A weed education program, and the biology and control of spotted knapweed (Centaurea maculosa Lam.) in Montana
by Celestine Ann Lacey

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Agronomy
Montana State University

Abstract:
Leafy Spurge (Euphorbia esula L.) and spotted knapweed (Centaurea maculosa Lam.) are introduced perennial weeds infesting over 1.1 million hectares of range and pastureland in Montana. In an effort to stop the spread of these weeds, a statewide weed education program was expanded in 1983; and research was initiated on the biology and control of spotted knapweed in Montana.

The educational program utilized newsletters, demonstration plots, field tours, and a ransom program to increase awareness and disseminate information on leafy spurge and spotted knapweed. Herbicide demonstration plots and field tours provided information on weed identification, control, and sprayer calibration. A ransom program was initiated in Sweetgrass County, Montana in 1984. The program led to increased public awareness and control of existing spotted knapweed infestations. The effectiveness of the weed education program was evaluated by surveying landowners in four counties. Results of the survey indicated that landowners attending tours were more aware of the weed problem than those that did not attend tours. The number of landowners utilizing weed control practices was also greater among tour participants.

The effect of low rates of picloram (4-amino-3,5,6-tri-chloropicolinic acid) and picloram in combination with 2,4-D ((2,4-dichlorophenoxy)acetic acid) on controlling spotted knapweed was evaluated at two locations in Montana. All rates of picloram significantly reduced spotted knapweed density compared to the control. The persistence of picloram in the soil determines the length of control of spotted knapweed. The reduction of spotted knapweed density resulted in forage increases of 200 to 770 percent.

Differential tolerance to 2,4-D was observed in spotted knapweed in field experiments conducted at two locations in Montana. When plants from both locations were grown under identical condidtions in the field, there was no difference in response to 2,4-D. Laboratory studies indicate that uptake and translocation of 14C 2,4-D was the same in both strains of spotted knapweed. The observed tolerance to 2,4-D in the initial field studies appears to be the result of differences in plant vigor.

The longevity of viability of spotted knapweed seed in the soil was studied from 1982 through 1984. Results of the seed burial study showed that less than 50 percent of the seed had germinated two years after burial. In field studies, about 65 seed per 0.5 m2 remained viable in soil 26 months after seed production was stopped.

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This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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ABSTRACT

Leafy Spurge (Euphorbia esula L.) and spotted knapweed (Centaurea maculosa Lam.) are introduced perennial weeds infesting over 1.1 million hectares of range and pastureland in Montana. In an effort to stop the spread of these weeds, a statewide weed education program was expanded in 1983; and research was initiated on the biology and control of spotted knapweed in Montana.

The educational program utilized newsletters, demonstration plots, field tours, and a ransom program to increase awareness and disseminate information on leafy spurge and spotted knapweed. Herbicide demonstration plots and field tours provided information on weed identification, control, and sprayer calibration. A ransom program was initiated in Sweetgrass County, Montana in 1984. The program led to increased public awareness and control of existing spotted knapweed infestations. The effectiveness of the weed education program was evaluated by surveying landowners in four counties. Results of the survey indicated that landowners attending tours were more aware of the weed problem than those that did not attend tours. The number of landowners utilizing weed control practices was also greater among tour participants.

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PREFACE

Weeds are becoming a major threat to the productivity of rangeland in Montana. The two most troublesome weeds include leafy spurge (Euphorbia esula L.) and spotted knapweed (Centaurea maculosa Lam.).

Both weeds have a major impact on cattle carrying capacity of rangeland. Leafy spurge and spotted knapweed reduce the carrying capacity by up to 75 and 90 percent respectively (Alley et al., 1984; Chicoine, 1984). The cost to the cattle industry in Montana is approximately $5.9 million in lost forage production (French and Lacey, 1983; Reilly and Kaufman, 1979).

The following thesis examines the use of an educational and research program on leafy spurge and spotted knapweed. The major emphasis of the thesis work included:

(1) A public education program was expanded in 1983 in an effort to increase awareness and control of leafy spurge and spotted knapweed. The effectiveness of the program was evaluated.

(2) Chemical control of spotted knapweed with 2,4-D and picloram was evaluated in an effort to determine the optimum herbicide rate necessary to control spotted knapweed.

(3) The longevity of viability of spotted knapweed seed in soil has not been determined. Studies were continued to determine the length of time spotted knapweed seeds remain viable in soil under natural and buried conditions.

PART 1

THE LEAFY SPURGE AND SPOTTED KNAPWEED

PUBLIC EDUCATION PROGRAM

CHAPTER 1

LITERATURE REVIEW

Introduction

Leafy spurge (Euphorbia esula L.) and spotted knapweed (Centaurea maculosa) are the two most troublesome range weeds in Montana. Leafy spurge currently infests over 221,632 ha of rangeland in the state (Noble et al., 1979) and can reduce cattle carrying capacity 50 to 75 percent (Alley et al.,1984). The extensive root system and vegetative buds of leafy spurge make it difficult to eradicate by chemical, cultural or mechanical means (Dunn, 1979; McIntyre, 1972).

Spotted knapweed currently occupies about 890,000 ha of rangeland in Montana (Harris and Cranston, 1979), and an additional 13.8 million ha are susceptible to spotted knapweed invasion (Bucher, 1984). The weed reduces carrying capacity by as much as 90 percent on severely infested sites and can spread rapidly because it contains an allelopathic chemical which inhibits the growth of competing plant species (Flecther and Renney, 1963).

Factors which lead to an increase of weeds on range land are: 1) the inability of ranchers to correctly identify noxious weeds and 2) ignorance of the potential threat the invading plants pose to livestock production (Barreto and Fay, 1983). In addition, many ranchers in Montana do not have experience with herbicide application. The key to controlling both leafy spurge and spotted knapweed is to educate

landowners to the importance of early detection of invasion and subsequent treatment.

Extension Techniques

Effective educational programs help bridge the gap between agricultural producers and research results (Myren, 1964; Bradfield, 1966). The information presented must meet the needs and interests of all classes of producers from innovators to late adopters and laggards (Bohlen et al., 1962).

Audio -Visual Techniques

Mass media techniques, such as radio and television, are useful for reaching large numbers of people about agricultural concerns (Dale, 1954; Kelsey and Hearne, 1963; Awa and Van Crowder Jr., 1978). These techniques are suited to increasing overall public awareness of agriculture (Coleman et al., 1962), as well as providing specific information to agricultural producers (Brown and Collins, 1978; Rockwell, 1984). Changes in marketing, planting, and harvesting strategies have been attributed to specific radio and television programs (Kroetz and Cole, 1978; Rockwell, 1984).

Computers are useful educational tools. There are simplified computer programs which make current technical information readily available to county extension agents and agricultural producers (Chase, 1984; Harrison and Rades, 1974; Paisley, 1983). These programs provide easy access to current information on marketing, weather, and production technology. Computer-based videotext information delivery systems are suitable for problem-solving and decision-making tasks with specific information requirements (Paisley, 1983).

Computer programs have been developed which simulate agricultural situations (Amend, 1985). Some of these programs have been used to educate adults and young people about the value of agriculture.

Demonstration Plots and Group Meetings

Field Demonstration plots are effective tools to show new agricultural practices since visual comparisons of various treatments can be made easily (Barreto and Fay, 1983; Cunningham and Simeral, 1977; Witt, 1968). To be most effective, demonstration plots should be established at numerous locations since environmental conditions can effect results.

Group meetings such as symposiums, workshops, seminars, field tours, or formal classes offer an opportunity for farmers and ranchers to discuss specific problems with research and extension personnel (Barreto and Fay, 1983). Involving local producers increases interest and acceptance of new techniques (Witt, 1968). The quantity and quality of publicity that precedes a program has a major impact on the size of the audience (Barreto and Fay, 1983; Cunningham and Simeral, 1977; Bradfield, 1966).

Written Communication

Bulletins, flyers, newsletters, and circulars are an effective way to create interest, publicize events and dispense information (Bradfield, 1966; Myren, 1964; Awa and Van Crowder, 1978). To be effective, the written material must be concise and meet the needs and interests of the reader (Kelsey and Hearne, 1963; Reisbeck, 1980).

Printed media appears to be more effective than audio-visual communication for reaching specific audiences (Awa and Van Crowder, 1978). Bulletins, short pamphlets and newsletters were more effective than television and radio in reaching low income families (Awa, 1974). Dairy farmers in New York state ranked printed media higher than radio, television or interpersonal visits as the most effective extension communication effort (Awa and Van Crowder Jr., 1978).

Newsletters are a preferred form of written communication if concise, well written and pertinent (Brown and Collins, 1978; Kelsey and Hearne, 1963; Reisbeck, 1980; Harshman, 1981). Important articles in newsletters should be headlined to gain the attention of the reader (Harshman, 1981; Reisbeck, 1980).

Evaluation of Delivery Systems

Mailed questionnaires have become a popular method for collecting survey data. Not only are they cheaper than interpersonal surveys, but recent improvements in procedures for conducting mail surveys suggest that limitations of this method (such as low response rates and dependence on short questionnaires) can be overcome (Dillman, 1978).

The mail questionnaire must be well designed to obtain answers from survey participants. The content of the survey, rather than the length, paper color, or amount of personalization, appears to determine response rate (Dillman, 1978). Follow-up letters to mailed surveys have been used effectively to increase response rates (Kanuk and Berenson, 1975).

The effectiveness of various communication channels for transferring agricultural information has been measured by surveying

agricultural producers and researchers (Adams and Parkhurst, 1984; Awa and Van Crowder Jr., 1978). These surveys indicated that farming strategies would be improved if the most efficient delivery system was selected (Adams and Parkhurst, 1984).

The effectiveness of a given communication method varies according to the size of an individual farmer's production unit (Adams and Parkhurst, 1984). In addition, the means of communication which is most effective is dependent upon the type of subject matter being delivered (Brown and Collins, 1978). For example, the primary source of production information for large commercial farms is the Cooperative Extension Service and the university system. Radio was the most effective media for business and management information (Brown and Collins, 1978). Farm magazines were the most important source of agricultural information for farmers in Nebraska (Jaeger and Reifschneider,1965; Adams and Parkhurst, 1984). However, those farming large acreages in Nebraska rated farm journals higher than those managing smaller acreage (Adams and Parkhurst, 1984).

Income level also affects communication channel effectiveness. Bulletins, flyers and newsletters were more effective than audio-visual media for low income families (Awa, 1974). Experiment station bulletins were rated higher as information channels for those in the middle and upper income levels (Adams and Parkhurst, 1984).

Summary

Spotted knapweed and leafy spurge are the most troublesome range weeds in Montana. The key to controlling both weeds is to educate

landowners so that early identification and control of pioneer infestations occurs.

A variety of techniques should be utilized to educate landowners. Audio-visual techniques including radio and television will increase public awareness of the problem. Field tours and demonstration plots will permit landowners to view and record the results of various practices and permit attendees to interact with researchers and extension personnel. Newsletters, extension bulletins and circulars can provide interested persons with accurate information about specific problems. Mail surveys can be utilized to obtain information about the effectiveness of various communication techniques. Utilizing the most effective communiction methods can save money by allowing educators to key in on specific audiences.

CHAPTER 2

EXTENSION TECHNIQUES

Abstract

An on-going statewide weed education program was expanded in 1983. The objectives of the program were to continue the leafy spurge awareness effort started in 1980, and initiate a similar effort on spotted knapweed. Newsletters, herbicide demonstration plots, field tours and a ransom program were techniques utilized to meet the objectives. Leafy spurge and spotted knapweed newsletters provided information on current research programs and research results to agricultural producers, researchers, and extension specialists. Field plots were established at twenty-two locations to demonstrate herbicide efficacy. Field tours were held in twenty-six locations. The tours included information on the biology and control of leafy spurge and spotted knapweed, herbicide efficacy, and sprayer calibration. A ransom program on spotted knapweed was initiated in Stillwater County, Montana. The ransom program led to increased awareness of spotted knapweed, control of existing knapweed infestations, and compilation of a map delineating existing spotted knapweed infestations. The overall education program increased public awareness of leafy spurge and spotted knapweed, established long-term demonstration plots, and served as the catalyst for several localized weed action projects.

Introduction

Leafy spurge and spotted knapweed are major threats to the productivity of range and pastureland in Montana. The key to controlling both weeds is early detection and treatment. Thus, in 1983, an educational program was initiated to help decrease the rate of spread of leafy spurge and spotted knapweed in the state. The overall objective was to increase public awareness of spotted knapweed and leafy spurge. Specifically, the leafy spurge newsletter was continued and a newsletter on spotted knapweed was initiated, a ransom program was started, demonstration plots were established, and field tours were conducted.

Communication techniques must be effective to tranfer technological advances to agricultural producers. Newsletters are a preferred form of written communication if they are concise and relate to the needs and interests of the receiver (Awa,1974, Brown, 1978, Kelsey, 1963, and Reisbeck 1980. Barreto (1982) utilized a newsletter to increase public awareness, coordinate research and provide information to people interested in leafy spurge control.

Demonstration plots are an effective educational tool (Cunningham and Simeral, 1977), if the practices being demonstrated provide practical solutions to local problems (Kelsey and Hearne, 1963). This allows agricultural producers to view and record the results of various treatments under local environmental conditions (Witt, 1968). Field tours held at demonstration sites provide an informal setting where farmers and ranchers can discuss production problems with extension specialists and researchers (Barreto and Fay, 1983). However, field

tours must be carefully planned to meet the needs and interests of producers (Kelsey and Hearne, 1963) and be well advertised to be effective (Cunningham and Simeral, 1977).

Materials and Methods

Newsletters

Leafy Spurge Newsletter: Publication of the Leafy Spurge Newsletter was continued on a quarterly basis. The general format and methodology for printing the newsletter was described by Barreto (1982).

Knapweed Update: A letter was sent to researchers and extension specialists in Idaho, Washington, Oregon, Montana, British Columbia, and Alberta in September, 1983 to determine if there was a need for a newsletter about the knapweeds. These specialists provided suggestions for the format of the newsletter and names of extension agents, researchers, politicians, weed supervisors, and agricultural producers for the initial mailing list. A mailing list was stored on a computer disk and updated monthly as requests for the newsletter were received. The art work for the letterhead and return address was developed and a silkscreen of the drawing was produced by the photographic department at Montana State University. The letterhead and return address was printed by the Multilith Department.

Researchers and extension specialists were contacted for contributions one month prior to printing the newsletters. The articles were summarized, typed, and sent to the Multilith Department for printing onto the letterhead paper.

Demonstration Plots and Field Tours

Herbicide treatments were applied to spotted knapweed or leafy spurge at twenty two sites in June, 1983 and 1984 (Figure 1). Site locations were selected by county extension agents, weed supervisors and chemical company representatives. The sites were easily accessible and located near population centers when possible. Picloram, (4-amino-3,5,6-trichloropicolinic acid), dicamba (3,6-dichloro-o-anisic acid) and 2,4-D [(2,4-dichlorophenoxy) acetic acid] were applied to plots at each site. The treatments were not replicated. Individual plot size varied from 6.6 X 26.6 meters to 6.6 X 36.3 meters. The herbicide rates and application timing were recommended by weed specialists at Montana State University, chemical company representatives, and county extension agents. Retreatments were made on a portion of the plots in 1984. A detailed description of herbicide demonstration plots at each location is shown in Appendix B. Twenty six field tours were held in 1983 and 1984 (Figure 1). Eighteen of the tours were held at herbicide demonstration locations established in 1983 and 1984. The remainder of the tours were held at locations which contained experimental plots that were previously established (Barreto, 1982).

Local landowners, county extension agents, weed supervisors, and state and federal employees helped plan and execute the educational program. This integrated approach helped improve public relations and increased the overall effectiveness of the program.