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Influence of white cabbage cultivars on oviposition preference of the *Pieris rapae* L. (Lepidoptera: Pieridae)

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Abstract. The aim of the present study was to determine the oviposition preference of Small White (*Pieris rapae* L.) on five different white cabbage *(Brassica oleracea* var. *capitata f. alba*) cultivars. The experiment showed that in first year butterflies preferred late-matured cultivar ′Krautkaizer′ as the site for oviposition; 35.8% of eggs counted during the observation period were gathered from this plant. The next choice was mid-season cultivar ′Lennox′ by 21.6%. In second year the preferred cultivars were late-matured ′Turquoise′ (26%), ′Lennox′ (22.1%) and ′Krautkaizer′ (20%). The egg laying activity was high during whole test period in both years of those variants.

Key words: white cabbage cultivars, butterfly, *Pieris rapae*, food plant, oviposition preference

INTRODUCTION

All herbivorus insects show some degree of host selectivity. Under natural conditions, insects confront many external stimuli, their own internal physiological stimuli, and a series of environmental constraints (Badenes et al., 2004). This makes it very difficult to the insect to discern the relative importance of chemical, visual, and mechanical stimuli from host and non-host plants (Hooks & Johnson, 2001). However, it is generally assumed that the host selection process in specialist insects is governed primarily by volatile chemical signals, later by visual stimuli, and finally by non-volatile chemical signals (Hooks & Johnson, 2001, Santiago et al., 2006).

Female butterflies reject many potential hosts when searching for egg laying sites. Host plant recognition and selection in Lepidoptera is a primary function of the ovipositing female and since newly emerged larvae are often limited in their dispersal abilities, oviposition is particularly crucial as it determines survival of their progeny (Renwick, 1989). Visual factors such as shape, colour and size, in many cases studied, were significant (Renwick and Chew, 1994), but chemical cues unambiguously play the major, if not decisive, role in host selection (Udayagiri and Mason, 1995).

Plant chemistry is probably the most important source of information contributing to the final decision by an insect to oviposit or not. It is actually the balance of opposing positive and negative cues evoked by phytochemicals that determines whether a plant is accepted or rejected by herbivore (Huang and Renwick, 1995, Renwick and Chew, 1994).

Small white (*Pieris rapae* L.) has been an important pest on cruciferous cultures in Estonia. In Estonian conditions it can produce two generations per year. The first generation feeds on cruciferous weeds and the second generation on cultured plants. Host plants of *P. rapae* include different cruciferous like: cabbage (*Brassica oleracea* var. *capitata* L.), turnip (*B. napus* var. *napobrassica* L.*),* cauliflower (*B. oleracea* var. *botrytis* L.*),* rape (*B. napus* ssp. o*leifera* L.), and horseradish (*Armoracia rusticana* P.Gaertn., B.Mey. et Scherb.). A single female can lay in average 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 into cabbage head, eating outer leaves of the cabbage head and gnawing passages into it. Plants soiled with excrements rotten easily.

P. rapae is a cosmopolitan butterfly species that accepts for oviposition and feeding only plant species producing glucosinolates, notably plants belonging to Brassicaceae. It is a common insect pest of Brassica crops. Egg-laying *P. rapae* can discriminate between potential host plants using visual cues before alighting (Jones, 1977; Ives, 1978; Myers, 1985). Prior to oviposition, the female evaluates a potential host plant by drumming the leaf surface with her fore-tarsi. Gustatory receptors present on the tarsi of Pieris females (Ma & Schoonhoven, 1973; Städler, et al., 1995) mediate information on the chemical composition of the intact leaf surface that bears glucosinolates (Renwick et al., 1992; van Loon et al., 1992).

Smelling sense of insects is very specific, and, in 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 growing of repellent plants between host plants. *P. rapae* is capable of discriminating between different species of brassicaceous plants, and between different leaf ages within a cabbage plants (Ives, 1978).

Decreasing attractiveness for oviposition could be an important mechanism by which a plant can limit damage inflicted upon it by *P. rapae*. We conducted a field study to determine if some cultivars of cabbage were more attractive to oviposition than others. Knowledge of *P. rapae* susceptibility of white cabbage cultivars will enable growers to employ the most appropriate control tactics for a particular cultivar.

MATERIALS AND METHODS

The experiments were carried out in the experimental garden of the Estonian University of Life Sciences in summer 2007 and 2008. The following five cultivars of white cabbage *(Brassica oleracea* var.*capitata f.alba*) were used: one early cultivar – ′Parel′; two mid-season cultivars – ′Krautman′ and ′Lennox′ and two late-matured cultivars – ′Krautkaizer′ and ′Turquoise′. The experiment included three replications, the size of experimental plots was 2 x 2 m^2, and each plot had 9 plants. Observations lasted from July to September. Once a week all eggs and caterpillars in all experimental cabbage plots were counted and removed from plants to avoid repeated counting. No pesticides were sprayed on the crops. Statistical comparisons were performed with one-way ANOVA followed by Tukey test. All means were considered significantly different at the $P < 0.05$ level.

RESULTS AND DISCUSSION

A statistical analysis (ANOVA) of the results indicated that in first year, compared with cultivars ′Krautman′ and ′Parel′ the number of eggs was reliably larger on ′Krautkaizer′ (ANOVA $P < 0.05$ $F_{4.16} = 2.46$; Tukey test $P = 0.01$) (Fig. 1) during the whole period of the experiment. Both on ′Parel′ and ′Krautman′, the oviposition activity of *P. rapae* was low during the whole period of experiment, and a comparison of those variants showed no statistical reliability.

The experiments of second year showed that significantly more eggs were laid on ′Turquoise′, ′Krautkaizer′ and ′Lennox′ than on other cultivars (ANOVA $P < 0.05$, $F_{4.29} = 3.25$; Tukey test $P < 0.03$) (fig. 2). ′Krautman′ was more attractive to oviposition that ′Parel′. A statistical comparison of ′Parel′ and ′Krautman′ showed that statistically more eggs were found on ′Krautman′ (ANOVA $P < 0.05$, $F_{4.29} = 6.12$; Tukey test $P < 0.012$).

When choosing oviposition sites, 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; Chew & Renwick, 1995; Poelman et al., 2008). Adults of *P. rapae* cover large distances in search of oviposition sites, although their flight is rather slow. The oviposition tactics of *P. rapae* 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).

Manipulated cage and field experiments have demonstrated that *P. rapae* females distinguish between cabbage varieties and plants of the same variety. Intravarietal preferences were for plants that were larger (Ives, 1978), greener (associated with a higher nitrogen and water content (Myers, 1985)). At the beginning of our observations, *P. rapae* preferred early cabbage cultivar ′Parel′, later this cultivar was not favoured probably due to age of outer leaves. Later, a mid-season cultivar ′Lennox′ and in the end of the experiment, the late-matured cultivars ′Krautkaizer′ and ′Turquoise′ were favoured. This result agrees with Jones (1977) and Jones & Ives (1979) reports that oviposition preference of *P. rapae* depended from physiological age of the host plants.

Jones & Ives (1979) showed a complex of responses to plant age, the butterflies aggregate their eggs on middle-aged plants. Since our experiment involved different cabbage cultivars, *P. rapae* was able to detect and prefer different cultivars, but also detect the specific age of leaves. The physiological maturity of cultivars growing alongside reached at different times and late matured cultivars had a longer period of time to give suitable plant tissues; therefore *P. rapae* had possibility to lay more eggs on those cultivars.

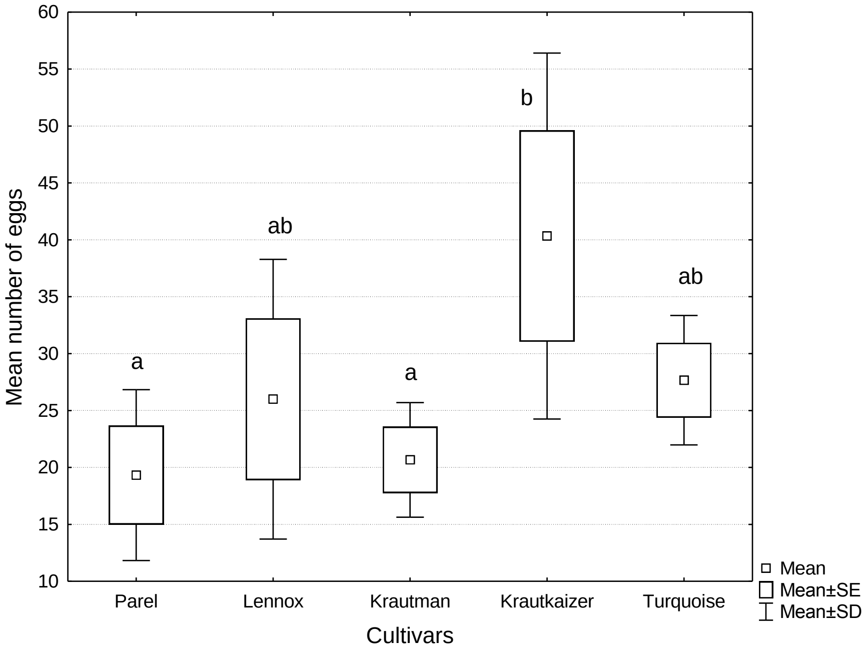

Fig. 1. Number of eggs of *Pieris rapae* on different cabbage cultivars in 2007. Means followed by the same letter are not significantly different ($P < 0.05$).

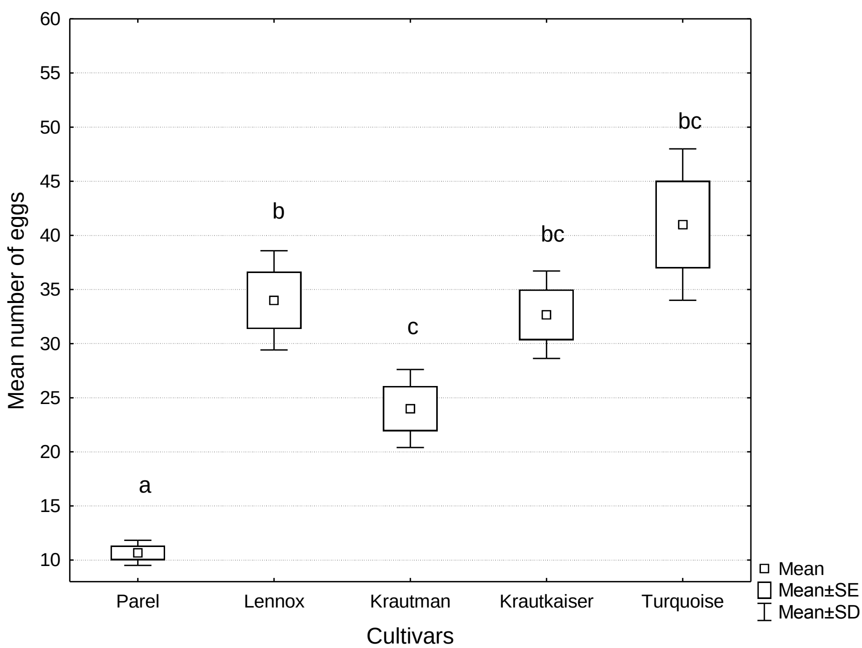

Fig. 2. Number of eggs of *Pieris rapae* on different cabbage cultivars in 2008. Means followed by the same letter are not significantly different ($P < 0.05$).

CONCLUSIONS

The experiments showed that *P. rapae* butterflies preferred late matured cultivars of white cabbage as the site for oviposition. Butterflies preferred more white cabbage cultivars ′Krautkaiser′ and ′Turquoise′, where egg laying activity was high during the whole period of experiments. Butterfly selected considerably less mid-season cultivar ′Krautman′ and early cultivar ′Parel′ as the site for oviposition.

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