Exploiting the clonal variability of Chondrilla juncea to detect virulent strains of Puccinia chondrillina for use in Australia.

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Summary

The use of P. chondrillina, a rust fungus, as a biocontrol agent for skeleton weed (C. juncea) has resulted in stable control of the most prevalent clone of that weed in Australia. However, the two other clones occurring there have remained unaffected due to the extreme specificity of the imported strain of the rust. Recent large scale collections from Eurasia have emphasized the inherent difficulty in finding specific strains that would be efficient against the resistant forms in Australia. Consequently, isozymes have been used to discriminate the Eurasian clones of the weed and to determine their relationships to the Australian clones, thus indicating the probable origin of the latter and also sources of potentially useful strains of the rust.

Introduction

Puccinia chondrillina (Bubak & Syd.) has been a very effective control agent for the most noxious clone of Chondrilla juncea L. in Australia (2). However, the two other clones known to occur there have remained totally unaffected due to the extreme specificity of the imported rust strain.

The potential for aggressive strains of this fungus to regulate the increasing population density of the two resistant clones in Australia and the difficulty of finding such specific strains by large scale collections in Eurasia has led us to implement a more systematic approach. This is based on the identification of as many European clones of the weed as possible by isozymes and subsequent comparisons of their genetic makeup with the Australian clones.

C. juncea is a triploid apomict which produces viable seeds without any prior fertilization or even the influence of the pollen (3). Thus, only limited variation was expected in this plant and the number of clones in Europe has been assumed to be in the vicinity of 30 (5). On this basis, the aim of these studies was to detect forms more closely resembling or identical to the Australian clones and thus define areas showing maximum potential as a source of useful strains of P. chondrillina.

Material and methods

Ripe seeds from individual plants were randomly collected from natural populations of C. juncea throughout its Mediterranean range, i.e. in Italy, Yugoslavia, Greece, Bulgaria and Turkey. Over three years, a total of 173 sites were visited and seeds from 983 individuals were analysed for five polymorphic enzyme systems previously detected under standard electrophoretic procedures (1). Two sampling regimes were applied. In the first year, a broad geographic survey was done of 123 sites from which the progenies of one maternal plant for each site were electrophoretically assayed. In the second and third years, the progenies from 7-35 (17 on average) maternal plants per site (n=50) were tested.

A continuous starch gel system (Tris-Citrate pH 7.0) was used for Isocitrate Dehydrogenase (IDH), Phosphoglucoisomerase (PGI) and
Phosphoglucomutase (PGM). For Esterase (EST) and Leucine aminopeptidase (LAP), a discontinuous Polyacrylamide gel-electrode buffer system (Tris-HCl 8.6/Tris-glycine 8.3) was employed.

Chromosome counts were made from at least three seedlings from each maternal plant representing a unique combination of the isozyme patterns detected.

Gels were scored for allozymes present. Pairwise comparisons were made between every European clone (multilocus genotype) found and the three Australian clones using Gregorius genetic distance (4).

Results and Discussion  
Based on seven loci and 26 alleles, a total of 326 triploid clones have been differentiated in Europe. This indicates an unexpected amount of variability in skeleton weed and can explain why no exact matches have been found for the three Australian clones. However, a number of sites possessing clones very similar enzymatically to the Australian clones were located (Table 1).

<table>
<thead>
<tr>
<th>Forms of C. juncea</th>
<th>N° of allelic differences</th>
<th>Turkey</th>
<th>Greece</th>
<th>Yugoslavia</th>
<th>Italy</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Narrow Leaf</td>
<td>1</td>
<td>*Sucati 537</td>
<td></td>
<td>*Socanica 10</td>
<td>*Vieste 25</td>
</tr>
<tr>
<td>B Intermediate Leaf</td>
<td>1</td>
<td>Karatepe 508, *Sivas 511, Sobran 554</td>
<td>Aratos 22</td>
<td></td>
<td>*Vieste 24</td>
</tr>
<tr>
<td>C Broad Leaf</td>
<td>1</td>
<td>Burnuk 503</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>*Burnuk 503, Yenikent 552, Cay1 561, Cay2 562, Sobran 554, Cayiryazi 597</td>
<td>Rodopolis 136</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*: two clones found similar to the corresponding form in Australia. Otherwise one closely related clone detected.

Table 1: Collection number and location of the European clones most resembling the three Australian forms of C. juncea, based on Gregorius genetic distance.
Rodopolis excepted, the seven sites where the nine closest forms to the Broad-leaf form occur are located in central-western Turkey, within two restricted areas delimited respectively by the towns of Afyon-Konya-Ankara and Kastamonu-Corum-Ankara. Of interest, these forms and the Broad-leaf form share the same genotype for IDH, which has been found solely in these two areas.

In contrast, the 11 sites which contained the 15 forms closest to the Intermediate-leaf form are much more scattered across Eurasia. This trend is also observed for the 19 clones similar to the Narrow-leaf form (Figure 1).

The areas thus delimited correspond to the locations of rust strains showing some pathogenicity on the Australian clones (6). For example, the vast majority of strains virulent on the Broad-leaf form was collected from the same regions as those defined by isozymes.

Moreover, diploid plants which reproduce sexually were detected within these two areas in central-western Turkey, which also show the highest amount of diversity among the triploid forms (1). Cold winters are conducive to sexual reproduction in the rust and therefore a substantial variation among strains probably takes place.

The main consequence of this research has been to concentrate the search for rust strains and to establish plots of the Australian forms in these areas. Recently, this has yielded strains strongly virulent on the Intermediate-leaf form, these being currently under further evaluation.

In addition, the effectiveness of this method is being documented in a similar project on forms of Chondrilla occurring in the USA. Forms identical to the Late-flowering and Banks biotype which occur in the USA have been found at three sites in Yugoslavia and rust isolates collected from these individuals have been found highly virulent on the corresponding US forms (7).

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References


Roundup CT
Broadacre Herbicide.

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