Resistance in *Lycopersicon hirsutum* f. *glabratum* to the greenhouse whitefly (*Trialeurodes vaporariorum*) increases with plant age

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Summary

In this study genetic variation for resistance to the greenhouse whitefly (*Trialeurodes vaporariorum*) of four genotypes of tomato (*L. esculentum*) and two subspecies of *L. hirsutum* was investigated. Resistance was quantified by the whitefly life history components adult survival, oviposition rate, pre-adult survival and developmental period, measured on plants inoculated with whiteflies in clip-on cages.

The largest differences between species were found when life history components were measured on adult plants of about four months old. On *L. hirsutum* f. *glabratum* whiteflies had the lowest adult survival, oviposition rate and pre-adult survival. On *L. hirsutum* these components were intermediate whereas on all *L. esculentum* genotypes they were highest. The variation between plants was low compared to the variation within plants. These results indicate that single plant tests can be used to determine accurately genetic variation between individual plants in a segregating population.

Introduction

One of the major pests of greenhouse cultivation of tomato (*Lycopersicon esculentum*) in the Netherlands is the greenhouse whitefly (*Trialeurodes vaporariorum*). It can be controlled effectively by the parasitic wasp *Encarsia formosa* (Woets & van Lenteren, 1976; Hulspas-Jordaan & van Lenteren, 1989). This biological control is applied on a large scale, but is not always successful and pesticides are still needed to prevent uncontrolled outbreaks of this pest. Resistant cultivars are preferred because of the lower costs and the lower risks for grower and environment.

All cultivars of tomato are very susceptible to the greenhouse whitefly (Gentile et al., 1968; de Ponti et al., 1975). In the wild species *L. hirsutum* f. *glabratum* however, a high level of resistance, characterized by a strongly reduced level of population growth has been found (de Ponti et al., 1975, 1984). The resistance to various insects of this species has been associated with 2-tridecanone present in exudate of type VI trichomes (Williams et al., 1980). However, the resistance to whitefly of *L. hirsutum* f. *glabratum* may be due to another mechanism as no detectable level of 2-tridecanone was observed in the accession PI 251304 that was highly resistant to whitefly (de Ponti et al., 1990). Attempts to introduce the resistance to whitefly of *L. hirsutum* f. *glabratum* into the cultivated tomato have been hampered by lack of reproducible and reliable resistance tests and the putative polygenic inheritance of the resistance.

One of the main complications in tests for insect
resistance is the mobility of the insects. The plant-to-plant movement can be overcome by isolating the plants physically by a cover. However, such covers can influence plant growth and whitefly development. Alternatively, whiteflies can be kept in small clip-on cages attached to the leaves, enabling detailed determinations of the life history components of population growth. However, this is very time and labour consuming and hardly applicable to large plant populations, required in breeding programmes for polygenic traits.

The selection of genotypes with a high level of resistance can be facilitated by the use of molecular markers (Tanksley et al., 1989). In a molecular marker aided breeding programme selection is based on DNA markers linked to genes conferring resistance. To determine the linkage between molecular markers and resistance genes a population is required that shows cosegregation of resistance genes with these DNA markers. The chance of finding linkage will increase with the accuracy of the evaluation methods for resistance. In a segregating population each genotype is represented by a single plant, precluding replicated trials. Hence, the test employed must be sufficiently accurate to estimate the genotypic value on individual plants. For this purpose clip-on cage tests are useful as they can be replicated on a single plant (Berlinger & de Ponti, 1981; Romanow et al., 1991). The present study aimed at estimating the environmental and genotypic variances of some life history components of the whitefly on five Lycopersicon genotypes differing for resistance to the whitefly. Also the effect of plant age on the whitefly population growth was studied. In addition, the population growth of the whitefly was measured in a non-choice greenhouse test. The comparison of both tests answers the question whether the whitefly population growth in a clip-on-cage represents the population growth on adult plants in the greenhouse, corresponding with conditions for commercial tomato fruit production.

Materials and methods

Lycopersicon genotypes

In this study four genotypes of the cultivated tomato (Lycopersicon esculentum) and two accessions of related species were used. The tomato genotypes consisted of two susceptible cultivars Moneymaker (an obsolete true breeding line) and Counter (a modern hybrid from De Ruiterzonen, Bleiswijk, The Netherlands) and two breeding lines IVT-WVR1 and IVT-WVR2, which had been selected for whitefly resistance in a backcrossing programme to introduce the whitefly resistance from L. hirsutum f. glabratum (De Ponti & Steenhuis, 1984; Romanov et al., 1991). In addition, one accession of L. hirsutum (CPRO89030) and one resistant accession of L. hirsutum f. glabratum (CGN1.1561) were used. All lines were maintained at the Centre for Genetic Resources (CGN-DLO, The Netherlands).

Clip-on cage test

Plant cultivation

Seeds of three tomato genotypes and two wild species (see Table 2) were sown twice with an interval of eight weeks. The plants sown first are referred to as ‘older plants’ and the plants sown eight weeks later as ‘younger plants’. Eleven days after sowing the seedlings were potted in 12 cm pots and cultured in a heated greenhouse with a day/night temperature set at 20/15°C. Plants with a height of about 50 cm were transplanted into twelve liter buckets at 60 cm distance in an insect-proof greenhouse compartment of 80 m² under conditions as described above.

Plants were pruned regularly and cultivated with one stem per plant. When the main stems of the plants reached a height of more than two meters, the stems were lowered to keep the top of the plants continuously at a height of about two meter. This method is common practise for commercial tomato production. Flowers were removed from the younger plants to avoid effects of fruitsetting; the older plants were allowed to set fruit.