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Biological control of leafy spurge: Stress factors, selection and evaluation of natural enemies

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Biological weed control programs are being analyzed to determine new techniques to select and evaluate agents. Few studies on the effect of the agents on the weed prior to release have been made, and in this report, several aspects of physiological and stress factors are discussed with reference to several agents used against leafy spurge (*Euphorbia esula*).

In Saskatchewan, several insects on leafy spurge are under investigation. Canadian laboratories have screened or are screening 13 spurge insects. Two flea beetles, *Aphthona flava* and *A. cyparissias* have completed one year in the field and survival for a second season remains to be confirmed. *Oberea erythrocephala*, which survived for several years, seems to have died out. The spurge hawkmoth, *Hyles euphorbiae*, established on leafy spurge in Montana and on cypress spurge in Ontario, and *Lobesia euphorbiana*, a leaf tying moth were released last year in Saskatchewan and evaluation of survival is in progress. Another flea beetle, *Aphthona czwalinae* was released this spring. In addition, there are several insects in quarantine at various stages of testing: *Minoa murinata* the spurge looper and two aphids, *Acrythosiphon cyparissae* and *Aphis esulae* in the Regina laboratory and other insects in other regions: *Pegomya* sp., the spurge root gall fly and *Aphthona nigriscutis*. *Chamaespecia empiformis* and *C. tenthredinisformis* (clear-winged moths) have been released, but did not survive on North American leafy spurge. A survey of endemic pathogens was made, but no promising prospects were found.

Degree of damage

It seems simplistic to state that the greater the damage to the plant as a result of agent feeding, the more the plant is adversely affected. The relationship between defoliation and plant physiology and growth has been examined by studies on *Minoa murinata* and by defoliation simulation. Ecological and crop defoliation studies have shown that most plants have a threshold level of damage, below which the plant is not adversely affected. Compensatory growth responses enable the plant to overcome the loss of tissue (McNaughton 1983). The threshold concept is important for the biological control of a plant like leafy spurge, which is likely to require several agents to achieve control (Harris in press). If the amount of damage needed to disadvantage the plant is known, then the

amount of damage caused by each agent can be related to the threshold value and progress toward the threshold can be measured. Preliminary results indicate that for perennial weeds, such as Canada thistle and leafy spurge, greater than 75% of annual production will have to be removed. Observations in 1984 with a cage release indicated that after a substantial defoliation by the spurge hawkmoth, regrowth of side shoots occurred and this year's growth is slightly delayed. There is also a possibility that insects have been released that benefit the plant. Preliminary root removal studies of leafy spurge at various ages indicate that certain levels of root removal stimulate ramet (shoots originating from the roots) production. Whether this is detrimental to the plant remains to be determined. Leafy spurge, under moist conditions, can withstand a large proportion of root removal without apparent changes in growth rate or weight, but this may differ under dry conditions. The effect of the *Aphthona* spp., whose larvae feed on the root, still has to be evaluated.

Time factors

Classical biocontrol is a long term commitment and an immediate and noticeable decline of the weed population does not occur. It is not known how many years of complete defoliation would be required to reduce the population.

Within the year, time is also an important factor. Current research on perennial weeds indicates that the longer feeding or other stress occurs, the more often it is repeated and for some forms of stress, such as gall causers, the earlier it occurs in the year the more detrimental it is to the plant (Forsyth and Watson in press). Leafy spurge emerges and completes its life cycle early; seed production occurs in mid to late July. It may be difficult to locate an agent that attacks the plant early.

One of the problems with classical biocontrol is that it is not possible to predict precisely and reliably the behavior of an agent in a new environment. There are no proven methods to determine whether an insect will feed or a pathogen will be virulent, how often attack will occur or whether or how often the agent will reproduce, as new weather conditions, ecotype of the weed et cetera are different from those of the area of origin of the agent. An example of failures attributable to these differences include the *Chamaespecia* spp., which cannot survive on Canadian leafy spurge. A new adult generation of *Lobesia euphorbiana* emerged just before frost last fall, and it has not yet been determined if this behavior has resulted in the demise of the colony.

Type of damage

For many years the type of damage was considered important; that there was a hierarchy of attack loci. This has not held true; several different feeding strategies have proven effective and effectiveness is a function of an interplay between amount and timing of damage and physiological state of the weed. For the more troublesome perennial weeds, which seem to need a large number of agents, perhaps the best strategy is to attack the plant in as many loci as possible, with the hope that with a combination, control will be achieved.

Biocontrol is done by government agencies as a public service. In Australia, public concern and support for biocontrol is registered by public hearings and thereby the government has the necessary feedback to evaluate the need, progress and problems of each project. Such a system could be useful in North America, but meanwhile action for biocontrol must be precipitated by the client group making known to the government that they are interested in biocontrol of spurge. Without this, progress is likely to be slow, since there are other public groups suggesting that spurge is valuable as a hydrocarbon, drug or sugar source or that the agents may endanger rare native spurges.

It is becoming increasingly obvious that in order to reach the threshold level of damage of leafy spurge and to overcome the high variability of the leafy spurge plant in North America, more and new agents with increasingly broader host ranges will have to be selected. In the highly variable hybrid, *Lantana camara*, insects defoliate some bushes, but not adjacent ones. An attempt to use agents with slightly broader host ranges has been tested recently. *Minoa murinata*, the spurge looper, has been approved for release by Canadian authorities, but approval has been withheld by the U.S. due to possible "harassment" of endangered or rare native spurges. Most evidence indicates that rarity or extinction occur because of a shortage of habitats resulting in part from displacement by weedy species, such as leafy spurge and chemical control measures against the weed, rather by than feeding of specialized insects.

In conclusion, biocontrol could be aided by improving the selection process to include more studies on the effect of the agent on the weed to be able to predict which and avoid agents that; (a) cause insufficient damage, (b) are poorly synchronized with the most susceptible plant stage and (c) will not survive in the new region. Also action needs to be taken to increase public support and to avoid conflicts of interest over possible "endangered species".

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