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PLANT PATHOGENS AND THE BIOLOGICAL CONTROL OF SOME IMPORTANT WEEDS OCCURRING IN THE MEDITERRANEAN REGION

S. Hasan*

INTRODUCTION

Although the role of plant pathogens in the biological control of weeds had been suggested as early as 1893 (Gregor,1932), their use has only recently received more attention (Wilson, 1969). An efficient and specific pathogen could reduce the vigour and population level of a weed to such an extent that the use of herbicides would be reduced and some of the disadvantages of using such chemicals would be avoided.

Several recent studies in the Mediterranean region have shown that such biocontrol pathogens do exist on weed species from this region which have become important pest plants in other parts of the world where they have been accidentally introduced.

RECENT INVESTIGATIONS OF PLANT PATHOGENS AS BIOCONTROL AGENTS

Uromyces rumicis (Schum.) Wint. on *Rumex crispus* L.

R. crispus, curly dock, is a plant of European origin and is regarded as an important weed in the United States and in many other parts of the world.

Inman (1971), working with *U. rumicis*, a rust of the curly dock, compared rusted plants with plants kept free of rust with a fungicide. His results showed that rusted plants bore fewer and lighter seeds than non-rusted plants. Only 45% of diseased plants regenerated whereas 95% of the healthy plants produced a new season's growth, and the roots of these healthy plants were up to 85% heavier than those of the others. Inman (1971) demonstrated, by testing against 36 cultivated and 12 wild plants that this rust was restricted in its asexual phase to *R. crispus* and the closely related *Rumex maritimus* L. The alternate host of this heteroecious rust is recorded as *Ranunculus ficaria* L. but Inman was unable to infest this plant with the teliospores of the form of the rust he had selected for study.

* C.S.I.R.O., c/o Australian Embassy, 23 Avenue Arak, P.O. Box 3408, Tehran, Iran.

U. rumicis appears to have sufficient specificity and effectiveness to act as a biocontrol agent for *R. crispus*. Discussions are still under way to decide on the advisability of introducing the fungus into the U. S. A. (Frank 1974).

Puccinia chondrillina Bubak et Syd. on *Chondrilla juncea* L.

C. juncea, skeleton weed, is an important weed of wheat cultivation in Australia. It is a native of the Mediterranean region, Middle East and Southern Russia. Hasan and Wapshere (1973) showed that *P. chondrillina* severely damages skeleton weed plants almost continuously throughout the year. It affects all stages of the plant and occurs wherever skeleton weed is found. Heavily attacked plants are either killed or placed under such heavy stress that seeding and rosette regeneration from the root is reduced.

By marking rust-infected and uninfected seedlings in the field, it was shown that mortality rates of rusted plants were 2.1 to 4.6 times greater than non-rusted plants. It was also found that seasonal declines in *C. juncea* populations were correlated with heavy or increasing rust infection. Plant populations were reduced mainly by the effect of the rust to levels 30-70% below those at the beginning of the growing season. The uredospores are dry and powdery and are readily dispersed by wind and rain. They germinate and invade the epidermis of *C. juncea* overnight if given the correct temperature and leaf moisture.

Hasan (1972a) selected a strain of *P. chondrillina* from Vieste (S. Italy) which was particularly effective against the common Australian form of *C. juncea*. He demonstrated the safety of this strain by testing against a large group of cultivated plants, all of which were found to be immune to the *Chondrilla* rust. The specificity of the rust to *Chondrilla* was further confirmed when a group of Compositae related to *Chondrilla* were found to be uninfected although inoculated with fungal spores and incubated at several temperatures between 5-30°C. (Hasan and Jenkins, 1972).

On these grounds of effectiveness and safety the introduction of this rust as a biocontrol agent against skeleton weed was recommended to the Australian Quarantine Authorities. After considerable discussion, the recommendation was accepted and rust spores from aseptically raised plants were sent to Australia in 1971 (Hasan, 1973a). The uredospores of the rust were multiplied and produced "en masse" and in June 1971 infection was established on selected points in the areas infested with *C. juncea*. Since then the rust has become widespread throughout the skeleton weed areas of Australia and has caused spectacular damage to the weed (Cullen *et al.*, 1973).

Erysiphe cichoracearum D. C. and *Leveillula taurica* (Lev.) Arn. on *Chondrilla juncea*.

Hasan (1972b, 1973b) observed that two powdery mildews, a strain of *E. cichoracearum* and the *Chondrilla* strain of *L. taurica* were causing considerable

damage to skeleton weed plants. *E. cichoraecearum* was the commoner mildew on *C. juncea* in Portugal, Spain, France and northern Italy, and *L. taurica* was more important in Greece and Turkey. Both mildews were affecting *C. juncea* populations in S. Italy.

The conidial stages of the two mildews appear on *Chondrilla* seedlings and rosettes as whitish-grey mildew patches in the leaves. In severe cases entire leaves become infected and die off and seedlings are destroyed. In late summer both species of mildew cover the flower shoot partially or completely with a white mycelial felt and seeding is reduced by severe infections.

Hasan (1973b) also correlated the decline in field populations of *C. juncea* with high levels of mildew infection particularly in southern Italy. *L. taurica* was particularly damaging to *C. juncea* flower shoots in eastern Greece.

The safety of the *Chondrilla* strain of *E. cichoracearum* was demonstrated by testing against a very large number of cultivated plants and varieties many of which were known to be hosts of other strains of *E. cichoracearum*. All these plants resisted the development of the strain of powdery mildew from *C. juncea* (Hasan, 1973c) but permission to introduce this strain as a biocontrol agent was refused by Australian Plant Quarantine Authorities because of the presence in Australia of forms of *E. cichoracearum* pathogenic to other plants.

Puccinia xanthii Schw. on *Xanthium strumarium* L. and *X. spinosum* L.

Xanthium strumarium and *X. spinosum* are warm climate cosmopolitan weeds of American origin. *Puccinia xanthii* is a rust of north American origin which occurs only on *Xanthium* and related *Ambrosia* species (Arthur and Cummins, 1962). It has spread to Europe and been recorded in Spain, France, Italy and Yugoslavia between the present day and the beginning of this century.

The rust which exists only in the telial stage deforms the leaves and stems, causes a reduction in transpiration (Arthur, 1929) and reduces the weight of infected plants and the number of burrs produced (Hasan, 1974).

Preliminary testing by Hasan (1974) indicates that the rust is probably sufficiently specific to act as a biological control agent.

POSSIBILITIES FOR FUTURE INVESTIGATION

The above four cases are examples where a study has demonstrated fully or partially the safety and biological control effectiveness of fungal pathogens. Many other plants native to Europe and the Mediterranean region have become important weeds elsewhere and many are known to have fungal pathogens.

Encouraged by the results of the introduction of *P. chondrillina* as a biological control agent for skeleton weed, a general survey of the literature was undertaken to discover whether other weed species of importance to Australia possessed fungal pathogens, especially rusts, which could serve as biocontrol agents.

Weed	Parasite
Hypericum perforatum L. (Hypericinae)	*Melampsora hypericorum* (D.C.) Wint
— do —	*Uromyces hyperici* (Spring) Curt.
Senecio jacobaea L. (Compositae)	*Puccinia glomerata* Grev.
— do —	*P. expansa* Link
Silybum marianum (L.) Gaert. (Compositae)	*Puccinia mariana* Sacc.
— do —	*P. cruchetiana* Mayor
Centaurea spp. (Compositae)	*Puccinia centaureae* Mart.
Asphodelus fistulosus L. (Liliaceae)	*Puccinia barbeyi* (Roum.) Mag.
Heliotropium europaeum L. (Boraginaceae)	*Uromyces heliotropii* Suedinski
Convolvulus arvensis L. (Convolvulaceae)	*Puccinia convolvuli* (Pers.) Cast.

Most of these weeds are important in Canada and the United States as well as Australia and elsewhere. The rusts mentioned against each weed are autoecious and apparently specific to one plant species or several species of the same genus or to plants of a few closely related genera. These rusts are present in the Mediterranean region and are absent from the countries where their hosts are important weeds.

It is interesting to note that *M. hypericorum* already exists in Australia (McAlpine, 1906) but it has not been recorded on *H. perforatum* which is an important weed. It is quite possible that the rust which attacks *H. perforatum* is different from that infecting *H. japonicum* in Australia. Thus research could be carried out to look for the strain of *M. hypericorum* adapted to the Australian *H. perforatum*.

Further studies would be necessary to assess the damage caused by these fungal parasites to their hosts and to determine their host ranges. Also it would be essential to study the potential values of these parasites as biological control agent of their respective weed hosts.

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