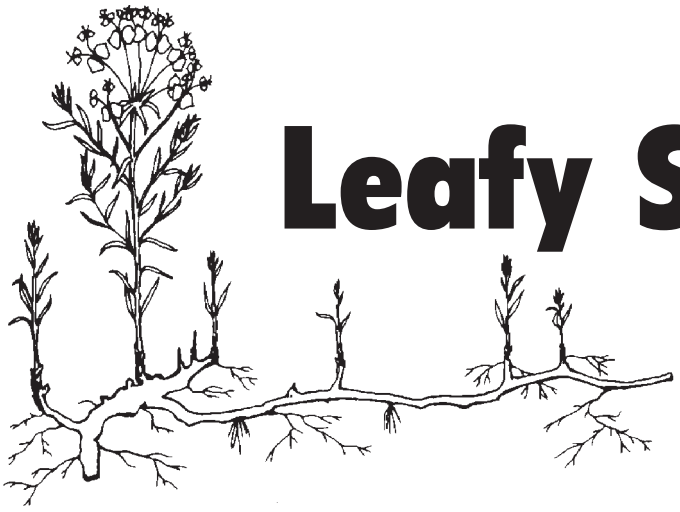

Leafy Spurge *News*

Agricultural Experiment Station
NDSU Extension Service
North Dakota State University, Fargo, ND 58105

Volume XXVI, Issue 2 December 2004

From the Editor's Desk

Once again the December issue of Volume 26 has been delayed mainly because of lack of material. But now thanks to Rod Lym, who beat the bushes for me and twisted arms, I have something to report to you, my faithful readers.

For the first time we have reports from the seven states that have been heavily involved in Leafy Spurge work: Montana, Wyoming, Colorado, North Dakota, South Dakota, Nebraska and Minnesota.

During the ten years that I have been your editor, I have repeatedly mentioned that I cannot manufacture the articles. The information has to come from you, the final user as well as from the research and extension personnel who are developing new techniques and field trials. Since the TEAM Leafy Spurge is history there is no information from that source any more. What this boils down to is, I will only put out the next issue of the **Leafy Spurge** *News* when and if you provide me with sufficient material. Perhaps some of the weed officers would be willing to help some of the end users provide some feedback on the leafy spurge situation.

In the August issue I asked the membership for feedback on an important question. Do you know how many people contacted me? **Less than five,** out of a membership over over 1700! Yes folks, it is as simple as that, I cannot operate in a vacuum. Your editor is not getting any younger as I turned eighty in 2004. So if anybody would like to step up to the plate and take over please be my guest. I realize that most of you are very busy people and the pace of life seems to accelerate all the time so I don't blame you. Hope that you enjoy this issue.

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Leafy Spurge Control: The North Dakota Success Story

Leafy spurge was first found growing in Fargo in 1919 and spread freely to infest nearly 1 million acres by 1997. Velva Rudd, a North Dakota Agricultural College (NDAC) M.S. student, conducted the first in-depth study of leafy spurge in 1931. Her work led to the first Agriculture Experiment Station bulletin about leafy spurge, published in 1934, and to the addition of the plant to the North Dakota noxious weed list in 1935. NDAC and the state legislature began a series of control efforts in the 1950s, but these were generally unsuccessful because of both poor available control methods and lack of consistent state-wide control programs. North Dakota became the leader in leafy spurge research and control with formation of an integrated research program at North Dakota State University in 1979, formation of the North Dakota Weed Control Association in 1983, and annual distribution of cost-share funds made available by the state legislature.

Leafy spurge was doubling in acreage in North Dakota every 10 years until the research and control programs began to slow the spread in the early 1990s (Figure). The multi-agency and multi-discipline approach to leafy spurge control reduced the spread from what likely would have been 2.8 million acres in 2005 to the reported 1.1 million acres today.

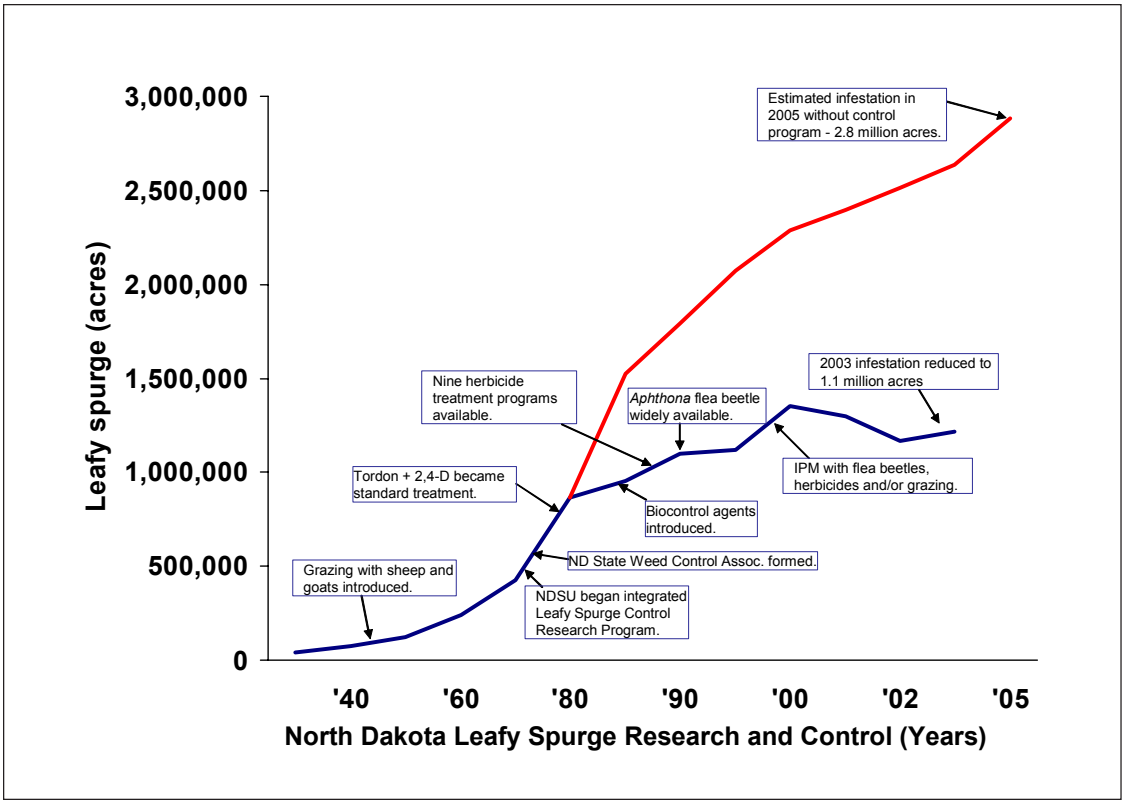
North Dakota continued on page 2

North Dakota continued from page 1

Where land managers initially only had an option of Tordon at one gallon per acre or 2,4-D at 2 quarts per acre for leafy spurge control, the current list of available herbicides and herbicide mixtures fills two pages of the North Dakota Weed Control Guide. The dream of biological control has been realized. At a symposium held in Bismarck in 1979, pathogens were envisioned to be the first biological agents introduced, with insects coming in the late-1980s. The insect biocontrol agents were released on schedule and are now established and controlling leafy spurge, while pathogens have yet to be released. Grazing sheep and goats to manage and contain the infestations has become more popular, and several species of grasses that compete with leafy spurge in pasture and rangeland are available. Researchers and land managers realize that no single method will control leafy spurge in all locations and environments. Thus, present research efforts are exploring the integration of two or more control methods for cost-effective long-term leafy spurge management.

It is likely that leafy spurge will always be a part of the North Dakota landscape, although at levels below the economic threshold. Leafy spurge caused the framework to be set for formation of the statewide North Dakota Weed Control Association. Because of the attention given to this weed, threats of spread from newly introduced invasive species, such as yellow starthistle, saltcedar, and purple loosestrife, can be identified early and a control program initiated promptly. The plan of cooperation established between various state and federal agencies needed to control leafy spurge on a state wide basis is now in place and ready to use for other weed control efforts. Thus, the legacy of leafy spurge could be prevention of further noxious weed invasions and preservation of the state's agricultural enterprises and native plant species.

Rod Lym



Leafy Spurge:
A Quarter Century of Management in Montana

Leafy spurge has been established in Montana for 82 years. The weed was first reported in the state in 1923, and by 1986 had spread to infest about 500,000 acres, equal to an annual spread rate of 23%. Implementation of an aggressive public awareness and research program in 1980, supported in part by grants from the Great Plains Agricultural Council (GPC), was the beginning of a statewide effort to reduce the spread and impact of leafy spurge in Montana. The regional research program focused on developing effective integrated techniques for managing leafy spurge using grazing animals, biological agents, herbicides, and competitive desirable grasses. Results of this initial effort and subsequent programs on leafy spurge shifted the focus from herbicide-only treatments to ecologically-based integrated weed management (IWM) programs.

A survey report in 2004 indicated that leafy spurge infested about 1.2 million acres in Montana. Although this is more than double the acreage reported in 1986, the annual spread rate from 1986 to 2004 is about 4.7% or five-fold less that the previous 63-year period. Environmental and ecological factors may be partially responsible for the reduction in spread rate; however, we believe the statewide management effort has had a significant impact on the weed. Although "success" of a program is often based on complete removal of a weed or reduction in acres, the "emerging success" of the leafy spurge program is based on a decline in spread rate, implementation of sustained long-term IWM of leafy spurge, and heightened public awareness and support.

Following are highlights of several facets of the IWM program:

1) There are currently nine introduced insects established on leafy spurge in the state. The greatest impact on the weed has been achieved primarily by the flea beetles *Apthona nigriscutis, A. czwalinae* and *A. lacertosa.* Although these insects have been widely distributed for only about 15 years, their impact on reducing leafy spurge density has been recorded throughout the state.

2) Sheep and goats are recognized for their value as an agricultural commodity in addition to their benefit as a management tool for leafy spurge. The Montana Sheep Institute was founded in 2002 to provide an incentive to producers to maintain or increase sheep numbers in the state. A major objective of the Institute is to increase the competitiveness of Montana's sheep industry by using sheep in large-scale weed management systems. In 2003/2004 the Sheep Institute promoted 22 grazing projects involving sheep grazing on 83,000 acres of leafy spurge-infested lands in the state.

3) Herbicides continue to be a critical component in integrated management of leafy spurge. However, the focus has changed since the early 1980's from large-scale applications to programs that contain infestations. Educational efforts promote use of herbicides for control of satellite infestations of leafy spurge and as a perimeter treatment to contain large infestations.

4) The Noxious Weed Trust Fund has provided financial cost-share assistance to about 285 Cooperative Weed Management Areas (CWMA's) involving integrated management of leafy spurge. These projects are located throughout the state and involve cost-share for sheep grazing, collection and release of biological control agents, herbicides, and restoration.

5) Protecting areas not infested by leafy spurge has received increased emphasis in the last five years. Early detection and rapid control of newly invading plants is a critical component of the leafy spurge program in Montana.

6) The Statewide Public Education and Awareness Campaign, Montana State University Cooperative Extension Service, and federal and state agencies continue to target leafy spurge in awareness and educational programs. There is a high level of public awareness regarding leafy spurge in Montana.

Leafy spurge is well established in Montana and will remain a component of the plant community. Implementation of ecologically-based IWM strategies optimizes our potential for successful long-term sustained management of leafy spurge. The key to management of leafy spurge is protection of non-infested sites, early detection and rapid control of newly established leafy spurge, and increasing support for and implementation of IWM strategies statewide.

Celestine Duncan
Weed Management Services, Helena, MT

Leafy spurge biological control in Minnesota:
Cooperation in Action 1989-2004

Many Minnesota cooperators are using multiple techniques to combat leafy spurge. For example, the Minnesota Department of Transportation is integrating biological controls into their traditional spraying programs along roadsides. Herbicides are being used on small isolated stands; and biological control is being applied to large patches of leafy spurge that have survived chemical treatments in the past. Land managers with the United States Fish and Wildlife Service and the Minnesota Department of Natural Resources have incorporated cultural techniques, such as prescribed burns, with selective herbicide use and biological controls. For example, burns are performed in the spring or fall to stimulate the growth and establishment of native grasses and forbs, herbicides are used sparingly on isolated patches, and biological control agents are being released on the large/dense infestations.

In Minnesota, biological control has been widely successful in managing problem infestations. Seven of the nine species (five flea beetles, a stem-boring beetle, and a gall midge) have been released at over 700 hundred sites throughout the state since 1989 (Figure 1 and Table 1). The flea beetles alone have been responsible for the suppression of several thousand acres of leafy spurge on agricultural, private, and public lands. All seven species of biological

Minnesota continued on page 5

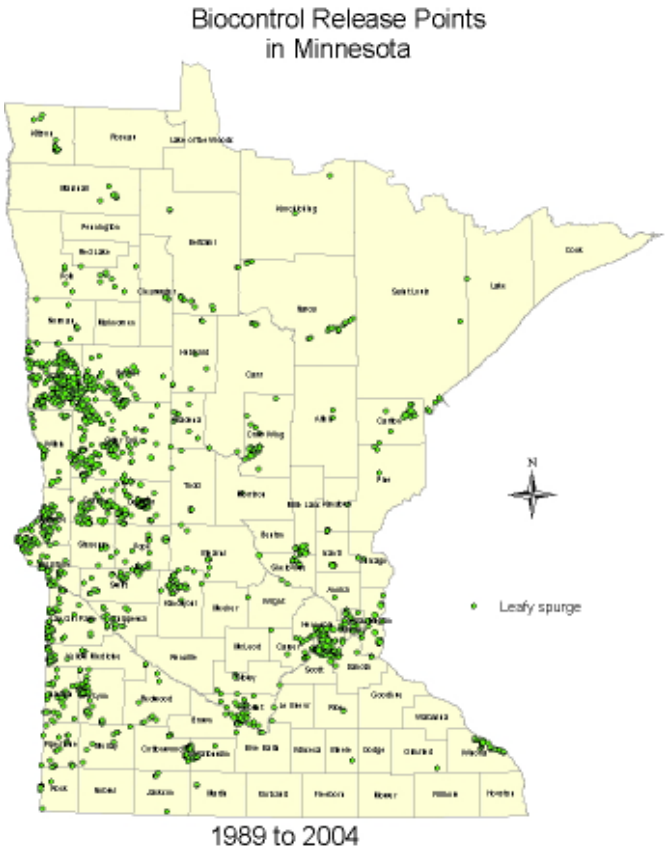


Figure 1. Biological control release sites in Minnesota from 1989 through 2004.

Table 1. Biological control releases in Minnesota by species, 1989 through 2004.

Year	*Aphthona lacertosa*	*Aphthona nigriscuti*	*Aphthona cyparissia*	*Aphthona flava*	*Aphthona czwalinae*	*Spurgia esula*	*Obera erythrocephala*	Quantity of Releases
1989	0	3,500	651	0	0	0	0	9
1990	0	8,500	0	0	0	0	0	12
1991	0	2,500	3,500	0	0	0	0	11
1992	0	2,200	2,850	1,550	0	0	0	14
1993	0	8,500	0	3,100	1,445	60	59	23
1994	5,000	12,300	0	2,000	0	60	200	19
1995	19,000	16,000	0	0	0	120	0	33
1996	114,650	19,980	9,000	21,720	250	150	0	92
1997	1,918,110	100,050	0	2,300	8,500	1,200	0	178
1998	2,027,400	129,100	500	350	750	0	0	298
1999	5,138,125	186,675	0	0	0	0	0	312
2000	6,947,100	446,900	0	100	0	0	0	473
2001	7,676,270	153,500	0	0	0	0	0	554
2002	6,888,900	426,000	0	0	0	0	197	645
2003	1,552,400	58,100	0	0	0	0	487	161
2004*	935,800	54,000	0	0	0	0	24	143
Total	**33,222,755**	**1,627,805**	**16,501**	**31,120**	**10,945**	**1,590**	**967**	**2,977**

* 2004 data summaries are incomplete at this time.

Leafy Spurge in Colorado

It is unfortunate, but leafy spurge is alive and doing quite well in Colorado. This of course in spite of our efforts to successfully manage this nasty invasive weed. Leafy spurge populations in Colorado have almost doubled over the past 15 years from about 44,000 acres infested ***with*** leafy spurge in 1987 to over 73,800 acres ***of*** leafy spurge in 2002. Our mapping methods are improved (using NAWMA standards) compared to the first inventory taken in 1987 and current data reflect a more accurate representation of what we now have. Core infestations still thrive in northwest Colorado near Meeker, in Larimer County near Fort Collins, and in the Denver metropolitan area. But, we have many new areas that are now infested and it is likely that these core infestations served as sources. The Larimer County infestations have moved from the Poudre River into the South Platte drainage near Greeley and leafy spurge now can be found along the entire length of the South Platte River almost into Nebraska. Larimer and Weld (immediately east of Larimer) Counties have very aggressive leafy spurge management programs and these increases would be much worse had their efforts not been in place. We are constantly finding new and widely dispersed infestations in the mountainous areas of our state and many new infestations are now found in the southwest part of Colorado where old, yet small infestations have now spread to many new locations. Development in our state has exacerbated the movement of leafy spurge to new locations. This situation is readily evident near Steamboat Springs and the surrounding areas where leafy spurge is spreading rapidly, again in spite of significant efforts by Routt County weed management.

Development and simple ignorance most likely are highly correlated with the tremendous spread of leafy spurge over the past 15 years in Colorado. The Colorado Department of Agriculture has an excellent biocontrol program for leafy spurge and has re-distributed millions of flea beetles around the state, especially along the Front Range counties (from Fort Collins south past Colorado Springs). In some locations, the flea beetles have controlled leafy spurge demonstrating a dramatic effect, but in many others, no control has been achieved. Spraying too has been enhanced over time, but not often enough coupled with seeding efforts to reclaim badly infested ground so spurge continues to rebound and re-infest many treated areas. Those who have spent the time, money, and energy to re-seed are enjoying better results than those who have chosen not to do so.

The tenacious nature of leafy spurge coupled with its broad ecological amplitude and rapid rate of spread allow it to have the upper hand in Colorado. But we continue to battle this highly invasive weed and improvements in our state weed law that occurred in 2003 will allow a more organized and concerted effort statewide. Our goal is to prevent its spread into uninfested areas, keep new infestations from expanding with hope of eradication in some cases, and shrink the core infestations. Lofty goals to say the least, but one thing is for certain, we will never give up the fight!

Dr. George Beck, Colorado State University

Minnesota continued from page 4

control agents are established in Minnesota; however, the flea beetle species are the only agents currently being collected and redistributed to new sites annually. This biological control program relies on cooperation from federal, state, and county agencies and has been coordinated through the Minnesota Department of Agriculture since 1999. The main objective of this program currently is to harvest leafy spurge biological control agents from sites with high populations and redistribute them to new infestations. Currently, in Minnesota, leafy spurge biological control focuses on the collection and distribution of *Aphthona lacertosa* and *A. nigriscutis* at no cost to land owners. Additionally, this program currently is monitoring existing biological control sites to record the progress of these agents over time.

Anthony Cortilet and Monika Chandler
Minnesota Department of Agriculture
Roger Becker
University of Minnesota

Spurge Battle Continues in South Dakota

The remaining 318,000 acres of leafy spurge continues to be a primary target for farmers, ranchers, land managers and county weed and pest officials. Progress is slow but steady. Success is measured through long-term control efforts, integration of all the "tools" and through planning that coordinates the resources and efforts in designated areas. Approaches used in TEAM Spurge continue to guide efforts.

Herbicide Evalutaion

Field plots have been maintained to provide a current data base. Emphasis has included results from long-term treatments, fall vs. spring timing and new combinations that provide cost effectiveness.

Spring vs. Fall:

Effectiveness of fall herbicides require adequate regrowth. Very dry fall seasons resulted in inadequate regrowth 3 of 4 years at the TEAM Spurge site in northwest South Dakota. Fall programs also require a spring set-up treatment to prevent seeding. Reduced rate of 2,4-D is used; mowing where possible usually produces better fall regrowth. Initial data from a grass ROW site in Moody County in southeast South Dakota are presented below.

Fall applied Plateau and Tordon provided over 90% control 8 MAT. Very dry spring conditions reduced effectiveness of spring treatments. Tordon provided 76% control 12 MAT. Other treatments using lower rates of Tordon in combination with Plateau and 2,4-D reduced the stand about 50%.

4-Year Study:

Plots were established in an enclosed area in range in northwest South Dakota as part of the TEAM Spurge Project. Treatments were applied each year. Very dry conditions during the study period resulted in greater variability from year to year. Visual ratings for leafy spurge are shown on page 7.

Initial control (99) after 1 application exceed 90% for Tordon spot treatment, split Plateau and Krenite. All treatments gave at least 60% control after two treatment cycles (00) and exceeded 80% control after four annual applications (02). Low rate combinations, 2,4-D, and dicamba treatments were more effective over a shorter period of time than experienced in tests in eastern South Dakota under higher precipitation conditions.

FALL HERBICIDES
(Applied 10/4)

Treatment	Rate/A	% Control 8 MAT
Check	——	0
Plateau+ MSO+28% N	8 oz+ 1 qt+1 qt	97
Plateau+ MSO+28% N	12 oz+ 1 qt+1 qt	93
Paramount+MSO	8 oz+1 qt	20
Tordon	2 qt	99
2,4-D ester	3 qt	23
Tordon+2,4-D ester	1.5 pt+1 qt	83
LSD (.05)		*23*

SPRING HERBICIDES
(Applied 6/21)

Treatment	Rate/A	% Control 12 MAT
Check	——	0
Tordon+Plateau+ 2,4-D amine+MSO	1 pt+4 oz+ 1 qt+1 qt	50
Tordon+2,4-D amine	1 pt+1 qt	39
Tordon	1 qt	56
Tordon	2 qt	76
Plateau+ 2,4-D amine+MSO	8 oz+ 1 qt+1 qt	46
2,4-D ester	1 qt	23
Distinct+NIS	8 oz+.25%	21
LSD (.05)		*14*

10-Year Test:

Treatments in a heavily infested pasture in northeast South Dakota were applied annually. Plots were evaluated each year before treating. Visual leafy spurge ratings are presented on the following page.

Tordon spot treatment provided 96% initial control 12 MAT. However, control tended to diminish with 2,4-D ester maintenance treatment each succeeding year. Reduced rate of Tordon + 2,4-D reached 85% control after five annual applications. Using 2,4-D ester in spring/fall split application became more effective than using the same amount of 2,4-D in a single spring treatment. Spring glyphosate and dicamba treatments were less effective. Serious grass injury (data not shown) reduced competitiveness.

Biocontrol

Biocontrol of leafy spurge has evolved over a twenty-year period in South Dakota. Initially the leafy spurge hawkmoth *(Hyles euphorbiae)* were released and evaluated as a biocontrol agent. Control results and survival concerns of the hawkmoth larvae prompted changing to the *Aphthona* species or leafy spurge flea beetles. Four species were evaluated starting in 1988. The brown flea beetle *(Aphthona nigrisutis)* and the black flea beetle *(Aphthona lacertosa)* were the major species released across the state.

Cooperatively, the South Dakota Department of Agriculture, county weed and pest boards, and USDA/APHIS

South Dakota continued on page 8

LONG-TERM EVALUATION - 4-Year*

Treatment	Timing	Rate/A	1-Year % Lesp 6/99	2-Year % Lesp 5/00	3-Year % Lesp 5/01	4-Year % Lesp 6/02
Check	——	——	0	0	0	0
Tordon (1st yr) & 2,4-D ester	Spring & Spring	4 qt & 1.5 qt	84	60	75	83
Tordon+2,4-D ester	Spring	1.5 qt+1 qt	33	93	84	84
Banvel	Spring	1 qt	23	63	80	77
Distinct+X-77+28% N	Spring	16 oz+.25%+2 qt	31	73	90	84
2,4-D ester	Spring	3 qt	25	81	90	88
2,4-D ester & 2,4-D ester	Spring & Fall	1.5 qt & 1.5 qt	48	89	92	91
2,4-D ester & Tordon	Spring & Fall	1.5 qt & 1.5 pt	58	98	90	99
Plateau+Sun-It II+28% N & Plateau+Sun-It II+28% N	Spring & Fall	8 oz+1 qt+1 qt & 4 oz+1 qt+1 qt	94	99	99	99
Krenite	Spring	2 gal	89	97	93	99
Roundup Ultra+2,4-D ester	Spring	1 pt+1.5 qt	33	68	75	86
Roundup Ultra+2,4-D ester	Fall	1 pt+1.5 qt	18	63	25	82
Paramount+X-77+28% N	Spring	1 lb+.25%+2 qt	29	92	86	87
LSD (.05)			*12*	*12*	*17*	*7*

* TEAM Leafy Spurge - Harding County

South Dakota continued from page 7

organized a collection, distribution and release program from existing sites in 1993. To date, over 50 million leafy spurge flea beetles have been redistributed across the state at no cost to the county weed programs other than assisting with the collections. Other public agencies and private organizations have also provided landowners with flea beetles through organized collections. Through these organized efforts the biocontrol program for leafy spurge has become very successful slowing the spread of this noxious weed.

Darrell L. Deneke
SDSU Extension IPM Coordinator
Leon J. Wrage
Professor, Emeritus

LONG-TERM EVALUATION - 10 Year

Treatment	Product/A	Timing	Yr 1 % Lesp 6/92	Yr 2 % Lesp 6/93	Yr 3 % Lesp 6/94	Yr 4 % Lesp 6/95	Yr 5 % Lesp 6/96	Yr 6 % Lesp 6/97	Yr 7 % Lesp 6/98	Yr 8 % Lesp 6/99	Yr 9 % Lesp 7/00	Yr 10 % Lesp 8/01
Check	——	——	0	0	0	0	0	0	0	0	0	0
Tordon & 2,4-D es 4L	4 qt 1.5 qt	S'91 S'92-96	96	93	91	91	83	78	78	84	81	87
Tordon 2,4-D es 4L	1.5 pt 1 qt	Spring Spring	35	67	78	85	87	91	93	96	97	97
2,4-D 4L	3 qt	Spring	29	51	48	53	55	60	69	81	83	89
2,4-D es 4L 2,4-D es 4L	1.5 qt 1.5 qt	Spring Fall	38	48	58	75	70	82	90	94	96	97
Roundup 2,4-D es 4L	1 pt 1 pt	Spring Spring	43	32	38	45	58	25	25	25	55	95
Roundup 2,4-D es 4L 2,4-D es 4L	1 pt 1 pt 1.5 qt	S'91 S'91 S'92-96	10	27	33	40	38	38	45	54	28	65
2,4-D es 4L Tordon 2,4-D es 4L	1.5 qt 1.5 pt 1 qt	Spring Fall Fall	46	74	84	92	91	97	98	95	89	96
Tordon	2 pt	Spring	21	56	53	56	53	60	59	74	59	82
Banvel	1 qt	Spring	16	34	23	33	35	35	25	35	28	37
2,4-D es 4L Roundup 2,4-D es 4L	1 pt 1 pt 1 pt	Spring Fall Fall	25	44	50	75	63	68	90	90	68	81
LSD (.05)			15	13	10	11	12	12	12	12	13	17

* Marshall County, South Dakota 1991-2001

Status of Leafy Spurge in Nebraska

The leafy spurge infestation in Nebraska has declined from 360,000 acres in 1993 to 312,000 acres in 2003, according to state noxious weed survey. The Nebraska Noxious Weed Law, passed in 1989, mandates acreage data must be collected annually. Since enactment of this law, several organizations including, the Nebraska Department of Agriculture (NDA), Nebraska Weed Control Association (NWCA), Nebraska Noxious Weed Advisory Committee, Leafy Spurge Working Task Force, USDA-ARS, and University of Nebraska have worked together to find solutions to the leafy spurge problem.

Over the past 12 to15 years, research and demonstration projects have been undertaken that support the need for integrated approaches to control leafy spurge. Herbicides remain a critical part of the equation when it comes to managing leafy spurge. Tordon 22K, 2,4-D, Plateau, and glyphosate are the most commonly used herbicides. Since the mid-1990's there has been a concerted effort to use various biocontrol agents. There have been successful demonstrations where sheep and goats have been used to consume leafy spurge as a forage. The most popular biocontrol approach has been the use of flea beetles (*Aphthona lacertosa* and *Aphthona czwalinae*). The NDA, NCWSA, and Leafy Spurge Working Task Force have worked closely with USDA-APHIS, North Dakota State University, and USDI-Bureau of Reclamation to gain access to flea beetle release sites in North Dakota and collecting these agents and redistributing them to leafy spurge-infested sites in Nebraska.

This collaborative effort has resulted in the release of several million flea beetles across Nebraska. Currently, insect survival and population growth has been so phenomenal on some of these Nebraska sites that they now serve as insectaries from which flea beetles are collected annually and moved to other leafy spurge infestations. The program has grown to the point where there are about 559 release sites in 36 Nebraska counties. It appears that the release of *Aphthona lacertosa* has been the most successful in terms of insects established and leafy spurge stand reductions. This species (in most cases) over winters well and reproduces large numbers of insects. Control has been sporadic with excellent reduction of plant density on some sites while smaller populations of flea beetles are sustained on other sites, but do not appear to be expanding and have little apparent impact on leafy spurge. Monitoring release sites has been one of the biggest challenges. Some counties require landowners to monitor and redistribute insects. Those counties have experienced good leafy spurge control while providing excess flea beetles for collection and release at other sites.

The Leafy Spurge Working Task Force continues to be a vital force for invasive plant control in Nebraska grasslands. The Task Force has annual meetings in which are incorporated field tours to demonstrate various control measures on a variety of invasive plants, including leafy spurge, which threaten Nebraska wildlands. Among the species highlighted in recent meetings include, saltcedar, yellow bedstraw, phragmities, and purple loosestrife. Although leafy spurge is here to stay, the Nebraska Noxious Weed Program and productive collaborations between governmental and non-governmental organizations has resulted in a decline in leafy spurge populations in Nebraska.

Bob Masters
Rangeland Scientist, Dow AgroSciences, LLC
and
Mitch Coffin
Noxious Weed Program Manager,
Nebraska Department of Agriculture

Abstracts

TEAM Leafy Spurgy Symposium at the Society for Range Management 2004 meeting

Comparison of hyperspectral and multispectral remote sensing for leafy spurge

Raymond Hunt and Amy P. Williams*

Leafy spurge *(Euphorbia esula L.)* has distinctive yellow-green bracts during flowering which can be detected and located using remote sensing as part of an integrated pest management strategy. Hyper-spectral remote sensing utilizes a hundred or more narrow, contiguous bands to obtain a reflectance spectrum, which is analyzed using techniques such as Mixture Tuned Matched Filtering. Multispectral sensors have a few broad bands, and are found on many operational satellites. Previous work has shown that a hyperspectral sensor, NASA's Airborne Visible Infrared Spectrometer (AVIRIS), was highly successful in detecting leafy spurge presence and amount at study sites near Devils Tower National Monument in northeastern Wyoming. Landsat 7 Enhanced Thematic Mapper Plus (ETM+) and SPOT multispectral imagery were aquired within a week after the AVIRIS overflight. Both images were atmospherically corrected using pixels in deep shadow and on the scree slope of Devils Tower. Multispectral indices based on the reflectance spectrum of leafy spurge bracts were not correlated to leafy spurge cover measured on the ground. Furthermore, maximum-likelihood supervised classifications based on training areas with leafy spurge and unsupervised classifications were not better than random chance. Whereas, leafy spurge can be located from the interpretation of high-spatial-resolution color infrared photography, automated methods to detect leafy spurge over large areas requires the use of hyperspectral remote sensing.

Application of eCognition to enhance the classification process for mapping leafy spurge

Monica Ruiz-Bustos, Carol S. Mladinich, Susan F. Stitt, Ralph R. Root, Gerald L. Anderson and Steve N. Hager*

The software eCognition follows a new, object oriented approach toward image analysis. It does not classify single pixels, but rather image objects extracted in a previous segmentation step. We are evaluating this software to map leafy spurge in the south unit of Theodore Roosevelt National Park. The results obtained with Landsat7 ETM+ data have an accuracy of 59%, slightly lower than the results obtained with previously available software. Nevertheless, it is a good tool to obtain a quick, meaningful classification of the whole region into known land cover types. Classification with CASI data is underway, this data has a higher spatial resolution and is more suitable for use with eCognition.

The use of Earth Observing-1 Advanced Land Imager (ALI) data for mapping leafy spurge

Susan F. Stitt, Ralph R. Root, Karl E. Brown, Steve N. Hager, Carol S. Mladinich, Gerald L. Anderson, Kathleen B. Dudek, and Raymond F. Kokaly*

Leafy spurge *(Euphorbia esula L.)* is an invasive exotic plant that can completely displace native plant communities. Automated techniques for monitoring the location and extent of leafy spurge, especially if available on a seasonal basis, would add greatly to the effectiveness of control measures. This study examines the utility of mapping the location and extent of leafy spurge in Theodore Roosevelt National Park using Earth Observing-1 satellite Advanced Land Imager (ALI) scanner data. An unsupervised classification methodology was used producing accuracies in the range of 59% to 66%. This methodology could be useful for broad, landscape scale, mapping efforts from which control measures can be based.

Issues of ortho-rectification of multi-source imagery for the mapping of leafy spurge

Carol S. Mladinich, Thomas Owens, Gerald L. Anderson, Steve N. Hager and Ralph R. Root*

Airborne imaging spectroscopy data is progressing from concentrating on investigations of spectral properties to the use of the technology for operational applications. In order to effectively validate classification results, geocoding techniques need to be refined to handle localized geometric artifacts and provide for terrain correction of the data. If the data are to be merged with other types of geodata to perform geo-spatial analysis and assess classification accuracy, the locational problems need to be minimized. However, the geometric distortions inherent in airborne sensors cannot be easily corrected using traditional ground control, point-based, polynomial transformations. This paper discusses a method that geo-rectifies and terrain-corrects Advanced Visible/Infrared Imaging Spectrometer (AVIRIS) and Compact Airborne Spectrographic Imager (CASI) data. Results from the corrected data will help characterize the relative extent of leafy spurge (Euphorbia esula L.), an invasive weed, which is a major problem in much of the upper Great Plains region, which includes parts of Montana, South Dakota, North Dakota, Nebraska, and Wyoming. This work was completed to support a broader U.S. Geological Survey project investigating mapping and monitoring techniques of leafy spurge from multi-sensor image data in Theodore Roosevelt National Park (TRNP) in southwestern North Dakota.

Abstracts

TEAM Leafy Spurgy Symposium at the Society for Range Management 2004 meeting

The Ecological Areawide Management (TEAM) of Leafy Spurge

Gerald L. Anderson, Chad W. Prosser and Robert D. Richard*

The Ecological Areawide Management (TEAM) of Leafy Spurge program was developed to focus research and control efforts on a single weed, leafy spurge, and demonstrate the effectiveness of a coordinated, biologically based, integrated pest management program (IPM). This was accomplished through partnerships and teamwork that clearly demonstrated the advantages of the biologically based IPM approach. However, the success of regional weed control programs horizontally across several states and provinces also requires a vertical integration of several sectors of society. Awareness and education are the essential elements of vertical integration. Therefore, a substantial effort was made to produce a wide variety of informational products specifically designed to educate different segments of society. During its tenure, land managers and agency decision makers have seen the potential of using the TEAM Leafy Spurge approach to accelerate the regional control of leafy spurge. The example set by the TEAM Leafy Spurge organization and participants is viewed as a model for future weed control efforts.

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seeded to perennial grasses and the flea beetles became abundant.

The Wet-Blade mower was tested starting in 1997 and we found that 1 quart of Tordon worked as well as areas that were conventionally sprayed with 2 quarts of Tordon. Wet-Blade mowing worked best when mowing was done leaving an 8 to 10 inch stubble because there was less biomass under the mower to bind with the herbicide. Plateau applied at 5 to 6 fluid ounces/acre was equal to 8 to 10 ounce applications done with a conventional sprayer. The Burch Company making the mower has been acquired by the Diamond Mower Company in South Dakota and the mowers are now available new from that company.

All of the tests that the University of Wyoming conducted from 1982 to present can be best summarized in one statement. Leafy spurge control is only long-term when a systems approach is used and becomes sustainable when perennial grass competition becomes the final goal. The perennial competition must be maintained with chemicals, insects, sheep or goats, reseeding and proper grazing.

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Leafy Spurge Control in Wyoming

It is with mixed emotions that I write this article for the last leafy spurge newsletter. The good feeling comes when I think about all that has been accomplished in the last 25 years for best management practices developed for leafy spurge. The sadness comes from seeing our team member's move to other areas of focus.

When I think about the research at the beginning of the project I realize that we were trying to use annual cropland weed management technology for control of perennial weeds in a perennial ecosystem that needs a long-term approach. We tested Tordon, Banvel, 2,4-D, Escort, Telar, Roundup, Paraquat, Starane, and Plateau at every growth stage, for perennial grass tolerances, and in every rate and combination that we could imagine. We had over 1000 test plots at the Wyoming Leafy Spurge Test Ranch in 1986. We found our best long-term control came from areas treated with Tordon and Plateau at 1-2 quarts/acre and 8-10 fluid oz./acre, respectively for those two products. Controls were greatest and lasted longer when areas had good stands of perennial grass in the understory which were then released and became competitive. I also noticed that established perennial grasses such as quackgrass and smooth bromegrass prevented leafy spurge from ever starting. From this research we could see that competition from desirable perennial grasses was critical for long-term control. Mark Ferrell and I decided that competition was important enough that we needed to establish testing on different varieties of perennial grass in 1986. We found that Bozoisky Russian Wildrye and Luna Pubescent Wheatgrass established best and became competitive on dryland sites one to two years after seeding. Prior to seeding two 1 qt. applications of Roundup were applied in May and June followed by rototilling to prepare a seed bed. Grasses were seeded in late August. In addition to grass establishment we started doing proper grazing trials to enhance perennial grass stands for maximum competition. We found that grasses remained most competitive when grazing occurred after the grasses had gone to seed.

The leafy spurge flea beetle was introduced in our test area in 1989 and became well established. Six years later we had excellent leafy spurge control in areas that had been

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