

## Effect of plant architecture on infestation of *Brassica* genotypes by cabbage stem weevil, *Ceutorhynchus pallidactylus* (Mrsh.)

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### Abstract

The susceptibility of 16 *Brassica* genotypes to cabbage stem weevil (*Ceutorhynchus pallidactylus* (Mrsh.)) was evaluated in field trials conducted at four sites in north-western Germany in 2006. To determine morphological plant cues relevant for the oviposition preference of *C. pallidactylus* various plant parameters were assessed. The level of plant infestation by *C. pallidactylus* differed between the genotypes tested. The number of larvae per plant significantly increased with increasing number of lateral racemes and increasing number of leaves per main stem. Thus, in addition to secondary plant compounds of *Brassicaceae*, such as glucosinolates, plant morphological parameters can be assumed to have impact on host finding and acceptance by insect pests on oilseed rape.

**Key words:** Oilseed rape, *Brassica napus*, host-plant resistance, plant morphology, oviposition, *Ceutorhynchus pallidactylus*

### Introduction

The cabbage stem weevil, *Ceutorhynchus pallidactylus* (Mrsh.) (Col.: Curculionidae), is a major pest of winter oilseed rape (*Brassica napus* L.) in Europe (Williams et al., 2010). Following colonization of the crop in March/April, females feed on leaves and shoots and later deposit their egg batches into petioles and midribs of leaves during the early bud stage until flowering. On oilseed rape, first and second instar larvae feed galleries within petioles while third instar larvae bore into the stems, thereby affecting plant growth and yield. Host plant resistance could provide an efficient component in integrated pest management systems (Williams, 2004), however, the susceptibility of oilseed rape and other brassicaceous genotypes to *C. pallidactylus* has not yet been studied in greater detail.

To evaluate the susceptibility of selected genotypes of brassicaceous host plants to adult feeding and oviposition of *C. pallidactylus* under controlled conditions, specific screening methods have been established (Eickermann & Ulber, 2010). In field observations, single low cultivars of oilseed rape (high glucosinolate content, no erucic acid in seeds) showed higher infestations by *C. pallidactylus* than double low cultivars (low glucosinolate content, no erucic acid in seeds) (Mrówczyński, 1992). Significant differences were found between the infestation levels of modern double low lines and resynthesized rapeseed lines (*Brassica rapa* x *Brassica oleraceae*) in field trials (Eickermann et al., 2007). In addition to chemical plant cues, morphological plant characters might have an influence on host plant selection and acceptability by *C. pallidactylus* (Dechert & Ulber, 2004).

The objective of the present study was to evaluate the effect of morphological plant characters on the susceptibility of various genotypes of *B. napus* and *B. rapa* to infestation by *C. pallidactylus*.

### Material and Methods

A total of 16 genotypes (13 cvs of *B. napus* oilseed rape, two cvs of *B. napus* fodder rape and one cv of *B. rapa*) were evaluated for their susceptibility to adult feeding and oviposition by *C. pallidactylus* under conditions of natural infestation. Field trials were conducted in 2004 – 2006 on four experimental sites in north-western Germany (Goettingen, Hohenlieth, Asendorf and Merklingsen), arranged in a randomized block design with four replicated plots (12m \* 2.5m; 30m<sup>2</sup> per plot) of each genotype. The selection of cultivars was aimed to cover a broad spectrum of winter oilseed rape, fodder rape and winter turnip rape cultivars. The oilseed rape cultivar 'Express' was used as a standard and was also grown around the experimental blocks to avoid edge effects. Plant architecture (length of main stem, stem-base diameter, number of leaves and lateral racemes on main stem) was assessed from samples of 20 plants/plot at the end of April. The effect of host plant genotype on the abundance of stem weevil larvae was determined from samples of 20 plants/plot collected in mid May, before the larvae started to migrate to soil for pupation. Stems and lateral racemes were cut longitudinally to collect larvae of stem weevils. All data were subjected to ANOVA by using SPSS<sup>®</sup> Version 14.0 for Windows (Chicago, IL, USA); differences between means ( $p \leq 0.05$ ) were evaluated by Tuckey-HSD test. Percentages were transformed by arc-sin-transformation. Regression analyses were conducted by using Sigma Plot Version 10 (Systat Software, Erkrath, DE).

## Results and Discussion

The level of larval infestation, expressed in relation to the standard cv 'Express', differed between the tested genotypes (Fig. 1). The number of *C. pallidactylus* larvae per plant was reduced by 30% to 50% on *B. napus* cv 'KWS 6' and 'KWS 9', *B. napus* fodder rape cv 'Licapo' and 'Emerald', and on *B. rapa* cv 'Salut'. However, because population densities of *C. pallidactylus* varied widely between the four experimental sites, these differences were not statistically significant. Nevertheless, results obtained from these field experiments were correlated with results of our laboratory screenings (Eickermann & Ulber, 2010).

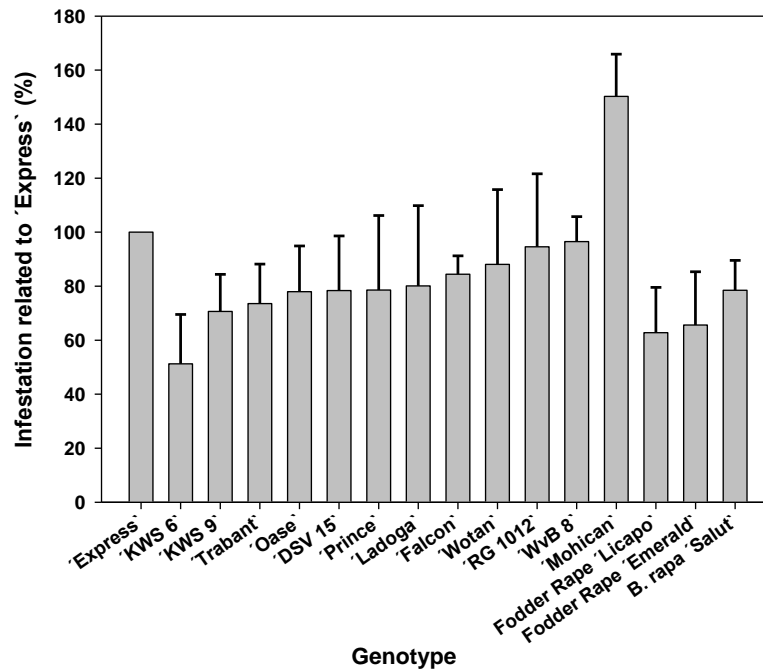


Fig. 1: Infestation of *Brassica* genotypes by *C. pallidactylus* larvae (mean +SE) in relation to the standard cv 'Express' (= 100 %) in multi-sited field trials in north-western Germany in 2006.

To identify plant characters that might be responsible for the susceptibility of genotypes to *C. pallidactylus*, various plant morphological parameters were examined. The number of eggs and larvae was found to be significantly correlated to the number of lateral racemes (Fig. 2) and the number of leaves per main stem (Fig. 3). An increase of either plant parameter resulted in a higher number of *C. pallidactylus* larvae per plant. It can be assumed, that higher numbers of lateral racemes and leaves per plant provide better resources for feeding and oviposition, leading to a higher number of progeny. A similar effect of plant architecture was found by Nuss (2004). However, the coefficient of determination ( $r^2$ ) was relatively low for the two plant parameters. This suggests that other plant factors, such as chemical plant cues, in addition to plant architecture might also impact host plant selection and oviposition of *C. pallidactylus* (Giamoustaris & Mithen, 1995; Cook et al., 2006; Eickermann et al., 2011).

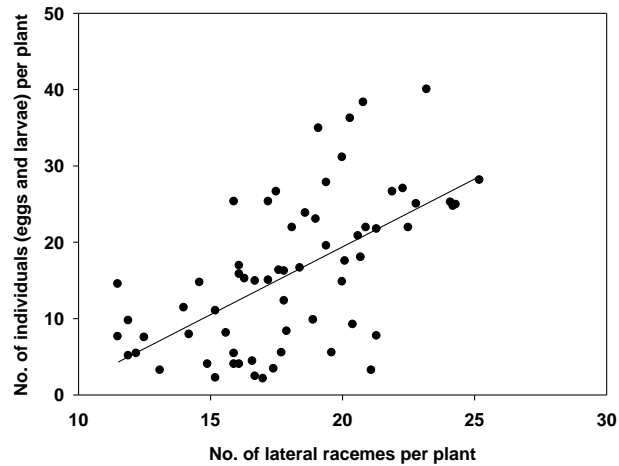


Fig 2. Relationship between number of eggs and larvae of *C. pallidactylus* per plant and the number of lateral racemes per plant ( $y = -16.126x + 1.776$ ;  $n = 64$ ;  $r^2 = 0.364$ ;  $p < 0.0001$ ).

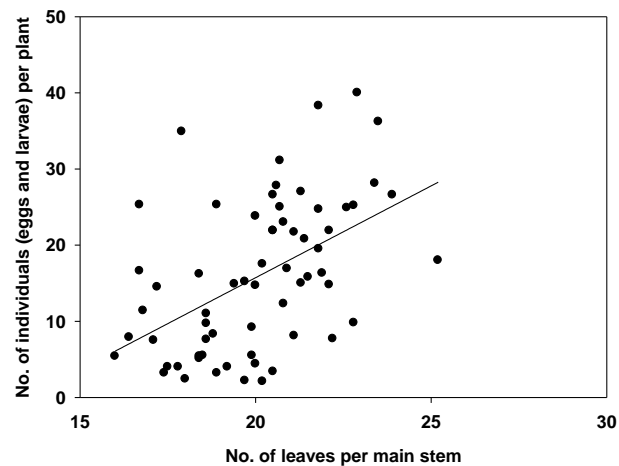


Fig 3. Relationship between number of eggs and larvae of *C. pallidactylus* per plant and the number of leaves per main stem ( $y = -32.498x + 2.411$ ;  $n = 64$ ;  $r^2 = 0.244$ ;  $p < 0.0001$ ).

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### References

- Cook S.M., Smart L.E., Martin J.L., Murray D.A., Watts N.P. & Williams I.H. (2006). Exploitation of host plant preferences in pest management strategies for oilseed rape (*Brassica napus*). *Entomologia Experimentalis et Applicata* **119**, 221-229.
- Dechert G. & Ulber B. (2004). Interactions between the stem-mining weevils *Ceutorhynchus napi* Gyll. and *Ceutorhynchus pallidactylus* (Mrsh.) (Coleoptera: Curculionidae) in oilseed rape. *Agricultural and Forest Entomology* **6**, 193-198.
- Eickermann M. & Ulber B. (2010). Screening of oilseed rape and other brassicaceous genotypes for susceptibility to *Ceutorhynchus pallidactylus* (Mrsh.). *Journal of Applied Entomology* **134**, 542-550.
- Eickermann M., Trittermann C.F. & Ulber B. (2007). Susceptibility of *Brassica napus* genotypes to infestation by cabbage stem weevil, *Ceutorhynchus pallidactylus* (Mrsh.). 12th International

- Rapeseed Congress, March 26-30, 2007 (Wuhan, China), **IV** (Plant Protection), 265-267.
- Eickermann M., Ulber B. & Vidal S. (2011). Resynthesized lines and cultivars of *Brassica napus* L. provide sources of resistance to the cabbage stem weevil (*Ceutorhynchus pallidactylus* (Mrsh.)). Bulletin of Entomological Research doi: 10.1017/ S0007485310000489.
- Giamoustaris A. & Mithen R. F. (1995). The effect of modifying the glucosinolate content of leaves of oilseed rape (*Brassica napus* ssp. *oleifera*) on its interaction with specialist and generalist pests. Annals of Applied Biology **126**, 347-363.
- Mrówczyński M. (1992). Injuries of winter rapeseed variety types by pests. Part II. Stem Pests. Prace Naukowe IOR Poznan – **XXXIV** (1/2).
- Nuss H. (2004). Effect of plant density and plant architecture on the abundance and within-plant distribution of stem borers of winter oilseed rape. PhD-thesis, Georg-August-Universität, Goettingen.
- Williams I.H. (2004). Advances in Insect Pest Management of Oilseed Rape in Europe. In: Horwitz, A.R. (Ed.), Insect Pest Management. Springer, pp. 181-208.
- Williams I.H. (2010). The major insect pests of oilseed rape in Europe and their management: An overview. In: **Biocontrol-Based Integrated Management of Oilseed Rape Pests**, Ed. Ingrid H. Williams, Springer Science+Business Media B.V., pp. 1-43.