University of Groningen

Characterization of the *Tm-2*^{2} locus of tomato and its durability

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Dedicated to my mother and father

Contents

Scope of the thesis

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The Solanaceae contain agronomically important plants like tomato, tobacco and pepper. This plant family bears 3000-4000 species in almost 90 genera. Amongst those *Solanum* is the largest genus by carrying 1500 species. A section of this genus, Lycopersicon, mainly consists of tomato and its wild relatives. Tomato and tobacco plants are under continuous threat of tobamo-virus infections during their life cycle. Tomato/Tobacco Mosaic Virus (ToMV/TMV) was the first characterized tobamo-virus. Both viruses are readily sap transmitted but can also be transmitted through root infection from contaminated soil. ToMV infections are aggressive and contagious and its particles can be found in the infected seeds of tomato. The *Tm-2*^{2} gene derived from tomato confers a durable resistance against ToMV isolates. The research in this thesis is focused on characterization of the *Tm-2*^{2} gene, its functional expression in another plant family and an attempt to find alternative or homologous genes in wild species of *Solanum.*

Chapter 1 summarizes the contemporary knowledge of defense mechanisms used by tomato and tobacco plants against tobamo-viruses. This also shows how various ToMV *R* genes were isolated, characterized and expressed in both plant species. To date four dominant ToMV resistance genes were found in wild *Solanum* species and they have been introduced into commercial lines. These include the *N* gene from *Nicotiana glutinosa*, the *Tm-1* gene from *Solanum hirsutum*, and both the *Tm-2* and *Tm-2*^{2} genes from *S. peruvianum*. The *Tm-1* gene resides on chromosome 5 and the *Tm-2* and *Tm-2*^{2} genes are allelic and present on chromosome 9. The resistances of the *N*, *Tm-1* and *Tm-2* genes have been broken but the *Tm-2*^{2} gene is still conferring resistance to ToMV during almost five decades. Both alleles of the *Tm-2* and *Tm-2*^{2} genes share many properties. Their gene products belong to the major class of R proteins, CNL (CC-NBS-LRR), and share a common Avr factor (the movement protein, MP). Most interestingly, there are only four amino acid differences between their encoded proteins. Two of those are in the NBS and the other two are in the LRR domains/regions of their proteins, while the remaining part (CC region) is conserved. The question is now, what determines the durable Tm-2^2 resistance compared to the broken Tm-2 resistance. First of all which protein domain is

important, secondly which combination of amino acids or even single amino acid change is critical to confer the *Tm-2*^{2} specificity? These questions are addressed in **chapters 2 and 3**.

Until now the *Tm-2*^{2} specificity has been preserved in tomato and tobacco which belong to the same family. The question is raised whether the *Tm-2*^{2} gene is also functional in other plant families. *Arabidopsis thaliana* which is a plant species of the Brassicaceae family is also infected by tobamo-viruses. This plant species has become a model plant and its genome has completely been sequenced. Owing to this, the extra-family transfer of the *Tm-2*^{2} gene into *Arabidopsis* might be significant to study plant-pathogen interactions. This is dealt with in **chapter 4**.

Another aspect of the *Tm-2*^{2} gene is that this is showing durable resistance during almost five decades. This is a long time for an *R* gene to protect tomato plants against a wide range of tobamo-viruses. *R* genes are always under threat of function deprivation. Therefore, there is a need for new ToMV *R* genes or homologues of the existing *Tm-2*^{2} gene. This issue is the focus in **chapter 5**.