

A New Era of Biological Weed Control in the Western United States

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Abstract

In recent years there has been a dramatic increase in interest, public support, and research activity in biological weed control in the Western Region of the United States. The marginal economic aspects associated with much of our rangeland, the limited effectiveness, increasingly high cost, concern for environmental impact, and the physical and legal limitation on the use of herbicides have fostered support for, and encouraged the development of, biological weed control programs within the between States. With the increase in cooperation between States, Federal biological control laboratories/agencies, and international biological weed control organizations and with the addition of a new insect quarantine facility at Montana State University in Bozeman, Montana, scheduled for completion in 1987, activities in biological weed control will reach greater heights than previously possible.

Ère Nouvelle dans la Lutte Biologique Contre les Plantes Nuisibles dans l'Ouest des États-Unis

Depuis quelques années l'ouest des États-Unis manifeste un intérêt de plus en plus marqué pour la lutte biologique contre les plantes nuisibles et intensifie les recherches dans ce domaine. Les aspects économiques marginaux de l'exploitation des pâturages, l'inefficacité, les restrictions d'utilisation, les coûts élevés et les préoccupations concernant les effets des herbicides sur l'environnement sont autant de facteurs qui nous ont portés à appuyer et à encourager les programmes de lutte biologique contre les plantes nuisibles mis en oeuvre dans les états soit séparément soit en collaboration les uns avec les autres. Pour la première fois, divers états subventionnent le rassemblement à l'étranger d'ennemis naturels des plantes nuisibles et les essais de sélection. Grâce à la construction d'une nouvelle installation de quarantaine des insectes à l'université du Montana à Bozeman, Montana, qui devrait être terminée en 1987, et à l'aide de APHIS/PPQ, un organisme de l'USDA qui se chargera de la redistribution des ressources dans l'ouest des États-Unis, la lutte biologique contre les plantes nuisibles réalisera des progrès sans précédent.

Introduction

In recent years there has been a dramatic increase in interest, public support, and research activity in biological weed control in the Western Region (Washington, Oregon, California, Idaho, Utah, Montana, Wyoming) of the United States. A number of factors have contributed to this change. The invasion and infestation of much of our rangeland by leafy spurge, *Euphorbia pseudovirgata* (*sensu* Ebke & McCarty) (Euphorbiaceae) (= former *E. esula* L.), and spotted and diffuse knapweed, *Centaurea maculosa* Lam. and *C. diffusa* Lam. (Compositae), respectively, have resulted in the reduction of

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favorable forage species and contributed to substantial losses in range productivity (Harris and Cranston 1979; Maddox 1979; Messersmith and Lym 1983). The consequences of reduced range productivity, the low market price for range livestock, and the slim profit margin realized per acre by the ranchers have put a premium on more economically feasible weed management strategies such as biological control (Maddox 1979; D. Woolworth, pers. comm., 1984). Furthermore, conventional weed control strategies such as chemical and cultural control, when applied in an economically feasible fashion, have proven ineffective in controlling some of our more noxious weeds of rangeland such as leafy spurge. As an example, conventional control efforts directed against well-established infestations of leafy spurge generally have resulted in only containment at best (B. Maxwell, pers. comm., 1984). The limited effectiveness (Lym and Messersmith 1983), increasingly high cost (Harris 1971; Maddox 1979; Schroeder 1983), concern for potential environmental consequences (Reichelderfer 1981; Andres and Clement 1984), and the physical and legal limitations on the use of herbicides have fostered support for, and encouraged the development of, biological weed control programs and/or projects within and between states. In recent years, faculty positions with responsibilities in biological weed control have been added to universities in Washington, Oregon, Idaho and Montana, with the associated development of respective biological weed control programs. In addition, the active participation by State Departments of Agriculture and the monetary support from the Forest Service have further signaled increased activity in biological weed control in the Western Region.

Historical Development of Biological Weed Control in the Western Region

In tracing the historical development of biological weed control in the Western Region of the United States, one can cite the USDA and the University of California as being principally responsible for the initiation of biological control efforts against Klamath weed, *Hypericum perforatum* L. (Clusiaceae), during the mid-1900s and tansy ragwort, *Senecio jacobaea* L. (Compositae), during the 1960s. Initial responsibilities included collection, screening (host range and specificity tests), propagation, introduction and distribution of weed natural enemies. In addition, the USDA initiated numerous other projects on scotch broom, *Cytisus scoparius* (L.) Link. (Leguminosae), gorse, *Ulex europaeus* L. (Leguminosae), Italian thistle, *Carduus pycnocephalus* L. (Compositae), yellow starthistle, *Centaurea solstitialis* L. (Compositae), Mediterranean sage, *Salvia aethiops* L. (Labiatae), dalmation toadflax, *Linaria dalmatica* (L.) Mill. (Scrophulariaceae), and other weeds during the late 1950s and early 1960s. With the early success realized in the biological control of prickly pear cactus, *Opuntia* spp. (Cactaceae), in Australia and Klamath weed in California, biological weed control became more and more respected as a viable weed management practice in rangeland. As new biological control projects were launched against leafy spurge, musk thistle, and spotted knapweed during the late 1960s and early 1970s the USDA's efforts were augmented by State cooperators who began to play an active role in the release and redistribution of natural enemies. As interest and activities in biological weed control grew, State cooperators began to meet annually with USDA personnel as participants of the Regional Research Project on Biological Control (W84), for purposes of coordinating research activities for biological control of insects and weeds.

Another important recent development has been the allocation of regional Cooperative State Research Service (CSRS) monies to the USDA Western Region, designated for purposes of developing and coordinating biological control activities for weeds of rangeland. In 1982, a Regional Biological Control of Weeds Committee was

formed and consisted of USDA and State scientists from the western U.S., including Hawaii. Since that time, biological control personnel and weed scientists from the Western Region have had annual meetings to develop optimal plans for the utilization of these CSRS resources and the coordination of biological weed control activities. Some of the biological control projects funded to date by CSRS include: (1) rearing and redistribution efforts for insects attacking leafy spurge, spotted and diffuse knapweed, musk thistle, *Carduus nutans* L., Canada thistle, *Cirsium arvense* (L.) Scop., and dalmation toadflax; (2) collection and screening of insects and/or pathogens of leafy spurge and spotted knapweed; (3) a four-State (Washington, Oregon, Idaho, Montana) regional distribution and impact study of the seed-head flies, *Urophora affinis* Frld. and *U. quadrifasciata* (Meig.) (Diptera: Tephritidae) on spotted knapweed seed production, plant biomass and plant density; and (4) a regional leafy spurge taxonomic effort utilizing the latest cytogenetic, chemical, and morphological taxonomic techniques and plant material from all western States with infestations of leafy spurge. In addition, the USDA Agricultural Research Service (ARS) has provided funding through cooperative agreement grants, for the collection and screening of insects and/or pathogens of leafy spurge, musk thistle, and yellow starthistle and for taxonomic studies of the European 'spurge' complex.

Another development that has helped increase the number of agents collected and screened for release against rangeland weeds has been the monetary contribution from States to the USDA and Commonwealth Institute of Biological Control (CIBC) foreign collection programs. To date, monetary contributions from Oregon, California, Idaho, Montana, Wyoming, and South Dakota have helped expedite the collection and testing of weed natural enemies and have helped insure that there are adequate numbers of natural enemies for release.

State support for biological weed control has taken other forms as well. The Montana Legislature in the last biennial session awarded \$5.3 million to Montana State University at Bozeman to build a new Plant Growth Center and Insect Quarantine Facility, scheduled for completion in 1987. The new Plant Growth Center will give us year-round capabilities for growing plant material to sustain and propagate weed natural enemies and minimize the reliance on artificial diets. The Insect Quarantine Facility will complement the ongoing biological weed control activities at the USDA Biological Control of Weeds Laboratory in Albany, California. We will be able to aid them in freeing natural enemies of parasites and diseases and help in natural enemy host range and specificity tests on native plants from the region in which they will be released. We also will be able to rear actively weed control agents right out our back door under the environmental conditions and using plant material on which they will ultimately have to survive. The general intent of the Insect Quarantine Facility is to enhance biological control efforts in Montana and provide a regional natural enemy rearing service to States in the Western Region that share similar weed problems.

Another exciting development has been the desire expressed by APHIS/PPQ to actively participate in future rearing and redistribution of natural enemies of weeds in rangeland. This agency has already undertaken a project to locate spotted knapweed infestations using remote sensing techniques to target populations of the weed for later seed-head fly redistribution. The agency has also expressed an interest in possibly locating some of their personnel at Bozeman, Montana, to concentrate on rearing and redistribution of natural enemies on weeds in the Western Region.

And lastly, the increase in cooperation between States, Federal USDA laboratories/agencies and international biological control organizations has enhanced our abilities to: (1) receive and handle weed natural enemies; (2) document natural enemy impact

and coordinate redistribution efforts on a regional basis; (3) better understand the type of weed problems we are faced with (through taxonomic and biological studies); (4) improve our chances of finding promising new natural enemies of weeds — both insects and plant pathogens; and (5) expedite host range and specificity testing of potential control agents on economically important plants and other desirable flora.

The USDA Biological Control of Weeds Laboratory in Albany, California, has played a vital role in screening, rearing, and distributing insect natural enemies of weeds to States in the Western Region. The development of improved communications between the States and this facility has helped us better plan for the receipt of new natural enemies and has allowed us to better synchronize the control agents with the appropriate stages of the weed. Through USDA/ARS Cooperative Agreement Projects with the Albany Laboratory and the USDA Plant Disease Research Laboratory, in Frederick, Maryland, States in the Western Region played an early role in the direction of biological control activities for the survey, collection, and screening of arthropod natural enemies of rush skeleton weed (*Chondrilla juncea* L.; Compositae) (Albany facility) and more recently for plant pathogens (Frederick facility) and insect natural enemies of yellow starthistle and leafy spurge.

International biological control agencies have also been helpful in the biological control of weeds effort. Agriculture Canada, primarily through the efforts centered at Regina, Saskatchewan, and the Albany Biological Control of Weeds Laboratory routinely apportion the various natural enemies destined for host-range and host-specificity testing to minimize unnecessary duplication and maximize the number of agents screened. The biological control laboratory at Regina has also been helpful in sending agents approved for release to States in the Western Region of the United States. Analogous to the relationship that has developed between the Albany and Regina biological control of weeds laboratories, the USDA Biological Control of Weeds Laboratory in Rome, Italy, CIBC, located in Delemont, Switzerland and the Australian Commonwealth Scientific and Industrial Research Organization (CSIRO) at Montpellier, France, have similarly delineated and coordinated their biological control activities. All three international laboratories have contributed greatly to the biological weed control effort in the Western Region. CIBC is currently involved in a project with Montana, CSRS, and Agriculture Canada to collect and determine the host range and host-specificity of key insects that attack spotted and diffuse knapweed. The Rome laboratory, in addition to their usual responsibilities of surveying, collecting, and screening of natural enemies of weeds, also have been helpful in collecting European leafy spurge plants, as has CIBC, in a cooperative effort with Montana, Agriculture Canada, domestic USDA laboratories, and other cooperating scientists to clarify taxonomically the European 'spurge' complex. In addition, CSIRO at Montpellier, France, was instrumental in the collection and/or screening of arthropod and pathogen natural enemies released against rush skeleton weed in Washington, Oregon, and Idaho. And lastly, another international cooperator that has recently become involved in a cooperative agreement project with the USDA Plant Disease Research Laboratory and Montana State University is the Institute für Phytomedizin in Zurich, Switzerland. Plant pathology researchers at this Institute are currently involved in the active search for plant pathogens of leafy spurge. They are currently conducting host-range and host-specificity tests on a promising systemic rust, *Uromyces scutellatus* (Uredinales), that attacks both leafy and cyprus spurge, *E. cyparissias* L. This Institute as well will be cooperating in the collection of European 'spurges' for taxonomic purposes, with the idea being that once we understand the extent of hybridization of this complex of plants then we may be able to match the type of plants that the natural enemies are collected

from with similar plants in North America and thus more appropriately match up the natural enemies.

With all the cooperation and increased research activity that has developed in recent years between State, Federal, and international organizations, the framework and stage has been set for new advances in biological weed control.

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