Agronomy Research **4**(Special issue), 191–196, 2006

Attractiveness and susceptibility of *Brassica rapa, B. napus* and *Sinapis alba* to the flea beetles (Coleoptera: Chrysomelidae)

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Abstract. The attractiveness and susceptibility of three different cruciferous plant species - turnip rape, *Brassica rapa,* oilseed rape, *B. napus* var. *oleifera* subvar. *annua* and white mustard, *Sinapis alba* – to flea beetles of genus *Phyllotreta* (Coleoptera: Chrysomelidae) was studied. Despite the fact that the number of flea beetles on *S. alba* was almost the same as on the other plant species, damage to *B. rapa* and *B. napus* exceeded damage to *S. alba* throughout the observation period, $P < 0.05$. Flea beetles preferred to forage on *B. napus*:100% of the plants exhibited holes from eating both in cotyledon and in the first true leaf stage. Although 100% of plants of *B. rapa* were also damaged in seedling stage, in true leaf stage damage extended only to about 70%. Significantly less feeding damage occurred on *S. alba,* where eating traces were counted on about 70% of seedlings and less than 50% in true leaf stage. The mean damage score of *S. alba* was the lowest, 1,5 at the cotyledon stage and only feeding punctures, not shooting holes, were found on the leaves; the majority of the true leaves were undamaged or had single superficial holes. Most severely damaged was *B. napus:* the mean damage rating, 2.7 in the cotyledon stage and somewhat less, 2.4 in true leaf stage. *B. .rapa* had intermediate damage rating 2.2 in cotyledon stage and 1.9 in true leaf stage.

Key words: *Phyllotreta* spp. *Brassica napus, B. rapa, Sinapis alba,* attractiveness, susceptibility

INTRODUCTION

Flea beetles of genus *Phyllotreta* (Coleoptera: Chrysomelidae) are serious and almost cosmopolitan pests of cruciferous plants (Burgess, 1977). In northern regions these pests have only one generation per year. The most damaging stage to the rape crop is overwintered adults on seedlings in spring (Burgess, 1977). Young adults of the summer generation do not cause economically significant losses. Flea beetles' host range is restricted to plants of Crucifera, Capparidae and Tropaeolacea families (Feeny et al., 1970). Variation in susceptibility of cruciferous plants to flea beetles has been determined by many authors (Lamb, 1984; Bondaryk et al., 1994; Palaniswamy et al., 1992a; 1997). It is documented that "volatile mustard oil" attracts flea beetles to the Brassicas, but the question remains as to how this attraction might be used in pest management.

The aim of this work was to investigate attractiveness and susceptibility of three different cruciferous plants to the flea beetles.

METHODS

The experiment was conducted in three variants with three replicates in each: turnip rape, *Brassica rapa*, oilseed rape, *B. napus* var. *oleifera* subvar. *annua* and white mustard, *Sinapis alba.* Seeds were sown on 15 May 2005. The field was set-up in Latin square and plots (1x10 m) were separated by 1 m cultivated strips, surrounded by a summer wheat field. When the cotyledons emerged from the ground, 20 seedlings per plot along the centre rows of each plot were labelled, thus 60 seedlings in each variant were selected for assessment. The assessment was made twice in the cotyledon stage and three times in true leaf stage. On each assessment all seedlings and true leaves with feeding damage were determined; all the beetles were counted and the mean number of beetles per single plant was calculated. The damage rate of leaves was estimated visually according to the following scale: score 1 indicates no visible damage, 2 - less than 10 holes; 3 – from 10 to 20 holes; 4 – over 20 holes, and 5 – the leaf is totally destroyed (Smith, 2000). For statistical analyses one way ANOVA was used. All means were considered significantly different at the P = 0.05 level. Data are presented as mean ± standard error.

RESULTS

Plant development. White mustard sprouted first, followed by *B.rapa* and about five days later by *B. napus*. The development of *S.alba* was somewhat faster at first, but *B. rapa* required a shorter time to mature than *B. napus* and *S.alba*.

Weather conditions. Spring 2005 was extremely unfavourable for flea beetles. Cold, rainy and cloudy weather with low temperatures dominated during the period of emergence and in the first true leaf stage of the plants.

Infestation rate. The flea beetles were found on plots immediately after sprouting of the first seedlings.

By the first observation the number of beetles was somewhat higher on *S. alba* than on the *B.rapa;* the *B.napus* had not emerged yet. After emergence of *B. napus* the beetles colonised it immediately and the number of beetles equalised between the variants, $P > 0.05$ (Fig.1).

The number of flea beetles remained on a very low level almost throughout the whole observation period in all variants irrespective the species of the plant (Fig 1). Only by the last observation had the number of beetles on white mustard increased drastically in comparison with turnip rape and oilseed rape, $P = 0.000695$, $F_{2,6} = 7$ (Fig. 1).

Damage rate**.** Despite the fact that the number of flea beetles on *S. alba* was almost the same as on the other plant species, damage to *B. rapa* and *B. napus* exceeded damage to *S. alba* throughout the observation period, $P < 0.05$ (Fig. 2). Flea beetles preferred to forage on *B. napus;* 100% of the plants showed eating holes both in cotyledon and first true leaf stages. Also 100% of plants of *B. rapa* were damaged in seedling stage, but in true leaf stage damage extended only about to 70% (Fig 2). Significantly less feeding damage occurred on *S. alba*, where eating traces were counted on about 70% of seedlings and less than 50% in true leaf stage (Fig. 2).

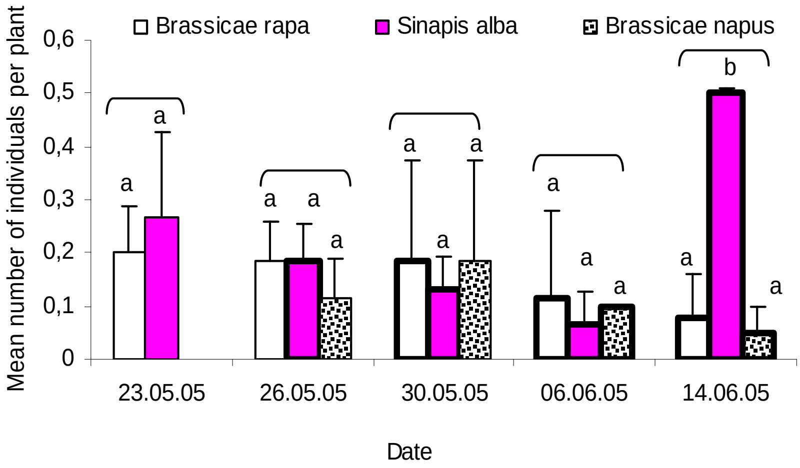

Fig. 1. Mean number of flea beetles, *Phyllotreta* spp. on three different cruciferous plants, *Brassica napus, B. napa* and *Sinapis alba.* Thin lined columns represent the cotyledon stage and bold lined columns the true leaf stage of plants. The bars on the columns indicate standard error of the mean. Mean values marked with same letters do not differ significantly (based on one way ANOVA test). The horizontal clippers indicate that statistical comparison is validated by grouping the measurement results of the same date.

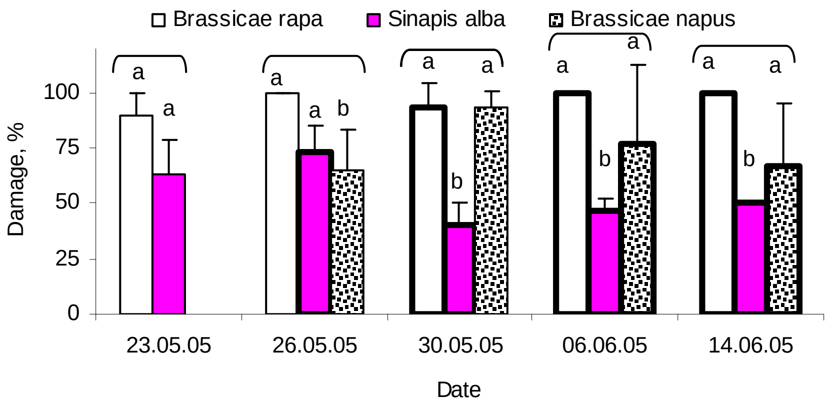

Fig. 2. Percentage of plants damaged by flea beetles, *Phyllotreta* spp. Thin lined columns represent the cotyledon stage and bold lined columns the true leaf stage of plants. The bars on the columns indicate standard error of the mean. Mean values marked with same letters do not differ significantly (based on one way ANOVA test). The horizontal clippers indicate that statistical comparison is validated by grouping the measurement results of the same date.

Damage score. The mean damage score of *S. alba* was the lowest, 1,5 at the cotyledon stage and only feeding punctures were on the leaves, not shooting holes; the majority of the true leaves were undamaged or had single superficial holes. Most severely was damaged *B. napus* the mean damage rating was 2.7 in the cotyledon stage and somewhat less, 2.4 in true leaf stage. *B.rapa* had intermediate damage rating, 2.2 in cotyledon stage and 1.9 in true leaf stage.

DISCUSSION

Attractiveness of plants in the mustard family to flea beetles results from the presence of various volatile mustard oils (Smith, 2000). The question remains how this attraction might be used in pest management. The use of trap crops to protect culture without the chemical control has been among research subjects for years. Cruciferous trap crop may have opposite effects. Firstly, flea beetles could be lured from the crops we need, to protect cruciferous trap crops that are more attractive. Later chemical treatment can be applied on this crop to destroy pest populations. On the other hand, flea beetles could be lured from long distances to trap crops, which they will quickly destroy. Next, the beetles could move to the cultivated plants if they haven’t another choice and therefore the feeding damage may even increase (Chaput, 1999).

Variation in susceptibility of cruciferous plants to flea beetles has been found by many researchers (Lamb, 1984; Bondaryk et al., 1994; Palaniswamy et al., 1992a; 1992b; 1997, etc.). *S. alba*, *B. rapa* and *B. napus* differ significantly in their attractiveness or palatability to flea beetles (Putman, 1977; Lamb, 1984; 1988; Brandt & Lamb, 1994). However attractiveness and susceptibility of plants to insect damage must be distinguished. Smith (2000) has found that green wave mustard and black and white mustard are more attractive trap crops for flea beetles than canola. But it doesn’t mean that beetles prefer feeding on mustard. We found that white mustard was as attractive as *B .napus* and *B .rapa,* and from time to time even more specimens were detected on this plant species. Despite that, *S. alba* was damaged to a lesser degree in cotyledons and especially in the first true leaf stages (Fig. 2)**.** If *B. rapa* and *B. napus* had shot holes in leaves, then *S. alba* feeding damage was observed as feeding trace looking like slight punctures. Hopkins et al. (1998) have realized as well that *S. alba* is less susceptible to damage by beetles than *B. napus.* According to Henderson (Henderson et al., 2004) *B. napus* is a preferred host and *S. alba* is a non-preferred host with with similar slight punctures moderating resistance to flea beetles.

There may be many reasons why the population density of flea beetles on mustard did not correlate to the damage caused by them. Nielsen (1988) suggests that flea beetles were deterred rather than repelled by *S. alba*. Cotyledons of *S .alba* possessed antixenotic resistance to the feeding of flea beetles (Elliot & Rakow, 1999). Palaniswamy and Lamb (1992a) and Lamb and Palaniswamy (1990) described white mustard as generally resistant to flea beetles. Plants with hairy leaves like *S. alba* are fed on by flea beetles less than hairless species (Lamb, 1980).

Different plant species in our experiment were sown very closely, and beetles were able to move from plot to plot feeding on *B. rapa* or *B. napus* in warm and sunny weather and resting on *S. alba* when the temperature was low. Rapid increase of the number of the beetles on *S. alba* by our last count (Fig. 1) is not connected with the beetle’s feeding preference but rather with the phenological development stage of plants. The flea beetles show a strong positive phototactic response (En-Cheng Yang et al., 2003) preferring open sunny places and therefore will be attracted to the tallest, earliest crop available. When *B. rapa* and *B. napus* had developed only a rosette stage, maintained low compact growth with no adequate illumination, at the same time *S. alba* had developed sparse elongated secondary racemes.

B. rapa and *B. napus* are described as susceptible plants to flea beetle damage. In our experiment somewhat less flea beetle feeding damage was observed on *B. napus* than on *B. rapa* (Fig. 2). The same results were achieved by Dosdall (Dosdall et al., 1999). Lamb (1988) has contrary records, Brandt and Lamb (1994) found that *B. napus* and *B. rapa* were approximately equal in susceptibility to flea beetle attack.

In order to protect cruciferous crops against flea beetle damage without chemical control we must choose the right strategy. If the trap crop has the same attractiveness as the main crop, then it should be planted 10 days before the primary crop to encourage beetles to stay in the trap crop area (Dosdall et al, 1999). The early-season trapcrop should be planted along the field edge farthest from the crop we need to protect. Good nutrition and favourable growing conditions of plants facilitate survival from beetle attacks by shortening their vulnerable growth stages.

ACKNOWLEDGEMENTS. This study was supported by grant no 6722 of the Estonian Science Foundation.

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