# Validation of associations between plant traits and Thrips damage in cabbage

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## Abstract

When cabbage is cultivated for storage in the Netherlands, it is usually harvested around mid-October. This type of cabbage crop may be severely damaged by thrips (*Thrips tabaci*). The thrips population on the plants and the more severe symptoms develop mostly during September and October. Also during cold storage symptoms continue to develop. The damage caused by thrips is due to the symptoms that develop after feeding, which are small callus-like growths that will turn brownish after some time and which may cover substantial amounts of leaf area.

Large differences exist between cabbage varieties in their susceptibility to thrips damage. Based on several years of field trials with more than 40 commercial varieties and gene bank accessions it was established that a large proportion of the variation for thrips damage could be explained by a few plant traits: the amount of leaf surface wax, earliness and Brix (Voorrips et al, 2008).

Using an F3-line population derived from a cross between a high-damage, low-wax, high-Brix, earlier heading and a low-damage, high-wax, low-Brix, later heading accession we determine whether the relations between plant traits and thrips damage can be confirmed.

## *INTRODUCTION*

Cabbage (*Brassica oleracea* var *capitata*) is an important field crop in the Netherlands, cultivated by conventional as well as organic growers. Cabbage cultivated for storage is usually harvested around mid-October. This type of cabbage crop may be severely damaged by thrips (*Thrips tabaci*). The damage caused by thrips is due to the symptoms that develop after feeding, which are small callus-like growths (intumescences) that will turn brownish after some time. These symptoms force growers to remove the outer leaf layers before marketing, leading to increased labor costs and yield losses.

Among red and white cabbage varieties, large differences have been reported in the amount of thrips damage (Shelton et al. 1983; Stoner and Shelton 1988; Fail and Penzes, 2001; Van de Steene et al. 2003; Voorrips et al. 2008) and in the numbers of thrips observed on the plants (Stoner and Shelton 1986; Van de Steene et al. 2003; Voorrips et al. 2008). However, the genetic background of tolerance or resistance to thrips is not clear, and breeding for resistance or tolerance to thrips is difficult. One of the problems is the large variability between years and locations in the severity and timing of thrips infestation. Also within genotypes in the same experiment, large plant to plant variations can occur in damage or thrips population size. Also, it is not easy to have all the accessions in a comparable developmental stage throughout the evaluation period, which is a requirement for reliable comparisons.

Indirect selection might help to overcome these problems. One possibility is to identify plant traits that are associated with the level of thrips damage. In previous work we have explored this approach, and found that a combination of earliness, the amount of leaf surface wax and Brix could explain about 75% of the variability in thrips damage among cultivars of white cabbage (; Voorrips et al. 2008). A problem with this analysis was that among the varieties studied we observed a significant negative correlation between earliness and the amount of leaf surface wax. Here we describe a validation of these results based on a larger set of cultivars, partially selected to reduce this correlation, and on a set of 150 F3 lines derived from a cross of two accessions contrasting for these traits.

## *MATERIALS & METHODS*

### Field experiments

In 2009 field experiments with a collection of 36 varieties were conducted at two locations in the Netherlands. Small cabbage plants were planted in the field in the last week of May. The experimental fields were divided into two blocks, with one plot per accession per block. At three harvest dates between mid-August and mid-October three plants were harvested from each plot. Harvested plants were scored for several traits including developmental stage, circumference of the head (cm), leaf thickness (mm), wax layer, compactness and Brix. One half of each head was peeled and assessed for thrips damage and the number of thrips adults and larvae.

In 2010 one field experiment with a set of 150 F3 lines and a few standard accessions was conducted in the Netherlands. The field was planted in the third week of May. The experiment was divided into three blocks, with one plot per F3 line and two plots per standard accession in each block. At four harvest dates between 6 September and 2 November plants were harvested, as close as possible to commercial harvest stage; however the data for the last harvest were not available yet for this presentation. Harvested plants were scored for developmental stage, circumference of the head (cm), wax layer and compactness. One half of each head was peeled and assessed for thrips damage.

In the 2010 experiment the thrips population was increased by interplanting shallot plants that had been pre-infested with thrips for one month.

### Plant Material

The plant material of the 2009 experiment consisted of 36 medium to late white cabbage varieties, including mostly F1-hybrid varieties and a few classical open-pollinated varieties, as well as one glossy mutant line. The material of the 2010 experiment consisted of 150 F3 lines, all derived from one F1 plant of a cross between the OP varieties Bewama (relatively early maturing, low amount of leaf wax, high Brix, sensitive to thrips damage) and Langendijker Bewaar (late maturing, high leaf wax, low Brix, tolerant to thrips damage). Also included were six standards: the two parents, the F1 and three F1-hybrid cultivars (Bartolo, Galaxy and Zerlina).

## *RESULTS*

### Varieties experiment, 2009

In 2009 the amount of thrips in both fields was quite low, resulting in relatively low levels of thrips damage and therefore also in relatively low correlations between the amount of thrips damage and the different plant traits. Taking the date with the most severe damage at each location as reference, 11 varieties were not significantly different from the most resistant one with respect to damage, and five were not significantly different from the most susceptible. The set of 11 most resistant varieties included the reference variety Galaxy and the resistant parent of the F3-line population: Langendijker Bewaar. The set of 5 most susceptible varieties included the reference variety Bartolo and the susceptible parent of the population: Bewama.

The correlations between thrips damage and leaf surface wax varied between harvests and locations from -0.39 to -0.45, which is lower than the values observed in previous experiments (Voorrips et al. 2008) but still significant. The same was the case for the correlations between damage and earliness. Most correlations between damage and Brix were not significant.

In spite of our attempt to select varieties with all combinations of wax layer and earliness we still observed a correlation between these traits. Part of the correlation is caused by the early maturing glossy mutant. However, there was also still a lack of late accessions with little surface wax (Figure 1).

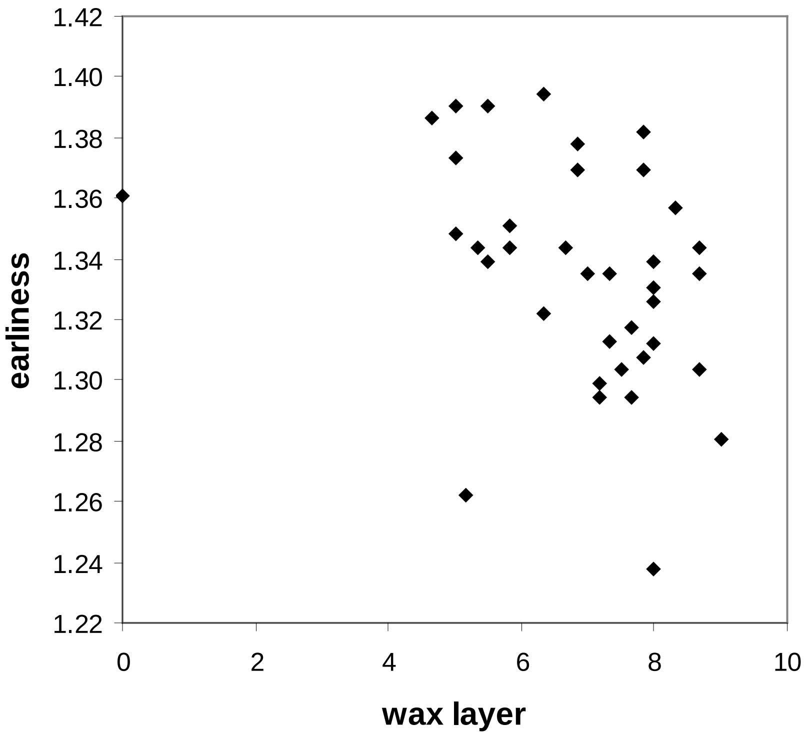


Figure 1. Scatterplot of earliness vs wax layer for 36 white cabbage varieties and accessions in the 2009 field experiment. The one accession with a 0 score for wax layer is a glossy mutant line.

**F3 lines experiment, 2010**

The thrips damage in 2010 was considerably higher than in 2009. No transgression was observed in the F3-line population, i.e. the parents were not significantly less resp. more damaged than the least resp. most damaged line. The same was true for the amount of leaf surface wax. However the parents were intermediate for earliness, in contrast to what was observed in earlier experiments.

We observed significant correlations of thrips damage with the amount of wax (R=-0.68) and with earliness (R=0.66), comparable with what was observed earlier in variety tests but higher than in the 2009 experiment.

Among the F3 lines we also observed a correlation between the amount of leaf surface wax and earliness; as in the variety panel of the 2009 experiment the combination of lateness and low wax amounts was lacking.

## *CONCLUSIONS*

Both among a set of varieties and in a cross progeny we observed a relation between the amount of leaf surface wax and earliness: in both cases the combination of lateness and little wax was lacking. This suggests that the generally thick wax layer of late varieties is not only the result of selection, but may have a biological cause.

The experiments in 2009 suffered from a low amount of thrips in the field, and therefore correlations between plant traits and thrips damage were low. However in the experiment of 2010 with 150 F3 lines from a cross progeny the thrips damage was high, perhaps because extra thrips were brought into the field by interplanting infested shallots. In this experiment the previously found relations of high thrips damage with little wax and with earliness were confirmed.

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