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ABUNDANCE OF THE SMALL WHITE (*PIERIS RAPAE* L.) ON DIFFERENT CABBAGE CULTIVARS

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Abstract

The aim of the present study was to determine the association and dynamic of small white (*Pieris rapae* L.) on five different white cabbage *(Brassica oleracea* var*. capitata f. alba*) cultivars. The experiment showed that butterflies preferred medium cultivar ʻKrautkaiserʼ as the site for oviposition; 35.8% of eggs and caterpillars counted during the observation period were gathered from this plant. The next choice was late-maturing cultivar ʻLennoxʼ by 21.6%. In comparison with the previous cabbage variants, the butterfly selected the medium cultivar ʻKrautmanʼ (13.9%) and early cultivar ʻParelʼ (12.3%) as the site for oviposition considerably less.

Key words: cabbage cultivars, *Pieris rapae*, food plant, oviposition.

Introduction

Small white (*Pieris rapae* L.) is an important pest on cruciferous crops in Estonia, where it can produce two generations per year. The caterpillars of the first generation feed on cruciferous weeds and the generation of second on cultured plants.

A single female can lay 300–400 eggs, however, the number of eggs may also be as large as 1,000. Each young larva occupies an outer leaf of cabbage for feeding. Older larvae move onto inner cabbage leaves and cabbage head, eating outer leaves of the cabbage head and gnawing passages into it. In the case of cauliflower, inflorescences are destroyed. Apart from direct destruction, areas between leaves and inflorescences are soiled with excrements and as a result rotten easily.

It is generally known that various plant characteristics influence host plant selection in herbivorous insects, but plant chemistry can be especially important. For example, secondary plant metabolites are used by several insects for recognition of their host plants /Radcliffe, Chapman, 1966; Chew, 1988; Städler, 1992/. The typical pattern of host location among adult *Lepidoptera* is the use of plant odours for longer-range detection and evaluation of potential host plants, followed by contact chemoreception for selection of oviposition sites /Schoonhoven et al., 1998/.

The choice of egg-laying sites is also influenced by several other factors. The hypothesis that adult females prefer to oviposit on the plant species which had served as

their larval food plant is known as the Hopkins host selection principle /Szentesi, Jermy, 1990/.

Host plants of small white include different cruciferous like: cabbage (*Brassica oleracea* var. *capitata*), turnip (*B. napus* var. *napobrassica)*, cauliflower (*B. oleracea* var. *botrytis)*, rape (*B. napus* ssp. *oleifera*), and horseradish (*Armoracia rusticana*). Butterfly lays eggs on plants from other families as well. A precondition is that those plants, like cruciferous plants, must contain glucosinolates. The glucosinolates have been documented as feeding stimulants, attractants, or oviposition cues for many insects /Städler, 1992; Hern et al., 1996/.

The content of glucosinolates in different plant species is greatly varying. For example, in some plant species it makes up to 1% of dry weight /Rosa et al., 1997/, and seeds of some plants may contain as much as 10% of glucosinolates /Josefsson, 1970/. Distribution of glucosinolates differs in different parts of plants. Younger plants and/or parts of plants have generally higher glucosinolate content than older ones.

Smelling sense of insects is very specific, and, in the case of choice between different cruciferous species and varieties, it appears that insects have firm preferences. To identify these preferences, much research has been carried out. By isolating oviposition sites where odour /Hillyer, Thorsteinson, 1969/, or shape and colour /Alonso-Pimentel et al., 1998/ served as the stimulus, the influence of those stimuli to oviposition activity has been studied. Oviposition activity is also influenced by the quality of the host plant as well as the planting of insect- repellent plants around host plants.

The aim of the present work was to study the effects of cabbage cultivars on the oviposition activity of small white, *Pieris rapae.*

Materials and Methods

The experiments were carried out in the experimental garden of the Estonian University of Life Sciences. In the experimental field there were five white cabbage *(Brassica oleracea* var.*capitata f.alba*) cultivars. The sample cultivars included one early cultivar – 'Parel', two medium cultivars – 'Krautman' and 'Krautkaiser', and two late-maturing cultivars – 'Lennox' and 'Turquoise'. The experiment included three replications, the size of the experimental plot was 2 x 2 m², and each plot had 9 plants. Observations lasted from 18 July to 5 September. Once a week all eggs and caterpillars in all experimental cabbage plots were counted and removed from plants to avoid repeated counting.

Data were presented as mean ± standard error. Statistical comparisons were performed with repeated-measures ANOVA by Tukey test. All means were considered significantly different at the $P<0.05$ level.

Results and Discussion

The experiments showed that butterflies preferred white cabbage cultivar 'Krautkaiser' as the site for oviposition; 35.8% of eggs and young caterpillars counted during the observation period were gathered from this variant. The next choice of the butterfly was 'Lennox' by 22.6%. In comparison with the previous cabbage cultivars, the butterfly selected considerably less 'Turquoise' (15.4%), 'Krautman' (13.9%) and 'Parel' (12.3%) as the site for oviposition.

A statistical analysis (ANOVA) of the results indicated that, compared with cultivars ʻKrautmanʼ and ʻParelʼ the number of small white was reliably larger on ʻKrautkaiserʼ ($p<0.05$) (Figure 1) during the whole period of the experiments. Both on ʻParelʼ and ʻKrautmanʼ variants the oviposition activity of small white was low during the whole period of experiments, and a comparison of these variants showed no statistical reliability.

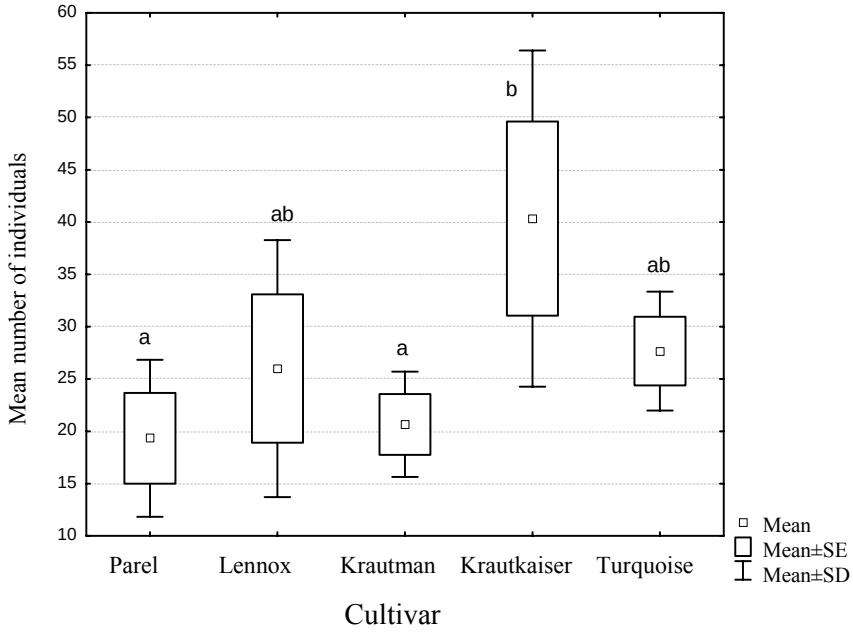

Figure 1. Mean number of individuals of small white (*Pieris rapae* L.) on different cabbage cultivars. Means followed by the same letter are not significantly different ($P<0.05$)

The dynamics of the number of Pieris rapae larvae. During the first observation (18.07), the highest number of larvae was found on early cultivar ʻParelʼ (Figure 2). Only few larvae were found on ʻLennoxʼ, ʻKrautmanʼ and ʻKrautkaiserʼ, on ʻTurquoiseʼ variant there were no larvae on the plants. There were statistically significant differences in the mean number of these variants compared with ʻParelʼ ($P = 0.023$). During the second observation (25.07), the highest number of larvae was found on medium cultivar ʻKrautkaiserʼ and, less on the other cabbage cultivars. A comparison of the variants showed that ʻKrautkaiserʼ had statistically reliably ($df = 4$, $F = 3.27$, $P<0.05$) more larvae than the other variants. The third observation (01.08) revealed again most of larvae on ʻKrautkaiserʼ, less on ʻTurquoiseʼ, ʻKrautmanʼ and ʻLennoxʼ, but ʻParelʼ had only few larvae. A comparison of the variants showed that cabbage cultivar ʻKrautkaiserʼ had statistically reliably ($df = 4$, $F = 2.46$, $P<0.05$) more larvae than on other variants. The fourth observation (09.08) revealed the bigger number of larvae on ʻKrautkaiserʼ, ʻTurquoiseʼ and ʻLennoxʼ variants, less was found on ʻParelʼ and ʻKrautmanʼ. However,

the difference in the numbers of larvae on different cabbage cultivars was not statistically reliable ($df = 4$, $F = 2.68$, P 0.09). During the fifth (15.08) observation the highest number of larvae was found on late-maturing cultivar 'Turquoise' and, less on other variants. The comparison of the variants showed that 'Turquoise' had statistically reliably ($df = 4$, $F = 3.27$, $P<0.05$) more larvae than the other variants. At the sixth (22.08) observation, few larvae were found on all test variants. During the seventh (29.08) and eighth (05.09) observation no larvae were found, and the experiment was finished.

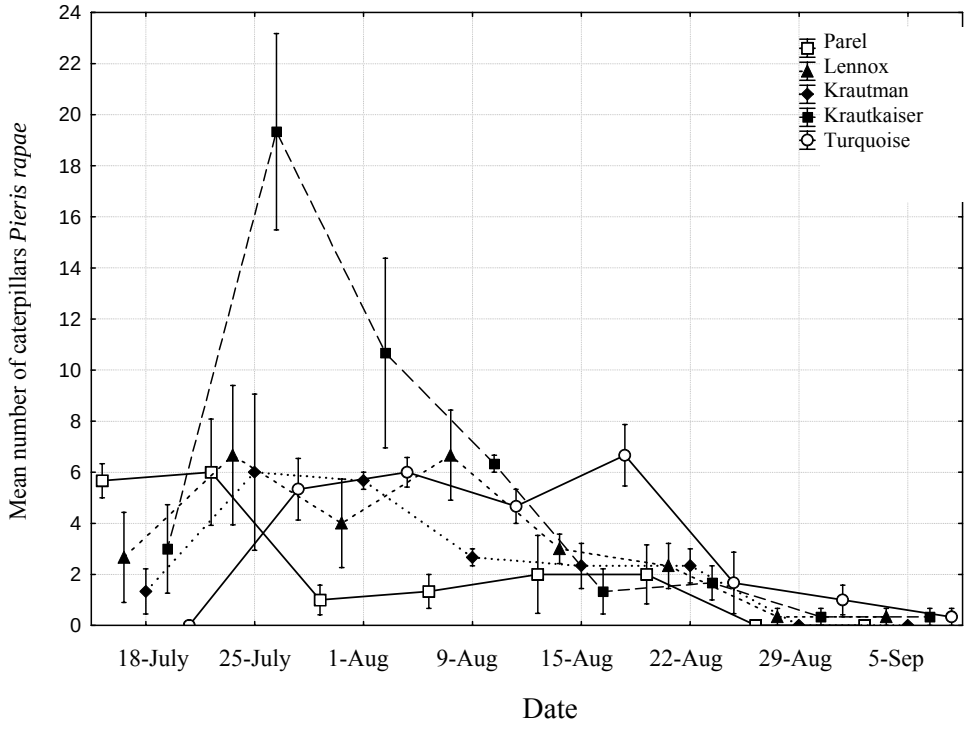

Figure 2. Dynamics of *Pieris rapae* caterpillars on different cabbage cultivars

Small white is a cosmopolitan butterfly species that accepts for the development of its offspring only plant species producing glucosinolates. Most of such plants belong to the cruciferous family. Small white ranks host plants by their suitability. For example, the first to be selected are varieties and cultivars of cabbage, the second are worm-seed mustard (*Erysimum*) and wallflower (*Cheiranthus*). There are receptors on the tarsi of female individuals of small white /Städler et al., 1995/, mediating information on the chemical content of leaf surface /Van Loon et al., 1992/. Therefore, prior to oviposition, the female evaluates a potential host plant by drumming the leaf surface with her foretarsi, being able to differentiate not only between different plant species and varieties but the age of leaves /Ives, 1978/. Since our experiment involved different cabbage cultivars, small white was able to detect and prefer different cultivars, but also detect the specific age of leaves. Leaves of middle age were chosen as oviposition substratum in

our experiment. At the beginning of our observation small white preferred early cabbage cultivar 'Parel', later this cultivar was not favoured probably by age of outer leaves. Later, middle cultivar 'Krautkaiser' was preferred, and at the end of the experiment the late-maturing cultivar 'Turquoise' was favoured. Therefore oviposition preference directly depended on plant age.

Adults of small white cover large distances in search of oviposition sites, although their flight is rather slow. The oviposition tactics of small white is such that in the case of scarcity of plants a butterfly lays only one egg and continues its flight in search of a new plant, and if there are plenty of plants suitable for oviposition it stays in the same area for a long time /Hiiesaar et al., 2002/. Eggs of the butterfly contain a deterrent pheromone preventing other butterflies from laying eggs on the same leaf /Hern et al., 1996/ Thereby an optimum amount of eggs on one plant is ensured. On the basis of the results obtained with 'Krautkaiser' and 'Parel', it can be concluded that there was repeated egg-laying of *Pieris rapae* females on 'Krautkaiser' variant as larvae were found within a long period of time. On 'Parel' eggs were laid only during short period.

In choosing sites for oviposition insects are influenced by signals of plants, whereas odour is the first signal. For species feeding on cabbages the existence of glucosinolates plays the key role /Chew, 1988/. The content of glucosinolates in different plant species is greatly varying. Distribution of glucosinolates differs even in different parts of plants /Josefsson, 1970; Rosa et al., 1997/. Younger plants and parts of plants have generally higher glucosinolate content than older ones /Louda, Rodman, 1983; Masiunas, Eastman, 1999/ and probably this might be one of the reasons why small white moves from early cultivar to medium and then to late maturing cultivar.

Conclusions

The *Pieris rapae* butterflies preferred white cabbage cultivar 'Krautkaiser' as the site for oviposition. The egg laying activity was high during the whole experimental period in this variant. The next choice was late-maturing cultivar 'Lennox'. In comparison with the previous cabbage variants, the butterfly selected the medium cultivar 'Krautman' and early cultivar 'Parel' as the site for oviposition considerably less.

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