Research Programs for Leafy Spurge Control in the United States and Canada

CALVIN G. MESSERSMITH AND RODNEY G. LYM

Leafy spurge was recognized as a potential weed problem as early as the 1910's and 1920's. Detailed research bulletins about leafy spurge were published as early as 1933 by Hanson and Rudd in North Dakota and in 1936 by Bakke in Iowa. Leafy spurge research has been conducted annually in the intervening years, but generally only as a small component of the scientific effort for any researcher. Probably the largest coordinated leafy spurge control research effort was by Canadian scientists through the 1960's and early 1970's.

Leafy spurge research has been restrained by the limited availability of alternative control methods such as new herbicides. Scientists logically emphasize control of weeds that cause the greatest economic loss, so priority generally is placed on control of annual weeds like wild oats and wild mustard in annual crops like wheat or sunflower. Scientific effort tends to reflect the public pressure for solutions to problems, since manpower and financial resource limitations always require the establishment of priorities. Leafy spurge has been recognized as a serious weed problem in infested areas for at least 50 years, but its acreage has increased greatly in recent years so the public recognizes that research on leafy spurge control should have high priority.

Individual states have worked to increase leafy spurge control through specific research projects and public supported control programs in recent years. For example, the North Dakota Agricultural Experiment Station established a specific research project for perennial weed control in 1972, with leafy spurge control as the primary objective. Wyoming initiated legislative involvement as early as 1975 through an emergency request for cost-share funding for leafy spurge control. Also, Wyoming presented the same request to the Old West Regional Commission in 1975, 1976 and 1977. However, regional coordination and enhancement of the leafy spurge control research effort in the United States gained impetus when the Leafy Spurge Symposium was held on June 26 and 27, 1979, at Bismarck, North Dakota, sponsored by the Cooperative Extension Service and the Agricultural Experiment Station of North Dakota State University, the United States Department of Agriculture (USDA) Science and Education Administration-Agricultural Research, and the United States Forest Service. The initial meeting was followed with the Northern Regional Leafy Spurge Conference on December 17 and 18, 1979, at Billings, Montana sponsored by the Montana Department of Agriculture, the Agricultural Experiment Station and Cooperative Extension Service of Montana State University, and the Leafy Spurge Committee of the Montana Community Resource Development.

Two positive achievements have come from the initial meetings. First, a joint research proposal submitted to the Old West Regional Commission was funded by the Commission to support additional research in North and South Dakota, Nebraska, Wyoming and Montana from March 1981 through February 1982. The Old West Regional Commission grant was followed in 1982 by USDA research grants through specific cooperative agreements with the Agricultural Experiment Stations of North Dakota, Montana and Wyoming to continue much of the research through 1983 or 1984. These grants provided program development funds with the intent that permanent financial support will be forthcoming through legislative channels. Second, an ad hoc administrative committee was formed to provide long term direction and coordination in the control of leafy spurge. The outcome was a permanent coordinating committee established in June 1981 through the Great Plains Agricultural Council as research committee GPC-14 Leafy Spurge Control in the Great Plains. Several states and the USDA have redirected programs significantly to support leafy spurge research, and research has been expanded using grant funds. The current challenge is to obtain permanent funding through legislative action so that research to control leafy spurge can continue when the grant funding expires.

Many states and federal agencies have active leafy spurge control programs. The general research activities and project leaders of various states, the USDA, and Agriculture Canada are summarized in Table 1. In addition, the specific research interests of each organization are discussed briefly in the paragraphs that follow. It should be noted that the university and USDA scientists located on the campuses of North Daktoa State, Montana State, and Nebraska cooperate closely, although the contribution of each governmental agency is separated in the following discussion. Also, most scientists have research responsibilities for more than one project, and many state scientists have teaching

Messersmith is professor and Lym is assistant professor, Department of Agronomy.

assignments, so most of the research efforts listed on leafy spurge represent less than one-half of a scientist's time.

NORTH DAKOTA

Leafy spurge control with herbicides has been the primary program objective since 1972. The project is under the leadership of Dr. Calvin Messersmith, weed scientist in the Department of Agronomy, and Dr. Rodney Lym has been employed on temporary funds since 1979 as the assistant project leader. One project emphasis has been long term management to control leafy spurge, including several different first year treatments followed by various retreatments in subsequent years. Yield of associated economic forages has been one important evaluation criteria to assess the economic benefit from various treatments. A second project emphasis has been evaluation of low volume applicators such as roller and wick applicators to greatly reduce the amount of herbicide that must be applied, since the most effective herbicides for leafy spurge control are very expensive.

The leafy spurge control program is being expanded in 1983 through addition of a biological control component by redirection of scientists from other projects. Dr. Robert Carlson in the Department of Entomology is leading the biological control with insects component and Dr. Larry Littlefield in the Department of Plant Pathology will be evaluating the potential of diseases for leafy spurge control. Dr. Don Galitz, plant physiologist in the Botany Department is interested in the potential function of allelopathy and disruption of winterhardiness in crown buds for control of leafy spurge.

MONTANA

Biological control of leafy spurge, and other perennial weeds, is the primary research objective at Montana State University. A building and greenhouse specifically for biological control of weeds was built in 1979 at Corvallis, Montana with the research program under the direction of Jim Story. Early in 1982, Dr. Robert Nowierski joined the staff as the entomologist to lead the effort to investigate the use of insects for leafy spurge control. Sherry Turner is a plant pathologist who worked during 1982 at the USDA Plant Disease Research Laboratory, Frederick, Maryland, to evaluate exotic pathogens as potential diseases for leafy spurge control.

The leafy spurge control program is balanced with research in chemical control and studies of the ecology of leafy spurge. Dr. Peter Fay is the project leader and was joined in May 1982 by Dr. Mike Foley who is a weed physiologist. A public education program has been a major program thrust for the past two years. A frequently asked question is whether leafy spurge has an economic benefit as sheep feed or as an alternate energy source, so Dr. Fay and colleagues are evaluating this question. Studies are in progress to determine whether sheep will preferentially graze leafy spurge and the effect of leafy spurge grazing on weight gain by sheep; these studies are under the direction of animal scientist Dr. Kris Havstad and Dr. Fay. The evaluation of leafy spurge as a potential alternate energy plant means that leafy spurge is grown using optimum crop production practices such as fertilizer and weed control to maximize yields, harvest is at peak production, and total energy production is determined. Initial results indicate that leafy spurge is more of a weed than a potential energy crop.

WYOMING

The major program emphasis has been on chemical control of leafy spurge. Wyoming has approximately 48,000 acres of leafy spurge, so the state and local governments and landowners have joined in a six-year program to stop leafy spurge now before it becomes a 500,000 to 700,000 acre problem as in Montana and North Dakota. The research project is led by Dr. Harold Alley with assistance from Tom Whitson and a small biological control effort by entomologist Dr. Robert Lavigne. The primary program objective has been long term management of leafy spurge involving annual herbicide treatment and harvest of pasture forage to determine the increased forage production from control of leafy spurge. A major effort has been soil sampling to determine whether root control is similar to the topgrowth control. A second project emphasis is evaluating the potential benefit of growth regulators with herbicides to improve leafy spurge control.

NEBRASKA

Leafy spurge infests 100,000 to 150,000 acres in Nebraska at this time. State supported research has been limited to chemical control experiments under the leadership of Dr. Alex Martin, extension weed scientist. Two special areas of interest have been evaluation of chlorflurenol, a growth regulator, as a additive with herbicides and use of several rope-wick applicators to reduce the amount and cost of herbicide applied.

SOUTH DAKOTA

The acreage of leafy spurge in South Dakota is relatively small, so most of the research has been limited to herbicide trials under the leadership of Dr. W. E. Arnold. Also, experiments are in progress to determine whether there is a relationship between the establishment of leafy spurge and soil characteristics such as pH or mineral content.

USDA

Biological control of leafy spurge with insects has been an area of study for at least 15 years. The project is led by Dr. Lloyd Andres at the Biological Control of Weeds Laboratory, Albany, California, and Dr. Robert Pemberton is the scientist working with leafy spurge.

Since the most promising exotic insects are found in Europe and Asia, the initial evaluation of potential insects for leafy spurge control is conducted at the Biological Control of Weeds Laboratory in Rome, Italy under the leadership of Dr. Paul Dunn. During 1982, Norman Rees, entomologist at the Rangeland Insects Laboratory at Montana State University, has been partially reassigned to work on the biology and dissemination of insects for biological control of leafy spurge and other weeds on rangeland. Initial collection of leafy spurge pathogens in Europe and Asia were made in the late 1970's, but the program of using pathogens for leafy spurge control was strengthened in 1982 under the leadership of Dr. William Bruckart at the Plant Disease Research Laboratory, Frederick, Maryland.

Scientists and farmers recognize the plant called leafy spurge, but leafy spurge appears to be a genetically diverse plant that provides a wide range of susceptibility or resistance to various insect or disease organisms. Dr. M. K. McCarty at the University of Nebraska has a nursery of leafy spurge plants from the United States, Canada, and Europe with the objective of clarifying the questions concerning the taxonomy of leafy spurge.

Several problem areas concerning the basic biology of leafy spurge are being studied by USDA scientists. There are two different approaches at the Metabolism and Radiation Research Laboratory in Fargo, North Dakota. Dr. David Davis is studying the morphology and anatomy of roots and underground buds to better understand the factors that contribute to survival of leafy spurge roots. Also, he is studying chemical factors that control root, shoot, and bud formation using tissue culture techniques. Dr. Jeff Suttle and postdoctoral associate Dr. Sarah Lingle are studying herbicide uptake and translocation in leafy spurge to determine the factors that limit movement of herbicides into the root system. A plant chemist, Dr. Gary Manners at the Western Regional Research Center in Berkeley, California, is studying the unique chemical compounds in leafy spurge that may affect feeding by insects or infection by diseases. Dr. Manners also is assessing the chemical constituents that may be leached from the plant into the soil to reduce the growth of competing plants.

The federal research described above is conducted by the Agricultural Research Service, USDA. The Forest Service, USDA, also is conducting leafy spurge control research. Dr. Ardell Bjugstad at the Forest Research Laboratory, Rapid City, South Dakota is conducting research on soil-site-plant relationships of leafy spurge to determine growth and plant density characteristics of the weed on various soils and sites. This knowledge will assist managers in the assessment of sites for possible new infestations of leafy spurge and the vigor of the plant if it becomes established. Dr. Bjugstad also is studying the potential role of fire to reduce leafy spurge seed viability in infested areas.

CANADA

Agriculture Canada has had an active program of research for leafy spurge control for around 20 years, and has conducted many of the basic studies on morphology, anatomy, and ecology of leafy spurge. The primary effort now is on biological control with insects under the leadership of Dr. Peter Harris, Agriculture Canada Research Station at Regina, Saskatchewan. The six insects cleared for release against leafy spurge in North America all have been the result of Canadian-sponsored studies. The European work on potential insects for biocontrol is conductd by the Commonwealth Institute of Biological Control (CIBC) centered at Delemont, Switzerland. The CIBC research on leafy spurge has been funded by Alberta, Saskatchewan, and Agriculture Canada. One difficulty in the biocontrol program has been finding specialized European leafy spurge insects that can develop and reproduce on North American leafy spurge. Dr. Alina Stahevitch of the Agriculture Canada Biosystematics Research Institute, Ottawa, Ontario, has started a taxonomic study to locate the European counterparts of the spurge introduced into North America to assist in the finding of biocontrol agents.

Also at the Regina Research Station, Dr. Knud Mortensen is surveying the indigenous pathogens on leafy spurge to determine if any are suitable for augmentative biocontrol, i.e., artificial culturing of native diseases and spreading the pathogen to heip cause enough plant disease infection to control the weed. Herbicides for leafy spurge control are being evaluated at several locations including Alberta, Saskatchewan, Manitoba and Quebec.

CONCLUSIONS

Five points should be made as an assessment of the total leafy spurge research effort in the United States and Canada.

1. Research progress to date has provided effective and relatively economical methods to control leafy spurge and increase forage production, e.g. annual treatments of 2,4-D or 2,4-D plus picloram. However, these methods do not eradicate leafy spurge and annual treatment is difficult on hilly or wooded terrain, so a need remains for more effective and economical control methods.
2. The relatively long list of contributing research projects may give false security concerning the relatively health of the leafy spurge control program. Most of the scientists are working on several projects, so leafy spurge research often represents only 20 percent of the effort by the scientists listed. Many projects either are underfunded for the amount of scientist time assigned or are funded by grant money that will terminate in one to three years unless continuing grants or permanent funding are obtained.
3. Approximately one-half of the research effort described represents new programs established within 1982, or at least the 1981-83 biennium. There is a natural lag period in new programs before research results can be obtained. Most of the new research is occurring through redirection

of programs so scientists are in the transition of reducing or terminating former projects to add the leafy spurge research component. A few new scientists have been added through temporary grant funds or new permanently funded positions.

4. Information channels have been established for scientists from the states, USDA, and Agriculture Canada, so there seems to be effective communication between scientists and a minimum of duplication.
5. This summary emphasizes the major research efforts of each agency, but nearly all groups are conducting additional research with the most successful control methods to observe the benefit under their local environmental conditions.

Table 1. Summary of leafy spurge research in the United States and Canada in 1982 by general research category, research organization, and project leader. Each listing represents approximately 0.2 scientist-years or more of research effort, but the list does not include many smaller projects that contribute to the total leafy spurge control effort.

General research category	Research organization	Project leader(s)
Chemical control (including herbicides and growth regulators)		
	North Dakota State Univ.	Calvin Messersmith Rodney Lym
	Montana State Univ.	Peter Fay
	Univ. of Wyoming	Harold Alley Tom Whitson
	Univ. of Nebraska	Alex Martin
	South Dakota State Univ.	W. E. Arnold
Biological control with insects		
	USDA Biological Control of Weeds Lab, Albany, CA	Lloyd Andres Robert Pemberton
	USDA Rangeland Insects Lab, Montana State U.	Norman Rees
	USDA Biological Control of Weeds Lab, Rome, Italy	Paul Dunn Antonio Rizza
	Agriculture Canada, Regina, Saskatchewan	Peter Harris
	Montana State Univ.	Robert Nowierski Jim Story
	North Dakota State Univ.	Robert Carlson
Biological control with plant diseases		
	USDA Plant Disease Research Lab, Frederick, MD	William Bruckart
	Eidgenossische Technische Hochschule (USDA) Zurich, Switzerland	Genevieve DeFago
	Montana State Univ.	Sherry Turner
	North Dakota State Univ.	Larry Littlefield
	Agriculture Canada, Regina, Saskatchewan	Knud Mortensen
Basic biology of leafy spurge		
Plant physiology	USDA Metabolism and Radiation Research Lab, Fargo, ND	David Davis Jeff Suttle
	USDA Western Regional Research Center, Berkeley, CA	Gary Manners
	Montana State Univ.	Mike Foley
	North Dakota State Univ.	Don Galitz
Plant Taxonomy	USDA, Univ. of Nebraska	M. K. McCarty
	Agriculture Canada, Ottawa, Ontario	Alina Stahevitch
Economic potential	Montana State Univ.	Peter Fay Kris Havstad
Plant-site relationships	USDA Forest Research Lab, Rapid City, SD	Ardell Bjugstad