PLANT PATHOSYSTEMS: AN ATTEMPT TO ELUCIDATE HORIZONTAL RESISTANCE

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SUMMARY

Resistance to parasites can be distinguished into true resistance and pseudo or escape resistance. In the former resistance mechanisms operate after intimate contact between the host tissue and the parasite has been established. The resistance is expressed by a reduced growth of the parasite in or on the host tissue. Escape resistances operate before the parasite has made contact with the host tissue and is expressed by a reduced chance of such contacts. True resistance genes are assumed to act in a gene-for-gene way with virulence genes in the parasite. Genes governing escape resistances are supposed to function independently from genes in the parasite (no gene-for-gene action). It is deduced, that escape resistances and polygenic true resistances both are of a horizontal nature. Vertical resistance is to be found in the category of monogenic true resistances.

INTRODUCTION

Since Van der Plank (1963) introduced the concepts of horizontal (HR) and vertical (VR) resistance much has been written about them. Parlevliet & Zadoks (1977) reviewed the results of all these writings and formulated ‘The integrated concept of disease resistance’. They discussed exclusively true resistance and concluded, that genes for true resistance act in a gene-for-gene way with virulence genes in the pathogen. The resistance genes in the host population and the virulence genes in the pathogen population co-evolved step-wise, forming one integrated system where both the host and the pathogen can co-exist as extremely variable and vigorous populations. In such natural populations it is of little use to discern HR and VR; all true resistance genes operate in a similar way within the integrated system.

In our agro-ecosystems, however, a totally different situation exists. The genotypic variation of the host population has been reduced enormously, leading to a marked specialization of the pathogen to the crop cultivars, or rather to their resistance genes. This specialization has not been checked by the reduction of the host population through too severe attacks, since man takes care of the multiplication of the host cultivars. The stability of the integrated system in natural populations has faded away and an, understandable, need for stable resistances has arisen, stable under the conditions of modern crop production. It is within the scope of the modern agro-ecosystems, that the concepts of HR and VR have a useful meaning.
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HORIZONTAL AND VERTICAL RESISTANCE IN RELATION TO GENE NUMBER AND GENE ACTION

Whether one deals with HR, VR or both can be tested by evaluating the degree of resistance of a number of host genotypes for a number of parasite genotypes (VAN DER PLANK, 1963, 1968). When all non-environmental variation in the resulting disease severity can be explained by differences between host genotypes and by differences between parasite genotypes (main effects) one deals with HR and horizontal pathogenicity. When part of the non-environmental variation in disease severity is caused by the interaction between host and parasite genotypes VR and vertical pathogenicity are present. As far as resistance is concerned this test describes the reaction of a population of host genotypes to the parasite population. It is therefore not justified to talk about horizontal or vertical resistance genes, as not the genes but a population of genotypes are tested and their reactions evaluated. Nevertheless it is of paramount importance to elucidate HR and VR in terms of genes and gene actions.

A host genotype may derive its resistance from one or more genes, and the genes may or may not operate on a gene-for-gene basis with gene(s) in the parasite population. Schematically four situations can be visualized; monogenic versus polygenic resistance, gene-for-gene action versus no gene-for-gene action (the resistance genes and the pathogenicity genes act independently of one another). Table 1 indicates when a HR or a VR pattern is expected. This has been derived from the findings of PARLEVLIET & ZADOKS (1977), who showed that HR pattern is expected in the cases of independent gene action and polygenic gene-for-gene actions.

<table>
<thead>
<tr>
<th>Resistance controlled: (gene number)</th>
<th>Gene action of resistance genes in relation to pathogenicity genes: on a gene-for-gene basis</th>
<th>independently</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monogenically VR</td>
<td></td>
<td>HR</td>
</tr>
<tr>
<td>Polygenically HR</td>
<td></td>
<td>HR</td>
</tr>
</tbody>
</table>

HORIZONTAL AND VERTICAL RESISTANCE IN RELATION TO TRUE AND ESCAPE RESISTANCE

Resistances occur in a great variety of forms, which can be divided into true resistances and escape or pseudo resistances. True resistance functions after intimate contact between host tissue and parasite has been established. It reduces the rate of growth and/or development of the parasite in or on the parasitized tissues (hypersensitive types of resistance, antibiosis). True resistances are assumed to act in a gene-for-gene way with virulence genes in the parasite, irrespective of whether the resistance is controlled monogenically or polygenically (PARLEVLIET & ZADOKS, 1977).

Escape or pseudo resistances, and a considerable number of perfectly useful resistances can be classified as such, operate before an intimate relationship between host tissue and parasite can develop. They reduce the chance of contact between the prospective host tissue and the parasite. Such resistances are often of a morphological