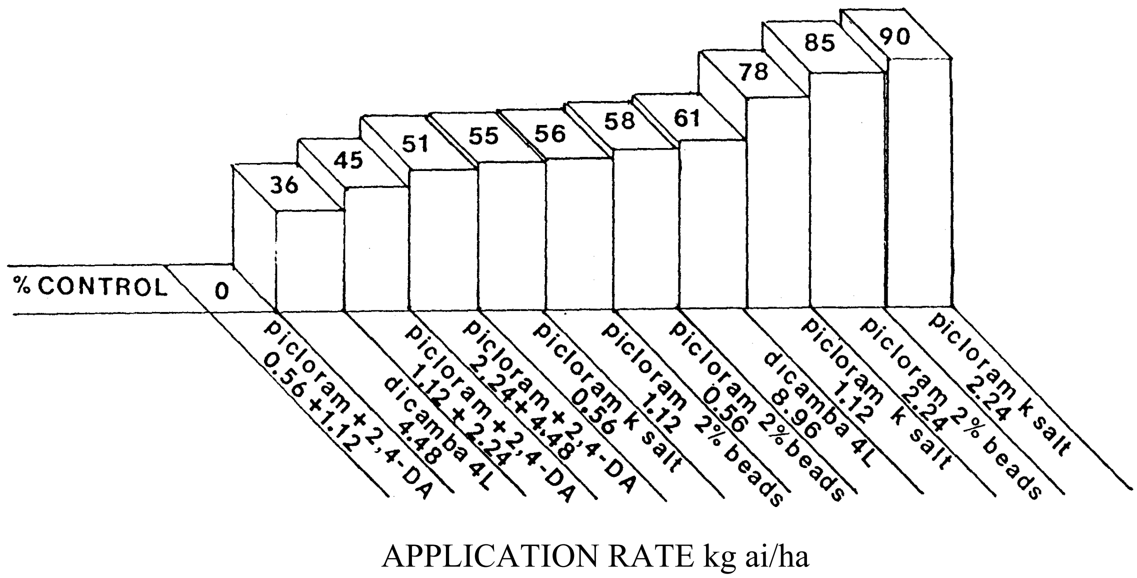

Figure 1. Longevity of leafy spurge shoot control resulting from treatments applied in 1978 and evaluated in 1982.

Table 1. Percentage leafy spurge shoot control resulting from the original and three successive herbicide retreatments.

Original Treatments[1] lb ai/A	Percent Shoot Control																		
	Retreatment lb ai/A																		
	2,4-D amine 2.0			picloram (K salt) 0.5			picloram (K salt) 1.0			dicamba 4L 2.0			dicamba/2,4-D amine 1.0 + 2.0			Check			
	1980	1981	1982	1980	1981	1982	1980	1981	1982	1980	1981	1982	1980	1981	1982	1979	1980	1981	1982
Picloram (K salt) 2.0	98	93	94	99	100	100	99	100	100	98	96	97	99	95	98	99	96	90	90
Picloram (K salt) 1.0	76	84	83	96	99	99	99	100	100	96	90	96	99	89	98	97	94	84	78
Picloram (K salt) 0.5	70	80	86	94	99	98	99	100	100	49	79	88	59	77	85	76	43	29	55
Picloram (2% beads) 2.0	90	90	87	98	99	99	100	100	100	96	98	96	96	87	98	99	95	83	85
Picloram (2% beads) 1.0	84	92	86	99	99	99	98	99	100	87	82	96	65	92	88	96	51	68	55
Picloram (2% beads) 0.5	78	76	76	99	100	99	99	100	100	69	77	70	64	78	91	87	32	36	58
Picloram/ 2,4-D amine 2.0 + 4.0	81	90	88	99	99	98	100	100	100	99	95	96	78	89	94	98	91	87	51
Picloram/ 2,4-D amine 1.0 + 2.0	63	76	81	96	98	98	100	100	100	68	89	94	39	64	91	71	38	31	45
Picloram/ 2,4-D amine 0.5 + 1.0	58	66	76	97	96	98	99	100	100	49	65	84	40	73	88	16	0	0	0
dicamba 4L 8.0	74	82	87	87	96	98	98	98	100	89	87	96	78	94	98	67	66	77	61
dicamba 41, 4.0	53	69	78	84	97	98	100	100	100	67	84	88	56	83	90	47	42	24	36
Check	9	58	62	96	99	97	93	100	100	72	85	92	11	63	84	11.6	11.1	11.4	13.9

[1]Original treatments May 25, 1978; retreatments June 21, 1979; May 13, 1980 and May 20, 1981; evaluated same dates in 1979 through 1982.

Table 2. Percentage leafy spurge shoot control resulting from picloram as the original treatment and picloram as a retreatment.

Original Treatment[1]	Retreatment[2] Rate lb ai/A picloram 0.5			picloram 1.0		
	1980	1981	1982	1980	1981	1982
picloram 0.5	94	99	98	99	100	100
picloram 1.0	96	99	99	99	100	100
picloram 2.0	99	100	100	99	100	100

[1]Original treatment: 1978.

[2] Retreatments: 1979, 1980, 1981.

Table 3. Percentage leafy spurge shoot control resulting from picloram as the original treatment and dicamba, dicamba/2,4-DA and 2,4-DA as a retreatment.

Original Treatment[1]	Retreatment Rate lb ai/A dicamba 2.0			dicamba/2,4-DA 1.0 + 2.0			2,4-DA 2.0		
	1980	1981	1982	1980	1981	1982	1980	1981	1982
picloram 0.5	49	79	88	59	77	85	70	80	86
picloram 1.0	96	90	96	99	89	98	76	84	83
picloram 2.0	98	96	97	99	95	98	98	98	94

[1]Original treatment: 1978.

[2]Retreatments: 1979, 1980, 1981.

Table 4. Percentage leafy spurge shoot control resulting from dicamba as the original treatment and picloram as a retreatment.

Original Treatment [1]	Retreatment Rate lb ai/A picloram 0.5			picloram 1.0		
	1980	1981	1982	1980	1981	1982
dicamba 4.0	84	97	98	100	100	100
dicamba 8.0	87	96	98	98	98	100

[1]Original treatment: 1978.

[2]Retreatments: 1979, 1980, 1981.

Table 5. Percentage leafy spurge shoot control resulting from dicamba as the original treatment and dicamba, dicamba/2,4-DA and 2,4-DA as a retreatment.

Original Treatment[1]	Retreatment								
	Rate lb ai/A								
	dicamba 2.0			dicamba/2,4-DA 1.0 + 2.0			2,4-DA 2.0		
	1980	1981	1982	1980	1981	1982	1980	1981	1982
dicamba 4.0	67	84	88	56	83	90	53	69	78
dicamba 8.0	87	87	96	78	94	98	74	82	87

[1] Original treatment: 1978.
[2] Retreatments: 1979, 1980, 1981.

Table 6. Percentage leafy spurge shoot control resulting from picloram/2,4-DA as the original treatment and picloram as a retreatment.

Original Treatment[1]	Retreament[2]					
	Rate lb ai/A					
	picloram 0.5			picloram 1.0		
	1980	1981	1982	1980	1981	1982
picloram/2,4-D 0.5 + 1	97	96	98	99	100	100
picloram/2,4-D 1 + 2	96	98	98	100	100	100
picloram/2.4-D 2 + 4	99	99	98	100	100	100

[1]Original treatment: 1978.
[2]Retreatments: 1979, 1980, 1981.

Table 7. Percentage leafy spurge shoot control resulting from picloram/2,4-DA as the original treatment and dicamba, dicamba/2,4-DA and 2,4-DA as a retreatment.

Original Treatment[1]	Retreatment [2]								
	Rate lb ai/A								
	dicamba 2.0			dicamba/2,4-DA 1.0 + 2.0			2,4-DA 2.0		
	1980	1981	1982	1980	1981	1982	1980	1981	1982
piclora m/2,4-DA 0.5 + 1.0	49	65	84	40	73	88	58	66	75
picloram/2,4-DA 1.0 + 2.0	68	89	94	39	64	91	63	76	81
picloram/2,4-DA 2.0 + 4.0	99	95	96	78	89	94	81	90	98

[1]Original treatment: 1978.
[2]Retreatments: 1979, 1980, 1981.

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Leafy spurge shoot control and forage production

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Increasing forage production through removal of perennial weed species is an important aspect of perennial weed control programs on pastures and rangeland. Chemical treatments should provide greater production to allow producers a return on their invested money. This study was undertaken to determine forage production as it relates to a leafy spurge infestation and the removal of this competition using herbicides.

Plots were established in Crook County, Wyoming, May 25, 1978, with liquid formulations being applied in 128 gpa water carrier with a garden tractor-mounted sprayer. Granules were applied with a hand operated centrifugal broadcaster. Plots were 11 by 22 ft, arranged in a split block design with two replications. Annual precipitation at the nearest recording station was 16.7 inches. Grass and grass-like species in the study area included: thread-leaved sedge, Kentucky bluegrass, western wheatgrass, blue grama, Japanese brome and downy brome. Treatment areas were located on a sandy loam soil containing 65.4% sand, 23.2% silt, 11.4% clay with 1.5% organic matter and a pH of 7.7. Treatment areas were clipped and shoots were counted on June 30, 1979, July 29, 1980, July 24, 1981 and July 22, 1982. Four 2.5 ft diameter quadrat areas were clipped per treatment area from which lbs airdry forage/A (12% moisture) was determined and average production computed. Four, four-square-foot quadrats were located randomly within each treatment area, leafy spurge shoots were counted and percent leafy spurge shoot control determined as a comparison to the untreated check plots.

A second area was treated in Johnson County, Wyoming on May 29, 1980. Treatments were applied to single blocks, 80 by 100 ft. Application and evaluation techniques were the same as previously described in the Crook County study. Soils were classified as a silty loam with 31.4% sand, 62.2% silt and 6.4% clay, with 2.8% organic matter and a pH of 7.6. Grass and grass-like species included: Western wheatgrass, prairie junegrass, basin wildrye, blue grama, Japanese brome, downy brome and thread-leaved sedge. Precipitation at the nearest recording station for 1981 and 1982 was 13.3 and 16.3 in., respectively. Plot evaluations were made June 12, 1981 and May 12, 1982.

Percent leafy spurge shoot control and forage yields in Crook County are compared in Table 1. Average yields over a four year period from plots treated with 2.0 lb ai/A 2% pelleted picloram and picloram liquid were 1594 and 1535 lbs/A, respectively. During the same period average leafy spurge shoot control percentages of 91 and 94%, respectively, were maintained. Plots treated with 4.0 and 8.0 lb ai/A of dicamba liquid produced average yields of 958 and 901 lb/A, respectively, while maintaining shoot control percentages of 37 and 58%, respectively. Untreated areas had a 501 lb/A production average during the four-year period.

In Johnson County areas treated with 1.0 and 2.0 lb ai/A 2% granular picloram and 6.0 and 8.0 lb ai/A 5% granular dicamba along with the untreated check produced average yields over a two year period of 1922, 2048, 1246, 1210 and 1255 lb/A (Table 2). The 6.0 lb ai/A application rate of dicamba was the only treatment producing higher yields than the untreated check the first year. The 1.0 and 2.0 lb ai/A application rates of picloram produced higher yields than dicamba treatments as well as the untreated check during the second year.

A comparison of treatment costs, forage production, beef production and economic returns (Table 3) show positive economic returns after four years with treatments of liquid picloram at 0.5, 1.0 and 2.0 lb ai/A, picloram 2% beads at 1.0 lb ai/A, picloram/2,4-D combinations of 2.0 and 4.0, 1.0 and 2.0 lb ai/A.

Table 1. Percentage leafy spurge shoot control and subsequent average forage yields resulting from a single herbicide treatment. A four-year study in Crook County, Wyoming.

Treatments[1] lb ai/A	1979 % shoot control	1979 Yield[2]	1980 % shoot control	1980 Yield	1981 % shoot control	1981 Yield	1982 % shoot control	1982 Yield	4 Year Average % shoot control	4 Year Average Yield
picloram (K salt) 2.0	99	1098	96	1010	90	1832	90	2200	94	1535
picloram (K salt) 1.0	97	896	94	558	84	1337	78	2400	88	1298
picloram (K salt) 0.5	76	1111	43	947	29	818	55	1298	51	1044
picloram (2% beads) 2.0	99	992	65	601	83	2278	85	2506	91	1594
picloram (2% beads) 1.0	96	981	51	786	68	1552	55	1867	68	1296
picloram (2% beads) 0.5	87	1005	32	621	36	620	58	890	53	784
plcloram/2,4-D amine 2.0 + 4.0	98	1054	91	520	87	1776	51	2622	82	1493
picloram/2,4-D amine 1.0 + 2.0	71	1240	38	1160	31	850	45	896	46	1036
picloram/2,4-D amine 0.5 + 1.0	16	930	0	616	0	676	0	564	4	696
dicamba 4L 8.0	67	917	66	471	77	862	61	1356	68	901
dicamba 4L 4.0	47	1137	42	665	24	708	36	1324	37	958
Check	0	535	0	416	0	402	0	652	0	501

[1]Treatments made May 25, 1978; evaluations made July 30, 1979, July 29, 1980, July 24, 1981 and July 20, 1982.

[2]Yields were air-dried to a 12% moisture level.

Table 2. Forage production and percent shoot control measured from plots treated with granular picloram and dicamba as compared to an untreated leafy spurge infestation. Johnson County, Wyoming.

Treatment[1]	Rate lb ai/A	Shoot % control		Air Dry Forage (lb/A)[2]		Average
		1981	1982	1981	1982	
Dicamba 5G	6.0	76	0	1082	1409	1246
Dicamba 5G	8.0	70	0	802	1617	1210
Picloram 2K	1.0	99	31	861	2982	1922
Picloram 2K	2.0	99	73	753	3344	2048
Check				970	1540	1255

[1]Treatments made May 29, 1980.

[2]Shoot counts June 12, 1981 and May 12, 1982.

Table 3. A comparison of leafy spurge treatment costs, forage production, beef production and economic returns. Crook County, Wyoming.

Original Treatment	lb ai/A	Treatment cost/acre	4 Year Totals: Forage Produced lb/A	4 Year Totals: Beef Production lb/A [2]	4 Year Totals: Return above check and herbicide cost[3]
Picloram (liquid) (Tordon)	2.0	$ 85.00	6140	245	$22.54
Picloram (liquid) (Tordon)	1.0	46.50	5192	207	36.38
Picloram (liquid) (Tordon)	0.5	27.25	4176	167	29.22
Picloram (2% beads) (Tordon)	2.0	$132.00	6376	255	-$18.33
Picloram (2% beads) (Tordon)	1.0	72.00	5184	207	10.68
Picloram (2% beads) (Tordon)	0.5	42.00	3136	125	- 12.57
Picloram/2,4-D (Tordon 212)	2.0 + 4.0	$ 96.00	5972	239	$ 7.15
Picloram/2,4-D (Tordon 212)	1.0 + 2.0	54.00	4144	166	1.64
Picloram/2,4-D (Tordon 212)	0.5 + 1.0	33.00	2784	111	- 12.72
dicamba 4L (Banvel)	8.0	$104.00	3604	144	-$62.40
dicamba 4L (Banvel)	4.0	58.00	3832	153	- 10.47
Check	---	0	2004	80	0

[1] Treatment cost include $8.00/acre application costs for liquid formulations and $12.00/acre for granular formulations. Herbicide costs based on Tordon 22K - $77.00 gal, Tordon 212 - $42.00 gal, Tordon 2% beads - $120.00 cwt, Banvel 4L - $46.00 gal.

[2] Forage to beef conversion - 25 lb forage = 1 lb/beef.

[3] Beef prices used to figure return - $65.00 cwt.

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Mapping leafy spurge communities from aerial photography

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Landowners, managers, and administrators have expressed the need for more information on the inventory and assessment of leafy spurge. These needs have been expressed in the form of three questions. (1) Where is the leafy spurge located? (2) How many acres are there? (3) What is the cost of an inventory? To help answer these questions a study was started to determine the feasibility of mapping leafy spurge communities using aerial photography.

This study is one phase of a larger, overall research study[1] in progress at the U.S. Forest Service, Rocky Mountain Forest and Range Experiment Station (Fort Collins, Colorado and Rapid City, South Dakota) that is looking at the inventory and analysis of leafy spurge sites. This feasibility study utilizes quantitative ground data and remote sensing techniques to: (1) Develop a quantitative approach to leafy spurge community description; (2) Determine the feasibility of mapping areas for leafy spurge infestations; and (3) Determine select soil-site relationships of leafy spurge.

Dick Myhre is working on the techniques for using aerial photography to locate and map leafy spurge infestations (Objective 2). Myhre was previously with the Rocky Mountain Station and has recently been reassigned to a Forest Pest Management unit, the Methods Application Group in Fort Collins, Colorado.

The test is comparing photo scales (1:16,000; 1:24,000; and 1:32,000), film types (color and color-IR), and seasons (peak flowering and fall coloration) to determine the combination(s) best suited for large area surveys. The aerial photography and ground data used in the study were acquired in the Devils Tower, Wyoming area.

Results of this study will be used to recommend scale/film/season combinations for inventories, accuracy and cost trade-offs between medium and small scale photo surveys, and the amount of accuracy that can be obtained for acreage estimates. The anticipated final product from this phase of the study (Objective 2) should be a users guide/handbook covering aerial photo specifications for acquiring photography, photo interpretation techniques, training aids (color stereo photos), photo interpretation aids, etc.

If time and money are available, this work should be completed by spring 1984.

[1] An abstract of the overall study, "Inventory and Analysis of Leafy Spurge Sites" by R.E. Francis, M.J. Morris, R.J. Myhre, D.L. Noble, and P.W. Skinner appears in the proceedings of "In-Place Resource Inventories: Principles and Practices", a national workshop, Orono, Maine, published by Society of American Foresters, Washington, D.C., 1982.

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European rust fungi evaluated for leafy spurge control in 1982 at the plant disease laboratory

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The Plant Disease Research Lab (PDRL) began evaluating plant pathogens for biocontrol of leafy spurge in January 1982, with the arrival of Sherry Turner from Montana State University. Her initial efforts to recover leafy spurge rusts from storage in liquid nitrogen were unsuccessful, so a collecting trip to Europe was organized to obtain viable pathogens and compatible host propagative material. Eighteen isolates of rust fungi were collected along with host material between July 22 and August 20, 1982, in the countries of Austria, Hungary, and Switzerland, and six pathogen isolates were propagated successfully in the containment greenhouse facility at PDRL. Two isolates of Melampsora species, which are autoecious on leafy and cypress spurges, have been studied for 8 months. One isolate, a pathogen of cypress spurge is very aggressive on its host, and sporulates profusely 7 to 10 days after inoculation of plants. Preliminary host range studies indicate that it will infect collections of both cypress and leafy spurge, some of which are from the U.S. The other isolate, attacking leafy spurge, is not nearly as aggressive as the former, but preliminary host range studies indicate that it too will infect some U.S. collections of leafy spurge.

The introduction of plant pathogens into the United States requires the cooperation of several Federal and State regulatory agencies as prescribed by law. Guidelines for introducing and evaluating plant pathogens as biocontrol agents of weeds (1) are, for the most part, supported by well organized agencies. One area where issues remain centers around the Endangered Species Act of 1973. Rather than ignore this piece of legislation, it is suggested that those involved with biological control of weeds take the initiative toward resolving potential differences.

Literature cited

Klingman, D. L., and J. R. Coulson. 1982. Guidelines for introducing foreign organisms into the United States for biological control of weeds. Weed Science 30:661-667.

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Does 2,4-D follow assimilate translocation in leafy spurge

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Introduction

Literature on spurge control has suggested that control by herbicides is more complete during certain growth stages because photosynthates are being accumulated in the roots, and therefore phloem translocation is predominantly basipetal. This study was done in order to establish a basic pattern of 2,4-D and sucrose translocation in leafy spurge, to investigate what factors influence this pattern, and to determine the relationship between sucrose and 2,4-D translocation.

Materials and methods

The model system devised by Jeffrey Suttle and Donald Schreiner was used in order to reduce variability in the physiological state of plant material.

Rooted cuttings of cloned plant material were obtained by the following method:

1. Tops are removed from older stems of cloned plants.
2. In one month new shoots are formed.
3. Shoots are removed and rooted in vermiculite.
4. In one month rooted cuttings are ready for experimentation.

Rooted cuttings were placed in mason jars in 1/4 strength Hoagland's solution two days before any treatment was made. Growth chamber conditions were: 25º/18º C (14-hour photoperiod) at 60% RH.

Non-radioactive herbicide solutions were applied in 5% ethanol + 0.05% Tween 20 using a Greenhouse Pot Sprayer with a T-Jet 8000067 nozzle.

Radioactive solutions were applied to three marked leaves on each plant. A fully expanded young leaf, a leaf in the middle of the plant, and an older but non-senescent leaf were chosen and gently abraded with carborundum in water. About 200,000 DPM of each ^{14}C-2,4-D (ring labeled) and ^{3}H-sucrose (uniformly labeled) were applied to each abraded spot.

Upon sampling, plants were removed from the growth medium, divided into root, leaf, and stem tissue (labeled leaves were discarded), freeze-dried and oxidized. Collected radioactivity was determined by liquid scintillation spectroscopy (LSC). Duplicate aliquots of growth medium were also counted by LSC.

All data are expressed as the percent of ^{14}C or ^{3}H moved from the labeled leaves.

Results and discussion

Each experiment will be represented by two figures. The first shows the influence of some factor on ^{14}C distribution in the plant. The second shows the influence of that factor on ^{3}H distribution in the same plants.

Increasing 2,4-D concentration (Figures 1 and 2) increased ^{14}C in the stem and decreased ^{14}C in the leaves. Increasing 2,4-D also had a tendency to increase ^{3}H in the stem. However, increasing 2,4-D did not decrease ^{3}H in the leaves. Since lower rates of 2,4-D were not consistently herbicidal, 2,4-D was applied at a rate of 1 kg/ha in all subsequent studies.

Stem tissue was the first tissue to show significant ^{14}C after application (Figure 3). The proportion of ^{14}C in the stem dropped off rapidly however as ^{14}C was translocated to the leaves and then root zone. The distribution of ^{14}C in the system reached an equilibrium about four days after application.

On the other hand, significant amounts of ^{3}H appeared in the leaves only 2 hours after application (Figure 4). This indicates that ^{3}H is translocated much faster than 2,4-D. It should also be noted that proportionally more of the ^{3}H than ^{14}C accumulated in the root zone.

Nutrient strength has been reported in the literature to have a large influence on assimilate translocation in plants. In this study, however, (Figures 5 and 6) except for the deionized water treatment, nutrient strength had very little influence on distribution of either ^{14}C or ^{3}H.

Decapitation of shoots has also been shown to increase sink strength of roots by removing the competing shoot apex. In this experiment the apex and immature leaves were removed at various intervals prior to 2,4-D treatment. This had the effect of decreasing both ^{14}C and ^{3}H in the leaf tissue (Figures 7 and 8). In intact plants the relative specific activity (DPM of isotope/gram dry weight of plant material) of both isotopes is extremely high in the shoot apex and young leaves (data not shown). Thus, both ^{14}C and ^{3}H tend to be translocated to strong sinks.

It has also been reported in the literature that ethylene can influence herbicide translocation in some species. The model system was used to test the effect of ethylene on ^{14}C and ^{3}H translocation in leafy spurge. Cerone, a commercial ethephon, was applied at 1 kg/ha at various intervals before 2,4-D application. Cerone decreased ^{14}C in the stems (Figure 9) if applied at the same time or up to a day before 2,4-D treatment. However, earlier Cerone pretreatment increased ^{14}C in the stems. These increases and decreases in stem ^{14}C was mirrored by decreases and increases in leaf ^{14}C. ^{14}C in the root zone was hardly influenced. Cerone had little effect on ^{3}H distribution in the plants.

The distribution of ^{14}C and ^{3}H were very different in several experiments (Table 1).

1. Distribution of ^{14}C and ^{3}H in leaves showed different responses with time.
2. Increasing 2,4-D concentration increased ^{14}C in the stem and decreased ^{14}C in the leaves. The effect of 2,4-D concentration of ^{3}H distribution was ambiguous.
3. Decapitation yielded similar responses with both ^{14}C and ^{3}H.
4. Nutrient strength decreased ^{14}C in the leaves, but decreased ^{3}H in the roots and stem.
5. Cerone caused several responses in ^{14}C distribution but had little effect on ^{3}H distribution.

Conclusions

The results of these experiments are summarized as follows:

1. The pattern of 2,4-D translocation is not necessarily similar to the pattern of sucrose translocation.
2. A great deal of applied ^{14}C-2,4-D remains in the leaves and especially the stem, suggesting that it moves out of the phloem and becomes less available for translocation.
3. A great deal of applied ^{3}H-sucrose enters the roots very quickly, indicating that the direction of phloem translocation is not impeding movement of applied materials to the roots.

Table 1. Effect of five factors on ^{14}C-2,4-D and ^{3}H-sucrose distribution in leafy spurge.

	M%		R%		L%		S%	
Factor	^{14}C	^{3}H	^{14}C	^{3}H	^{14}C	^{3}H	^{14}C	^{3}H
Time	**▲	**▲	**▲▼	*▲▼	**▲	**▼	**▼	**▼
(2,4-D)	NS	*▲▼	NS	NS	**▲	NS	*▼	**▲
Decapitation	NS	NS	NS	NS	**▼	*▼	NS	NS
(Nutrient)	**▲	**▲	NS	**▼	**▼	NS	NS	**▼
Ceron Pretreat.	*▼	NS	NS	*▲	**▲▼	NS	**▼▲	*▼

*, ** Indicate significance at 0.05 and 0.01 levels, respectively.

Figure 1. Effect of 2,4-D concentration on ^{14}C distribution 7 days after application.

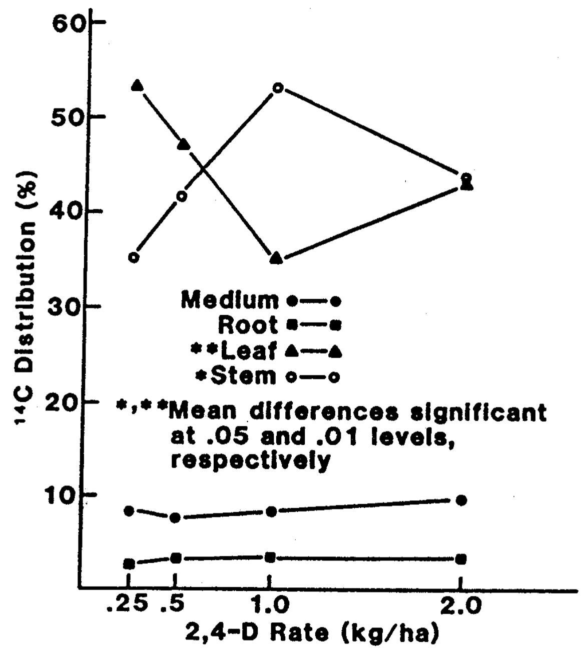


Figure 2. Effect of 2,4-D concentration on ^{3}H distribution 7 days after application.

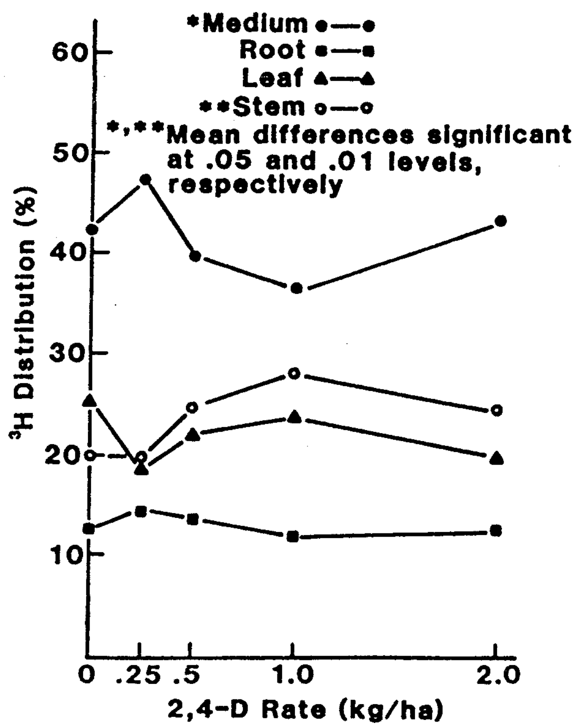


Figure 3. distribution of ^{14}C as a function of time after application.

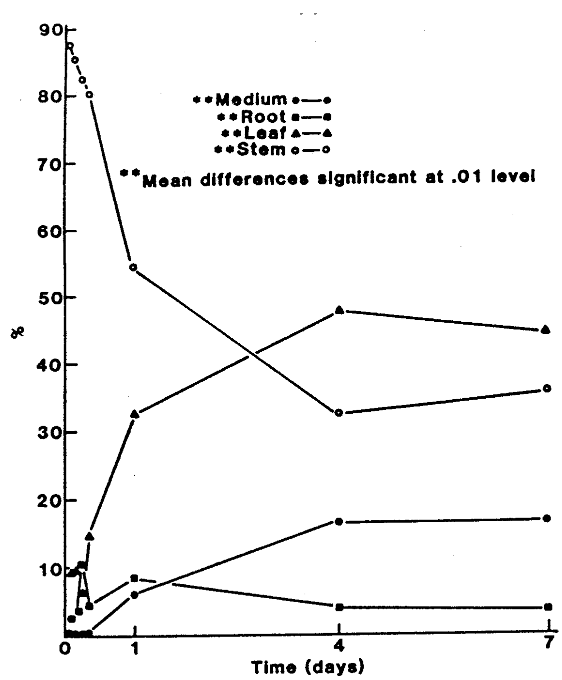


Figure 4. Distribution of ^{3}H as a function of time after application.

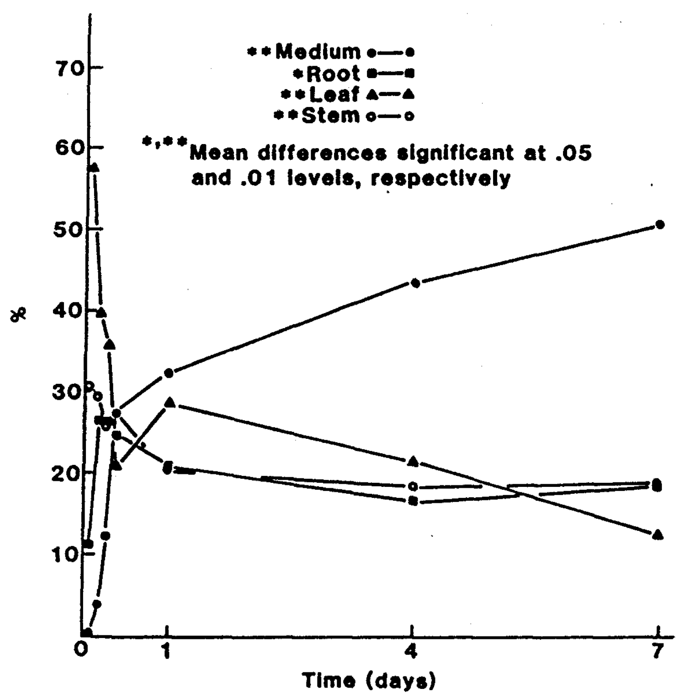


Figure 5. Effect of nutrient strength on ^{14}C distribution 7 days after application.

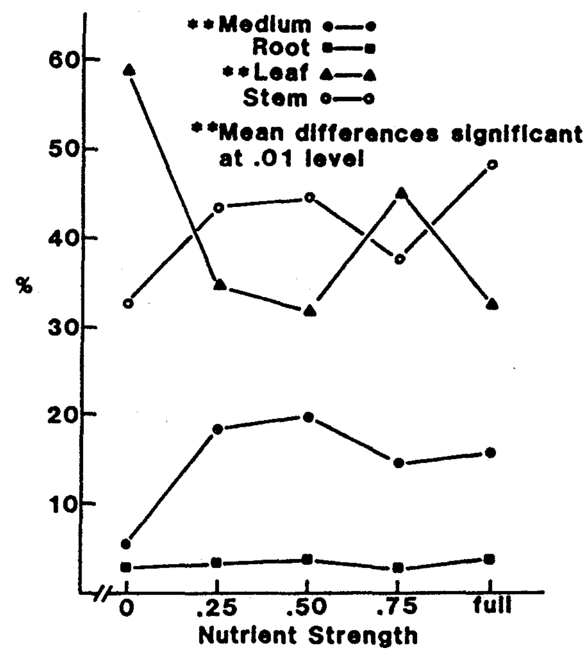


Figure 6. Effect of nutrient strength on ^{3}H distribution 7 days after application.

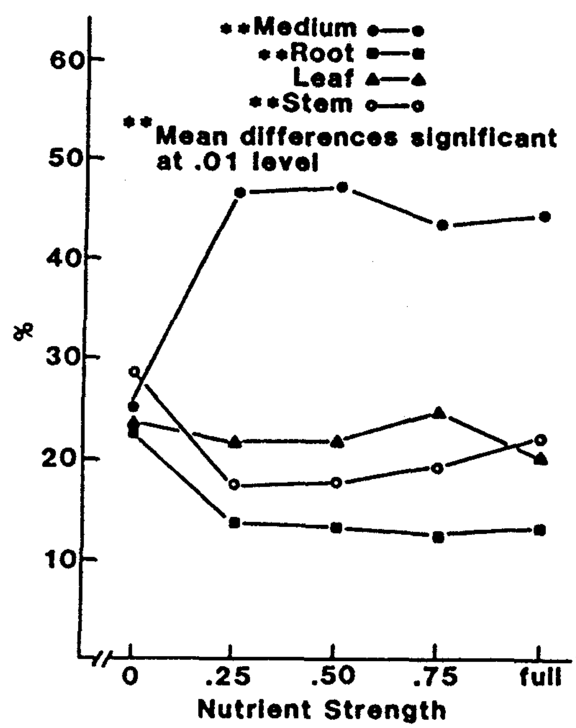


Figure 7. Effect of decapitation on ^{14}C distribution 7 days after application.

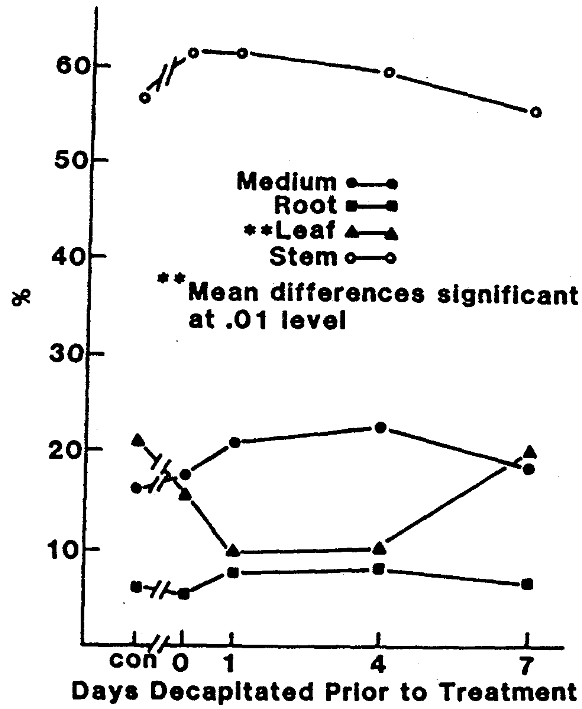


Figure 8. Effect of decapitation on ^{3}H 7 days after application.

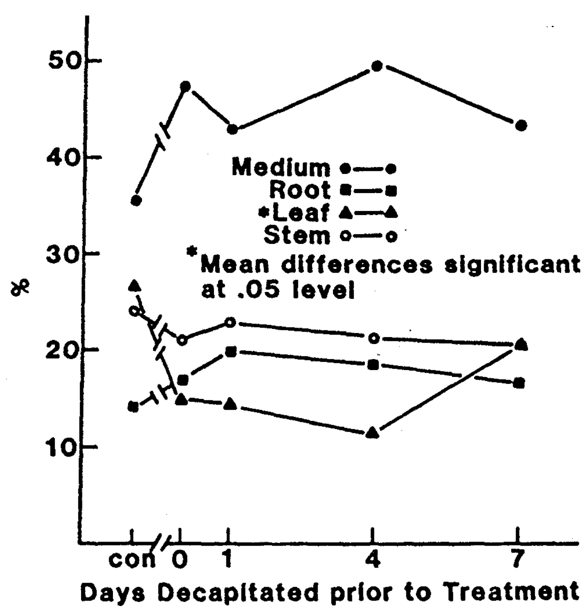


Figure 9. Effect of cerone pretreatment on ^{14}C distribution 7 days after application.

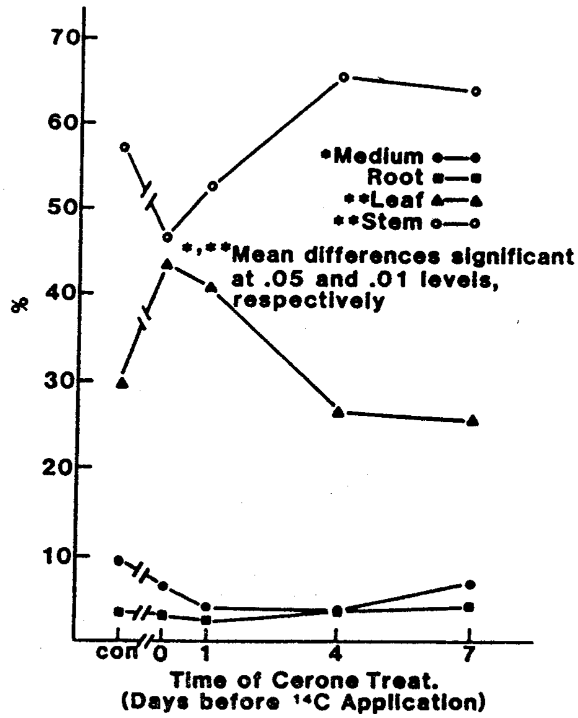
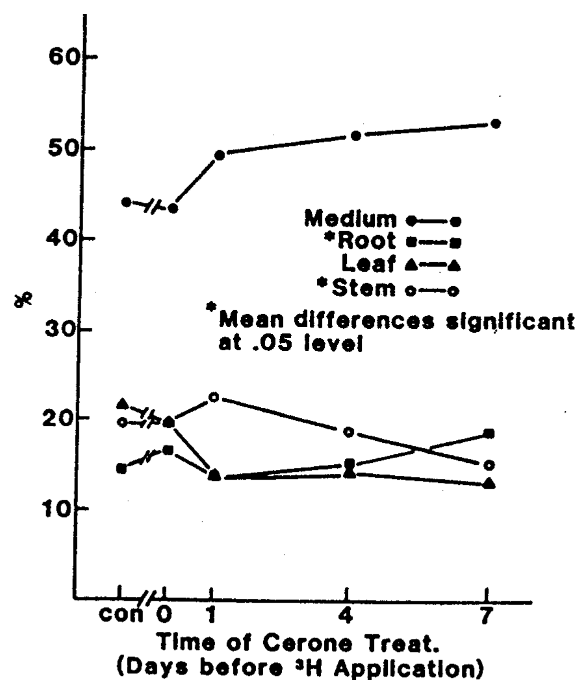


Figure 10. Effect of cerone pretreatment on ^{3}H distribution 7 days after application.



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Preliminary investigations on the herbicidal efficacy of compounds of natural origin and of experimental synthetic herbicides on greenhouse-grown leafy spurge plants

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Leafy spurge plants were grown in vermiculite in a greenhouse for primary research evaluation of several compounds on their effects on shoots and, most importantly, the subsequent regrowth of underground buds. The evaluations usually were initiated when the plants were about six weeks old and in a vegetative state. Shoots were sprayed with several concentrations of each compound, ranging from 0.1 mM to 1 mM active ingredient. Ten ml per plant corresponds to about 1 to 1-1/4 pounds per acre at the 1 mM concentration. The spray solutions contain up to 0.3% detergent. Compounds with very low water solubility were solubilized with acetone or methanol as needed, and detergent added for retention on the foliage. Plants were observed 2 to 3 weeks after treatment for shoot damage and subsequent regrowth. Shoots were then cut off and the roots were left in the pots for an additional 3 to 4 weeks to determine whether new shoots would form from underground buds.

Surfactants evaluated were Triton-X-100, Tween 20, Tween 80, acetone and methanol (the latter two at 10% v/v). Of the additives used, only Triton-X-100 (0.3% w/v) had any deleterious effects. Leaf edges became necrotic and leaves curled on treated plants. Triton-X-100 was not used for subsequent experiments so that the surfactant effects would not interfere with the evaluation of the other compounds.

Because only milligram quantities of some chemicals were available, the number of plants used for some treatments was very small (1 to 3 for a given concentration). Therefore, analyses on the basis of fresh dry weights are of limited value. The data presented in Table 1 is only a relative synopsis of the general effects of the chemicals on shoot tissues and their potential to prevent regrowth.

Table 1. General effects of compounds on shoots of greenhouse-grown leafy spurge.

I.	Additives:	
	Polyoxyethylene (9.5)octyl phenol (Triton-X-100)	1
	Polyoxyethylene-(20)-sorbitan monolaurate (Tween 20)	0
	Polyoxyethylene-(20-sorbitan monooleate (Tween 80)	0
	Methanol, acetone	0
II.	Trichodermin (rating of 3) and the following analogs:	
	Trichodermol	1
	Trichodermol-ethylether	0
	4-epi-trichodermol	1
	Trichodermone	0
	Trichodermol-carbaminate	3
	Trichodermol-trichloroacetyl-carbaminate	3
	4-α-chloro-12,13-epoxy-Δ^9-tricothecene	1
	4-α-azido-12,13-epoxy-Δ^9-tricothecene	1
	Trichodermal-epi-methansulfonate	1
III.	Miscellaneous:	
	Moniliformin	2
	CAT[a]	2
	Cytochalasin H	2
	Cladosporein	2
	Oosporein	2
	Methyl jasmonate	0
IV.	Synthetic Herbicides:	
	2-chloro-N-[(4-methoxy-6-methyl-1,3,5-triazin-2-yl) -aminocarbonyl] benzenesulfonamide	6
	Methyl 2-[[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)-amino]carbonyl] amino] sulfonyml]benzoate	7
	Methyl 2-[[[[4,6-dimethyl-2-pyrimidinyl)amino]carbonyl)amino]sulfonyl]benzoate	8
	2.3-dihydro-5,6-dimethyl-1,4-dithiin-1,1,4,4-tetraoxide (Harvade)	3

1-2 Necrosis of leaves.

3-5 Some shoots dead, regrowth occurred readily.

6-8 Shoots dead, regrowth slow.

10 Shoots dead, no regrowth.

[a]Name withheld due to proprietary agreement.

Most of the compounds listed in Table 1 had some effect on leafy spurge shoots. Trichodermin and seven of its analogs damaged shoots (Table 1). Regrowth occurred in all treatments, so none of the compounds appeared to be likely candidates for leafy spurge control. Two of the treichodermin analogs had no effect on shoots. The effects were more severe with increased concentrations.

All of the compounds (except for methyl jasmonate) listed as miscellaneous in Table 1 also damaged shoot tissues. In one experiment, oosporein inhibited regrowth, but in subsequent studies regrowth of shoots occurred. Harvade, a cotton defoliant, also defoliated leafy spurge shoots. New shoots developed on all of the treated plants. None of these miscellaneous compounds have proved to be likely candidates for leafy spurge control.

The first three synthetic herbicides listed in Table 1 have similar chemical characteristics. They stopped the growth of vegetative or flowering plants and inhibited regrowth, but did not prevent it. Therefore, even these chemicals at the higher concentrations tested do not appear to be likely candidates for leafy spurge control. However, other compounds from this class of herbicides should be tested further, because they appear to have potential. Other analogs might be more effective.

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The chemistry and allelopathy of *Euphorbia esula*

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Euphorbia esula L. (Leafy spurge) infests 2.5 million acres of range and pasture land in the upper great plains of the United States. The plant is toxic to livestock [1], allelopathic to desirable forage plants [5] and poses a serious threat to livestock production on open range lands. Leafy spurge can be controlled by herbicides. However, the cost of control is high and continuous since the weed cannot be eradicated chemically [15]. Spurge is controlled naturally in Europe by indigenous insect predators, however attempts to utilize these predators as biological control agents in North America have proven unsuccessful [10]. One plant (*Antennaria microphylla*) has been reported to be allelopathic to *Euphorbia esula* [5]. Individual *Euphorbia esula* biotypes have been previously examined chemically with the reported occurrence of n-alkanes (C_{25} through C_{32}) [4], long chain alcohols (C_{26} and C_{28}) [4,6], long chain aldehydes (C_{26}, C_{28}, C_{30}) [4], B-sitosterol [2], triterpenes (24-methylenecycloartenol, cycloartenol, lupeol) [2,7], flavanoid glycosides (kaempherol-3-glucuronide) [4] and phorbol esters (ingenol derivatives) [8,9,13].

We now report the results of a chemical investigation of leaf wax constituents of five *E. esula* biotypes relative to the potential chemical taxonomic differentiation of spurge biotypes for the efficient application of biological control methods. This presentation also reports an initial biological evaluation of *E. esula* water soluble chemical constituents as allelopathic agents against favored forage species. An initial biological assay of the extractives *Antennaria microphylla* as allelochemics toward leafy spurge is also described.

Euphorbia esula leaf wax constituents

Several biotypes of *E. esula* have been identified [11,14], suggesting the possible occurrence of separate North American and European Leafy spurge species which can not be differentiated morphologically or the existence, within a single species, of intraspecies physiological or chemical differences between the biotypes. These differences may have significant effects on insects which are predators to this weed.

Intraspecies chemical and/or biochemical comparisons of the recognized *Euphorbia esula* biotypes may provide chemical taxonomic information relative to biological control methods. This investigation is the first chemical comparison of North American and

European *E. esula* biotypes to evaluate the feasibility of using epicuticular wax constituents as chemical taxonomic indicators.

Leaf wax samples were obtained from four North American and one European field selected, greenhouse grown *E. esula* plants displaying similar floral characteristics but distinctively different leaf characteristics. Leaf material from these plants was dipped in chloroform to obtain raw leaf wax samples. Chloroform samples were dissolved in methylene chloride and concentrated with acetone to yield a pseudo-crystalline material. The solid material was filtered and the solid and filtrate were each examined individually utilizing gas chromatography and gas chromatography/mass spectrometry. Specific chemical compounds were identified by comparison of chromatographic and/or mass spectral data with recorded values or with standard compounds available in the laboratory. The results of the analyses are summarized in Tables 1-5.

The analysis of the leaf wax constituents of five separate *Euphorbia esula* biotypes showed, with minor variations, that all of the Leafy spurge biotypes contained similar hydrocarbon compounds, had high yields of the same long chain alcohols (particularly hexacosanol) and were similar in both aldehyde and acid composition. These data may be chemotaxonomically characteristic of the genus *Euphorbia* and are comparable to the suggested chemotaxonomic criteria for separating the panicoid and festucoid grasses at the genus level [12].

The dramatic differences observed in the yields and occurrence of the triterpenes -amyrin, -amyrin and -amyrenone among the five *E. esula* biotypes provides evidence supporting the suggestion that North American leafy spurge may be an interspecies hybrid of *Euphorbia esula* and *Euphorbia virgata* [11] and further suggests the potential importance of the wax triterpenes as chemotaxonomic indicators in leafy spurge. A more detailed examination of the nature and distribution of the epicuticular wax triterpenes among *Euphorbia esula* could provide important information relative to the chemotaxonomic differentiation of leafy spurge.

Table 1. Percent composition and yield of epicuticular waxes of five biotypes of *Euphorbia esula.*

	Biotype				
	North American				Austrian
Component	5	13	14	17	10
Hydrocarbons	12	18	16	14	25
Free Alcohols	54	52	53	57	29
Aldehydes*	1	1	2	1	4
Free Acids	3	2	3	2	4
Esters	17	13	7	10	18
Triterpenes	3	5	10	7	11
Triterpene Esters	2	2	4	3	2
Unidentified	8	7	5	6	7
Yield; % dry wt.(mg)	0.9 (86)	1.1 (256)	1.2 (183)	1.4 (47)	0.8 (139)
Acetone sol.(%)	5.8	7.8	13.7	10.6	11.5
Acetone insol.(%)	94.2	91.2	86.3	89.4	88.5

*Aldehyde yields of 5,13,14,17 rounded to next higher %

Table 2. Percent composition of hydrocarbons of epicuticular wax of five biotypes of *Euphorbia esula.*

	Biotype				
	North American				Austrian
	5	13	14	17	10
Carbon No.					
29	13	10	10	16	12
30	2	2	1	2	2
31	51	60	51	55	47
32	3	5	5	4	4
33	18	11	11	10	23
34	2	1	1	1	3
35	6	5	9	5	4
36			2		
37		1	4	1	1
38					
39			2		
Unident.	5	5	4	6	4

Table 3. Percent composition of free alcohols, aldehydes and acids in five biotypes of *Euphorbia esula*

	Biotype														
	North American												Austrian		
	5			13			14			17			10		
	ALC	ALD	AC	ALC	ALD	AC	ALC	ALD	AC	ALC	ALD	AC	ALC	ALD	AC
Carb.No.															
26	91	24	24	91	14	24	91	34	22	88	34	37	71	27	18
28	8	69	30	7	62	40	8	61	22	11	65	26	14	64	31
30	1	7	30	2	24	22	1	5	37	1	10	16	15	9	35
32			12			8			12			12			11
34			4			6			7			9			5

Table 4. Percent composition of esters of five biotypes of *Euphorbia esula.*

	C_{26}, C_{28} Alcohol BIOTYPE					C_{26}, C_{28}, C_{30} Alcohol BIOTYPE				
	N. American				Aust.	N. American				Aust.
	5	13	14	17	10	5	13	14	17	10
Acids										
C_{16}, C_{18}	14	13	12	7	18					
C_{18}, C_{20}	16	16	17	14	29					
C_{22}, C_{24}	38	42	35	28	42	26	24	27	30	21
Unidentified	6	5	9	6	4					

Table 5. Percent composition of free triterpenes of five biotypes of *Euphorbia esula*

	BIOTYPE				
	North American				Austrian
	5		14	17	10
Terpene					
Amyrin	5	4	9	7	44
Amyrenone	11	7	7	8	–
Amyrin	37	41	67	55	22
24-Me Cycloartenol	28	31	5	19	23
Lupeol OAc	4	5	1	4	2
Unidentified	15	12	11	7	9

Allelopathic evaluation of *E. esula*

In an effort to confirm the reported allelopathic activity of *Euphorbia esula* [5], a chemical separation of an aqueous extract of Leafy spurge was undertaken with the purpose of identifying biologically active constituents in spurge which act as allelochemical agents. Individual chemical constituents obtained from the water soluble extract were assessed for biological activity using a lettuce seed germination bioassay system.

The extraction and separation of Leafy spurge chemicals was accomplished according to Scheme 1. Lettuce seed germination bioassay of the fully differentiated water soluble extract of the plant showed significant biological activity to occur in the sodium bicarbonate soluble portion of the ethyl acetate extract of the aqueous plant extract. The flavanoid compound kaempherol-3-glucuronide (I) was isolated (0.06% of dry plant wt.) and characterized from this extract and subsequently evaluated in the lettuce seed bioassay. The yield of the glucuronide from the aqueous extract was approximately 100 times larger than previously reported in *E. esula*.

Lettuce seed bioassay results of kaempherol and kaempherol-3-glucuronide are summarized in Table 6. The bioassay results show significant reduction (49%) of lettuce seed root length at a concentration of 500 ppm and contrast with an observed root length elongation (5%) for kaempherol at the same concentration. The observed biological activity of the glucuronide, the high concentration of the compound in the plant and the expected slow degradation of the compound in the soil suggests the potential important contribution of this compound to the reported allelopathy of Leafy spurge toward other plant species.

Table 6. Lettuce seed bioassay of Kaempherol and Kaempherol-3-glucuronide from *Euphorbia esula.*

Compound	Root Length Reduction			% Yield (Dry wt.)
	500ppm	250ppm	125ppm	
Kaempherol	(5%)	(17%)	2%	1.9×10^{-4}
Kaempherol-3-Glucuronide	49%	11%	13%	5.9×10^{-3}

Biological activity of *Antennaria microphylla* extractives.

Antennaria microphylla (small everlasting) is the only plant reported to be allelopathic to *E. esula* [5]. This report strongly suggests the source of this allelopathy to be chemical in nature. The determination of the chemical of chemicals responsible for the phytotoxicity of this plant toward spurge could provide important information pursuant to the development of new herbicides with improved efficiency for the control of eradication of *E. esula*.

A biological assay (lettuce seed germination) was administered to four sequential solvent extracts of *Antennaria microphylla.* The results of this bioassay are summarized in Table 7.

Examination of the bioassay data for the *A. microphylla* extracts shows most biological activity to reside in the ether and water extracts of the plant. Although the water extract showed the greatest activity, the activity of the ether extract is probably of more significance because of the low solubility of this extract in the test system. The activity is also in sharp contrast to that observed for the preceding hexane extract and the following acetone extracts.

The preliminary biological evaluation of *A. microphylla* extracts confirms the presence of biologically active chemical constituents in this plant. Isolation, characterization and further biological evaluation of specific chemical constituents from the biologically active extracts is presently underway.

Table 7. Lettuce seed bioassay of *Antennaria microphylla* extracts.

Extract	Root Length Reduction 500ppm	% Yield (Dry wt.)
Hexane	6%	3.6%
Ether	21%	0.5%
Acetone	(5%)	1.5%
Methanol	12%	6.8%
Water	35%*	10.1%

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