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THE EFFECT OF LEAF COLOUR OF SELECTED FIELD BEAN CULTIVARS WHICH DIFFER IN ATTRACTING BLACK BEAN APHID (*APHIS FABAE* SCOP.)

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Abstract: The study was carried out in 2003, in a micro-plot experiment established in the Experimental Garden of the University of Warmia and Mazury. Following our previous long-term field observations on the infestation of a number of field bean cultivars by black bean aphid, three cultivars were selected for the present study. The cultivars demonstrated different attractiveness to the pest insects: cultivar Tinos was preferred by aphids, cv. Dino was less readily chosen and cv. Nadwiślański was the least preferred variety. The computer analysis of leaf colour enabled us to distinguish between the cultivars. The three examined cultivars are different in the colour of leaves, although the differences between cv. Dino and Nadwiślański being nearly negligible, especially in terms of hue (H) and intensity (I).

Key words: *Aphis fabae* Scop., black bean aphid, *Vicia faba* v. *minor*, field bean, computer image analysis

INTRODUCTION

Black bean aphid *Aphis fabae* Scop. is a phytophagous insect which poses an enormous threat to plantations of field bean *Vicia faba* v. *minor* (Goszczyński *et al*. 1992; Sądej 1996). In gradation years, dynamically growing colonies of black bean aphid can cause a complete loss of field bean seed yield (Niezgodziński 1993).

Polish cultivars of field bean are highly varied in their attractiveness to migrating black bean aphids (Złotkowski 1999; Sądej 2000). Kennedy (1976) claims that when

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choosing a host plant, aphids follow signals such as the plant's height and exterior, size of leaves and the angle at which they are set on stems, colour of the plant and length of light waves reflecting from the leaf surface. Wiwart and Sądej (1999) found out that the choice of host plants by aphids is most probably conditioned mainly by the colour of leaves, with lighter plants being more readily settled on than plants darker in colour.

Establishing why this happens can help to diminish substantially, although indirectly, the loss in seed yields and improve the economic profitability of field bean cultivation.

The purpose of the present study was to evaluate the colour of leaves using computer image analysis on three field bean cultivars, selected on the basis of earlier, long-term studies on field bean attractiveness to *A. fabae*.

MATERIALS AND METHODS

Following our previous long-term field observations on infestation of a number of field bean cultivars by black bean aphid, three cultivars were selected for the present study. The cultivars demonstrated different attractiveness to the pest insects: cultivar Tinos was preferred by aphids, cv. Dino was less readily chosen and cv. Nadwiślański was the least preferred variety (Sądej 2000).

The study was carried out in 2003, in a micro-plot experiment established in the Experimental Garden of the University of Warmia and Mazury. The experiment was set up in a random block design with three replications.

In early November of the year preceding the trials, three robust spindle trees were planted near the plots to provoke aphid infestation. The stems of the spindle trees were covered in aphid eggs. In the spring of next year seeds of the three field bean cultivars were point sown maintaining the density of 65 plants per m^2. Each micro-plot measured 1.5 m^2. Plants were grown according to the commonly approved agronomic practices. While field bean plants were being settled on by aphid migrants all colonized plants of each plot were counted three times.. On 30th June, 25 plants were collected randomly from each plot along its diagonal axis.

Computer image analysis was performed on 30 randomly chosen leaves of every cultivar. Three replications including 10 leaves each were assessed. The measurements were made using a Pentium III PC equipped with a MultiScan 8.08 software package (CSS Warsaw) and attached to a HP Scanjet 4500c scanner. Ten leaves from each sample, which made up one replication, were laid on the scanner glass pane and afterwards a 300 dpi image of the leaves was entered into the computer. Using a stereological net, three colour components were determined: R (red), G (green) and B (blue), for the middle parts of leaf blades. Then, the results were brought to an average for each leaf. The data obtained served to calculate the following colour components: H (hue), S (saturation) and I (intensity), according to the formulas (Gonzales and Wood 2002):

If

$0 < R, G, B < 1$

then

$$H = a\cos\left\{\frac{\frac{1}{2}[(R-G)+(R-B)]}{[(R-G)^2+(R-B)(G-B)]^{1/2}}\right\}$$

$$S = 1 - \min(R, G, B)$$

$$I = \frac{R+G+B}{3}$$

The final results underwent analysis of variance and a multiple SNK test was used to determine the significance of differences between the means, at p = 0.05.

RESULTS

The first individuals representing *A. fabae* appeared at the turn of the second and third decade of June. A significant difference in the counts of migrant aphids became evident during the full inflorescence stage of field bean plants. Entomological observations confirmed that black bean aphids settling on field bean preferred the plants which belonged to cv. Tinos (Table 1). The percentage of plants infested by *A. fabae* for each cultivar, as established during the pod setting stage, was 21% for cv. Tinos, 15% for cv. Dino and 12% for cv. Nadwiślański.

Table 1. Mean number of *Aphis fabae* individuals on field bean plants

Observation date	Phenological stage	Cultivar		
		Dino	Nadwiślański	Tinos
12.06	Early flowering	1.33	1.00	2.67
20.06	Full flowering	3.67 ab	2.00 b	5.33 a
28.06	Early pod setting	12.00 b	11.00 b	18.33 a

Values with identical superscripts do not differ significantly at p = 0.05

The computer analysis of leaf colour enabled us to distinguish between the cultivars in terms of all the three colour components: H, S and I (Fig. 1). The value of H established during the experiment ranged between yellow (H = 60) and green (H = 120), with the lowest values determined for leaves of cv. Tinos (68.23), significantly higher values for cv. Dino (77.87) and Nadwiślański (74.89). This means that leaves of the two latter cultivars were closer to the green colour. In addition, the colour of cv. Tinos leaves was characterised by above average values of intensity (0.66).

Colour intensity (I) is most strongly correlated with the image brightness. Leaves of the cultivars Nadwiślański and Dino showed the highest values of this variable (0.376 and 0.375, respectively), which means that their colour was significantly lighter compared to that of cv. Tinos leaves.

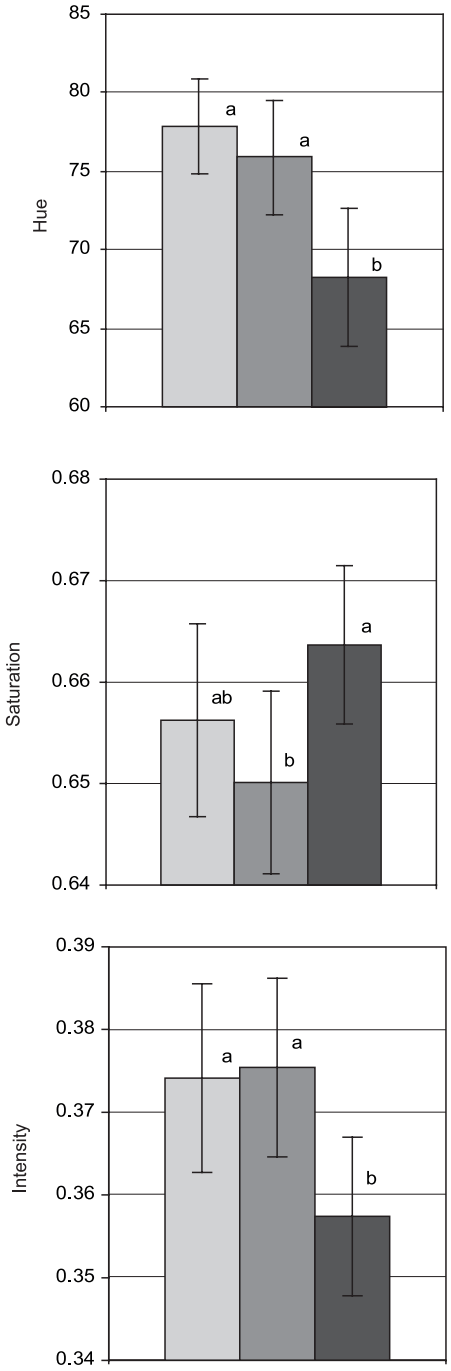

Fig. 1. Average values of H, S and *I* (± SD) for leaves of the field bean cultivars. a, b – homogenous groups at p = 0.05

CONCLUSIONS

The three cultivars of field bean which we examined are different in colour of leaves, although the differences between cv. Dino and Nadwiślański being nearly negligible, especially in terms of hue and intensity. The colour of leaves of cv. Tinos, in turn, proved to be significantly different in H and I from the other two cultivars and in S versus cv, Nadwiślański. The results suggest that there is some correlation between the colour of field bean leaves and infestation of these plants by black bean aphid, which should encourage researchers to try and find a quick an inexpensive method to evaluate field bean plants' attractiveness to migrating black bean aphids.

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POLISH SUMMARY

KOMPUTEROWA ANALIZA KOLORU LIŚCI WYBRANYCH ODMIAN BOBIKU O ZRÓŻNICOWANEJ ATRAKCYJNOŚCI DLA *APHIS FABAE* SCOP.

Mszyca burakowa *Aphis fabae* Scop. jest fitofagiem stanowiącym największe zagrożenie dla upraw bobiku *Vicia faba* v. *minor.* Podstawą badań było doświadczenie mikropoletkowe założone w roku 2003 w ogrodzie doświadczalnym Uniwersytetu Warmińsko-Mazurskiego w Olsztynie. Na podstawie wcześniej uzyskanych wyników, wieloletnich obserwacji polowych,do badań wytypowano trzy odmiany bobiku, Tinos, Dino i Nadwiślański. Największą atrakcyjnością dla migrantek *A. fabae* charakteryzowała się odm. Tinos, najmniejszą zaś Nadwiślański. Badane odmiany różnią się miedzy sobą kolorem liści, przy czym różnice między odmianami Dino i Nadwiślański są nieznaczne, szczególnie w zakresie odcienia i intensywności koloru. Kolor liści odmiany Tinos istotnie różni się natomiast pod względem odcienia (*H*) i intensywności (*I*) od koloru obu pozostałych odmian oraz pod względem nasycenia

(*S*) od koloru liści odmiany Nadwiślański. Uzyskane wyniki wskazują na współzależność między kolorem liści bobiku a zasiedleniem roślin przez *A. fabae*, co stwarza przesłanki do opracowania szybkiej metody oceny atrakcyjności roślin bobiku dla migrantek tej mszycy.