STRUCTURE OF GENES AT THE *L* LOCUS IN FLAX CONTROLLING RESISTANCE TO RUST

by

Md. Rafiqul Islam, M.Sc.Ag.

Thesis submitted for the degree of Doctor of Philosophy

Department of Agronomy
The Waite Agricultural Research Institute
The University of Adelaide
South Australia

November, 1986.

CONTENTS

ABSTRACT

Three aspects relating to the structure of genes at the *L* locus in flax controlling resistance to rust have been studied namely mutation, recombination and the reversion analyses. The temperature sensitivity of these genes has also been tested.

Rare double-susceptible plants obtained in testcross populations involving two different dominant genes each conferring resistance have so far been attributed to recombination. These plants may, however, also arise through spontaneous mutation from resistance to susceptibility of host genes. Populations of F_1 progeny ranging from 2203 to 5947 plants and involving six different *L* genes were screened with rust strains specific for these genes. No definite mutants were detected in any of these F_1 populations. Thus, it is now possible to exclude more confidently spontaneous mutation as the mechanism for obtaining the rare double-susceptible plants.

Analyses to detect recombination among progeny of testcrosses and double crosses, involving 13 new pairs of *L* genes, yielded only double-susceptible plants. Nine of the 13 pairs showed recombination frequencies ranging from 0.038 to 0.199 % : no recombinant were observed among progeny of the remaining four pairs. An important feature of these tests was the detection of rare plants showing a modified form of partial resistance with *Lx* gene. Double-resistant plants were, however, not recovered.

Shepherd & Mayo (1972) suggested that genes at the *L* locus may be functionally allelic and that *cis* recombinants may not be recognised as double-resistant plants. However, they predicted that if such recombinants occur among the double-susceptible plants, it should be possible to recover both parental specificities, as rare resistant plants, among their progeny. Hence, wherever possible, double-susceptible plants were progeny tested with rust strains specific for both the genes involved. Rare resistant plants were recovered among the progeny of double-susceptible plants derived from *LL7, LLx* and *L2L10* heterozygotes

namely *L7*, *Lx* and *L10*, respectively. However, only one of the parental specificities was recovered in each combination, thus confirming the result obtained earlier by Shepherd & Mayo (1972) with the *L2L10* combination.

K.W. Shepherd & G.M.E. Mayo (personal communication) argued that some form of suppression of *L10* (*suL10*) must have occurred to give rise to the double-susceptible plants from which rare *L10* plants were subsequently recovered. However, in further tests, they could not prove that host gene *L2* or a component of it was responsible for such suppression. In the present study additional progeny plants were tested in an attempt to resolve this question. Rare resistant plants were detected in the progeny of genotype *suL10/+L9* selfed but again they all had *L10* specificity. However, no resistant plants occurred among the progeny of *suL10/suL10*. A critical test involving progeny of genotype *suL10/L2+* selfed failed to produce progeny of *L10* specificity and this did not provide conclusive evidence on whether *suL10* could revert to *L10* in the presence of *L2*. There is indication that the rust strain used in this study, although capable of recognising host gene *L10* in homozygous condition, may not have had the ability to detect such rare plants in heterozygous condition.

In another study, the expression of *L* genes in two different genetic backgrounds was recorded at two continuous temperature regimes of 15 and 25°C. It was observed that the individual host-parasite interaction was specific to the environment. In many of the interactions, the expression of resistance remained unaffected by the change of genetic background and temperature. Where changes in expression were observed, plants heterozygous for a pair of *L* genes exhibit less resistance than plants homozygous for that pair. However, the genes were more effective in heterozygous condition when present in cultivar Bison background compared with cultivar Hoshangabad.

In general, genes conferring resistance were less effective at the lower temperature (15°C) which is opposite to the trend reported for the temperature sensitivity of genes in other host-parasite systems. The expression of host genes *L2, L4* and *L6* remained comparatively stable in these tests.

Certain strains of rust are known to possess inhibitor genes which interfere with the recognition process between host genes *L1, L7, L8, L10* and *Lx* and their corresponding genes for avirulence present in these strains. It was noted that at high temperature environment, these host genes showed immunity or a high degree of resistance with this group of rust strains which usually grow freely when inoculated onto these host differentials. It is postulated that at high temperature environment, the inhibitor gene become completely or partially ineffective, allowing the usual recognition process to take place. A model has been presented to explain this interaction.

The information obtained from all of these studies formed the basis of a discussion on the structure of the *L* locus in flax. Tests in this thesis failed to support a hypothesis of allelic interaction between genes at the *L* locus as proposed by Shepherd & Mayo (1972). It has been shown that temperature sensitivity of genes, as well as a difference in capability of rust strains to detect rare plants, may contribute to such failure. Alternatively, it is suggested that the occurrence of only susceptible plants in the recombinational analyses, occurrence of plants with modified resistance and reversion of one type of parental specificity resembles a system showing insertion and excision events involving transposable elements. However, no definite evidence is presented to support this hypothesis.