

Feeding Preferences of *Phyllotreta* Herbivores to Winter Rape and Chosen Weeds

JINDRA ŠTOLCOVÁ

Department of Entomology, Division of Plant Health, Crop Research Institute,
Prague-Ruzyně, Czech Republic

Abstract

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In model experiments with leaf disks from *Brassica napus* L. subsp. *napus* and *Thlaspi arvense* L. and *Sinapis arvensis* L. in spring periods (May–June) of 2006–2007 feeding preferences of *Phyllotreta* herbivores to the above-mentioned crop and two common weeds were investigated. In seedlings of identical ontogenetic stages insignificantly higher feeding injuries were recorded in *B. napus*. Between the two monitored weeds insignificantly higher herbivory was found in *S. arvensis* compared to *T. arvense*. In a comparison of older crop and younger weeds and vice versa, flea beetles significantly preferred the four-leaf seedling stage to the cotyledon seedling stage irrespective of the monitored plant species. Though generally in feeding preference of flea beetles a general drift *B. napus* > *S. arvensis* > *T. arvensis* was recorded, the sequence of leaves also played its role under conditions of this experiment.

Keywords: feeding preference; crop; weeds; *Brassicaceae*; herbivory; *Phyllotreta* spp.; model experiments

Recently, the role of injurious pests in agroecosystems has been re-evaluated, both of entomofauna and weeds, aimed to maintain the high level of biodiversity in agroecosystems.

It is known that a subcritical amount of weeds increases the level of biodiversity and favourably influences the occurrence of pest antagonists.

In this context the importance of weeds for pests themselves is evaluated less frequently, or the importance of another crop by way of “trap of pests” (TRDAN *et al.* 2005) or biostrips (LETHMAYER *et al.* 1997) in order to eliminate or compensate negative impacts of pests on the crop.

Just from this point of view this paper is based on the question if some weeds could be preferred by herbivores. Considering the opinion that oilseed crops and cruciferous vegetables are of high economic

importance and that cruciferous plants are ideal for biological studies as their chemistry is well understood and they support pest species from a wide range of insects (FINCH & COLLIER 2000) the species of the genus *Phyllotreta* and family *Brassicaceae* were used in this study for model experiments.

Feeding preferences of *Phyllotreta* spp. between (*Brassica napus* L. subsp. *napus*) – crop and (*Thlaspi arvense* L.) and (*Sinapis arvensis* L.) – common weeds were investigated.

MATERIAL AND METHODS

Model experiments were conducted in the Crop Research Institute at Prague-Ruzyně in spring periods of 2006–2007.

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In model treatments flea beetles of the genus *Phyllotreta* (*Phyllotreta nigripes* Fabricius, *Phyllotreta atra* Fabricius) currently occurring in field conditions on cruciferous plants were used. Flea beetles were sampled with an exhaustor in the field from plant species used in a model experiment; collected flea beetles were kept in PVC tubes in a fridge till the start of the experiment.

The plant species used in model experiments were: weeds – *Thlaspi arvense* L. (field penny-cress) and *Sinapis arvensis* L. (wild mustard), crop – *Brassica napus* L. subsp. *napus* (winter rape). All plants were grown from seeds to get distinct even-aged or all-aged cohorts of plant seedlings.

In all experiments only leaf disks removed with a cork borer from seedling leaves were used.

In a preference experiment with even-aged seedlings *T. arvense* and *B. napus* plants were grown till the stage of fully developed cotyledons. Leaf disks from cotyledons were sampled and put into the experiment.

In a preference experiment with all-aged seedlings *T. arvense*, *S. arvensis* and *B. napus* seeds were sown on different dates to get cohorts of older crop (*B. napus*) and younger weeds (*T. arvense*, *S. arvensis*) and vice versa to get cohorts of younger crop (*B. napus*) and older weeds. Leaf disks of younger plants were sampled from the cotyledon seedling stage of respective plants. Leaf disks of older plants were sampled from upper leaves of the four-leaf seedling stage of respective plants.

Plastic pots were used in model experiments. The whole bottom of each plastic pot was covered by a foam ring ca 1 cm thick. On this ring another foam ring 1–2 mm thin with disk-sized holes was placed. Both thick and thin foam rings were saturated with water. Five disks of each monitored species sampled from leaves of seedlings were inserted into the holes into 1 pot. It represents in total 10 disks per one pot in an experiment with *B. napus* and *T. arvense* and 15 disks per 1 pot in an experiment with *B. napus*, *T. arvense* and *S. arvensis*. Five flea beetles were put into each plastic pot. The plastic pot was covered by monofilament textile and fastened with a rubber band.

These plastic pots, both experimental and control variants (without flea beetles), in 20 replications were put into a climatic chamber under 20°C thermal and 16/8 h light schedule. During the 5-day experiment both experimental and control variants were monitored and supported by water; in the experimental variant dead flea beetles were potentially replaced.

After the 5-day experiment the flea beetles were removed. The frequency of attack (presented as a percentage proportion of disks attacked by flea beetles over 5 days) of individual species regardless of the intensity of feeding injury was recorded. Consequently, leaf disks were extracted and after drying at 80°C their dry weight biomass (g) per 1 disk was determined. Dry weight biomass (g) consumed during the experiment per 1 flea beetle was counted. Dry weight biomass determination was based on a comparison of dry weights on controls with dry weights on treated variants for the individual plant species.

The data were analysed by Basic Statistical Methods, Two-sample Analysis (program Statistica).

RESULTS

Brassica napus and *Thlaspi arvense*

Dry weight biomass of disks from *B. napus* cotyledons was on average approximately twice higher (5.56×10^{-4} g) than dry weight biomass of disks from *T. arvense* cotyledons (2.18×10^{-4} g) (Figure 1). The frequency of attack of disks in *T. arvense* was higher (88%) compared to *B. napus* (77%). The amount of dry weight biomass consumed by 5 flea beetles in 1 pot during the 5-day experiment in *B. napus* was 2.8×10^{-4} g, i.e. 1.12×10^{-5} g/1 flea beetle per day.

The amount of dry weight biomass consumed in *T. arvense* was lower, 2.2×10^{-4} g of dry biomass,

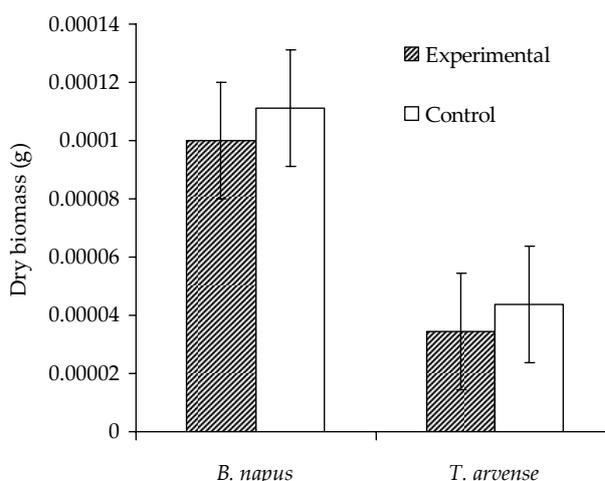


Figure 1. Dry weight biomass of leaf disks from *Brassica napus* and *Thlaspi arvense* cotyledons in experimental and control variants

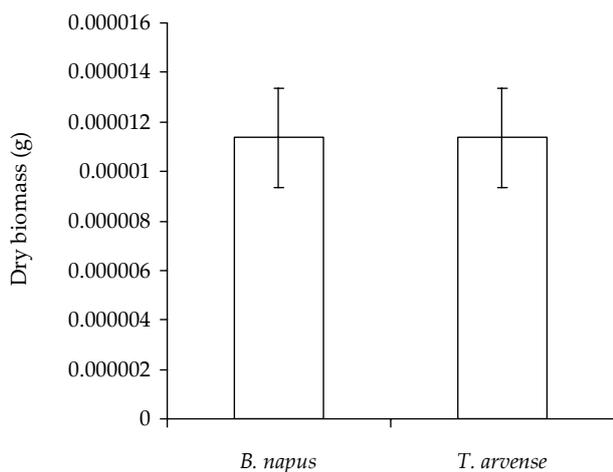


Figure 2. Dry weight biomass consumed by *Phyllotreta* herbivores in *Brassica napus* and *Thlaspi arvense* cotyledons

which is 8.8×10^{-6} g/1 flea beetle per day (Figure 2). The difference between dry weight biomass consumed in *B. napus* and *T. arvense* cotyledons was not significant.

Brassica napus, *Thlaspi arvense* and *Sinapis arvensis*

Older crop and younger weeds. Dry weight biomass of disks from four-leaf *B. napus* seedlings was on average more than double (3.46×10^{-4} g) compared to disks from *T. arvense* (1.38×10^{-4} g), and *S. arvensis* (1.42×10^{-4} g) cotyledons (Figure 3). The frequency of attack of disks by *Phyllotreta* herbivores was highest in *T. arvense* (89%) and lowest in *S. arvensis* (58%); in *B. napus* it was 68%.

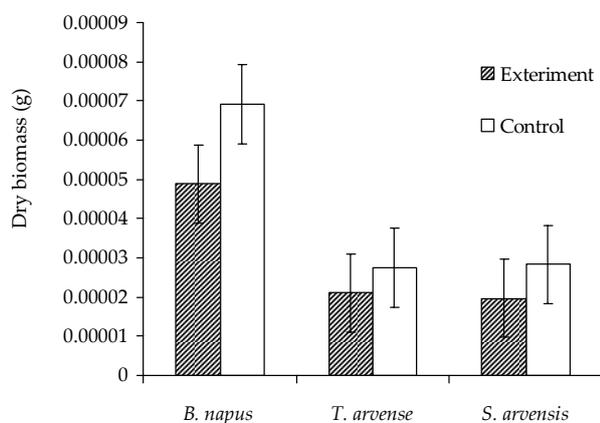


Figure 3. Dry weight biomass of leaf disks from *Brassica napus* upper leaves and *Thlaspi arvense* and *Sinapis arvensis* cotyledons in experimental and control variants

The maximum amount of dry weight biomass consumed by 5 flea beetles in 1 pot during the 5 day-experiment was in *B. napus* (5.1×10^{-4} g), which is 2.04×10^{-5} g/1 flea beetle/1 day. The lowest amount of consumed dry weight biomass was found in *T. arvense* cotyledons (1.6×10^{-4} g), that means 6.4×10^{-6} g/1 flea beetle/1 day. In *S. arvensis* cotyledons the dry weight biomass consumed by flea beetles amounted to 2.2×10^{-4} g, which is 8.8×10^{-6} g/1 flea beetle/1 day (Figure. 4). The amount of dry weight biomass consumed from the four-leaf stage of *B. napus* seedlings was significantly higher compared to dry weight biomass consumed from *T. arvense* and *S. arvensis* cotyledons. The difference in the amount of consumed dry weight biomass between weeds was not significant.

Brassica napus, *Thlaspi arvense* and *Sinapis arvensis*

Dry weight biomass of disks from *B. napus* cotyledons (4.96×10^{-4} g) was on average comparable to dry weight biomass of four-leaf stage *S. arvensis* seedlings (5.124×10^{-4} g). Dry weight biomass of disks from four-leaf stage *T. arvense* seedlings was considerably lower (3.166×10^{-4} g) (Figure 5). The frequency of attacks of disks by *Phyllotreta* herbivores was highest in *T. arvense* again (69%) compared to 58% in *S. arvensis* and 54% in *B. napus*. The maximum amount of dry weight biomass consumed by 5 flea beetles in 1 pot during the 5-day experiment was in *S. arvensis* (4.82×10^{-4} g) and *T. arvense* four-leaf stage seedlings (3.48×10^{-4} g), that means $1.928 \cdot 10^{-5}$ g/1 flea beetle/1 day and

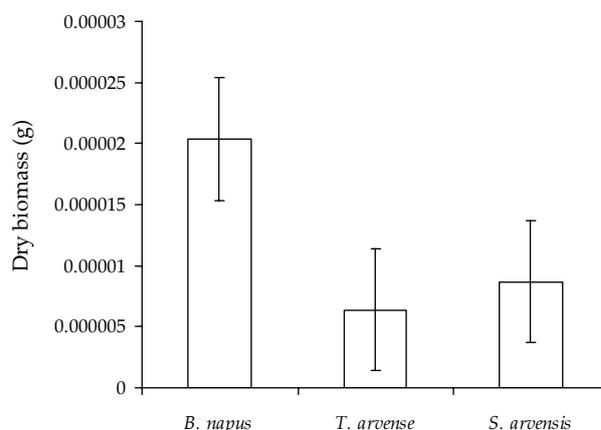


Figure 4. Dry weight biomass consumed by *Phyllotreta* herbivores in *Brassica napus* upper leaves and *Thlaspi arvense* and *Sinapis arvensis* cotyledons

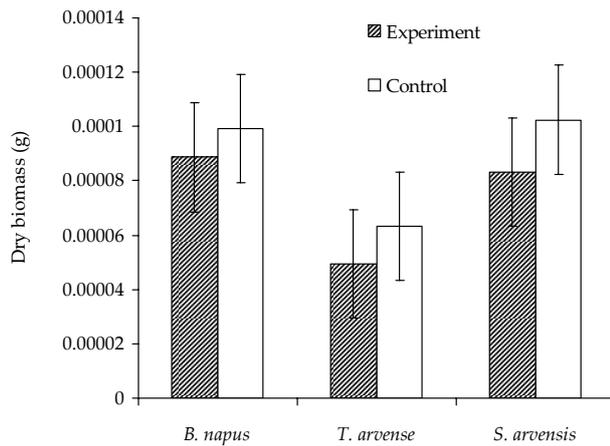


Figure 5. Dry weight biomass of leaf disks from *Brassica napus* cotyledons and *Thlaspi arvense* and *Sinapis arvensis* upper leaves in experimental and control variants

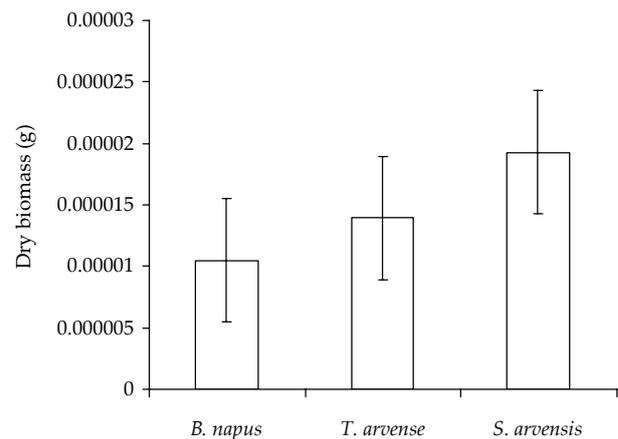


Figure 6. Dry weight biomass consumed by *Phyllotreta* herbivores in *Brassica napus* cotyledons and *Thlaspi arvense* and *Sinapis arvensis* upper leaves

1.392×10^{-5} g/1 flea beetle/1 day, resp. The lowest amount of dry weight biomass was consumed in *B. napus* cotyledons (2.62×10^{-4} g), which is 1.048×10^{-5} g/1 flea beetle/1 day (Figure. 6). The amount of dry weight biomass consumed from *B. napus* cotyledons was significantly lower compared to dry weight biomass consumed from *T. arvense* and *S. arvensis* in four-leaf stage seedlings. The difference in the amount of consumed dry weight biomass between weeds was not significant.

DISCUSSION

In the present paper no explicit preferences of herbivores to the crop *Brassica napus* subsp. *napus* or weeds *Thlaspi arvense* and *Sinapis arvensis* were found. In seedlings in the stage of cotyledons insignificantly higher feeding injuries were recorded in *B. napus* compared to *T. arvense*. Between the two monitored weeds insignificantly higher herbivory was found in *S. arvensis* compared to *T. arvense* under conditions of identical ontogenetic seedling stages.

In their experiments with plants from the family *Brassicaceae* BROWN *et al.* (2004) reported differences in *Phyllotreta cruciferae* injury both among species and among genotypes within one species; they found species differences in *Phyllotreta cruciferae* infestation and feeding injury regardless of the ontogenetic stage of seedlings.

However, the ontogenetic stage of seedlings played a role in our experiment. Although young

seedlings are known to be mostly infested by herbivores mainly in the stage of cotyledons, flea beetles in the presented experiment significantly preferred four-leaf stage seedlings to cotyledons irrespective of the monitored plant species. Different feeding injury in cotyledons and upper leaves may be related to different age of leaves and consequently to different glucosinolate level. SIEMENS and MITCHELL-OLDS (1996) found that herbivory by the specialist flea beetle *Phyllotreta cruciferae* (Goeze) varied curvilinearly with natural levels of glucosinolates in *Brassica rapa* so that maximum herbivory occurred at intermediate glucosinolate levels.

Rightly different quality of leaves may play a role in discrepancy between the frequency of attacks of disks and the intensity of feeding injury by flea beetles in individual species. The higher frequency of attacks in *T. arvense* compared to *B. napus* may be related to higher specific dry weight biomass of *B. napus* leaves and consequently to the higher amount of consumed dry weight biomass. In addition, the prefeeding behaviour of herbivores may also play its role. HENDERSON *et al.* (2004) monitored the prefeeding behaviour of *Phyllotreta cruciferae* on host and non-host crucifers; they recorded 3 stages of prefeeding behaviour where antennal and tarsal chemoreceptors are important for determination of host plant quality.

On the basis of this experiment it is impossible to identify distinctly differences in flea beetle preferences to the monitored crop *B. napus* and common weeds, *T. arvense* and *S. arvensis*, from the

family *Brassicaceae*. Though generally in feeding preference of flea beetles a general drift *B. napus* > *S. arvensis* > *T. arvense* was recorded, the sequence of leaves also played a role under conditions of this experiment.

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Corresponding author:

RNDr. JINDRA ŠTOLCOVÁ, Výzkumný ústav rostlinné výroby, v.v.i., odbor rostlinolékařství, oddělení entomologie, 161 06 Praha 6-Ruzyně, Česká republika
tel.: + 420 233 022 291, fax: 420 233 311 592, e-mail: stolcova@vurv.cz
