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THE PREFERENCE OF DIFFERENT BROAD BEAN CULTIVARS BY *SITONA LINEATUS* L. (*COLEOPTERA, CURCULIONIDAE*)

Elżbieta Wojciechowicz-Żytko[1], *Mariusz Młynarczuk*[2]

[1]Agricultural University, Department of Plant Protection
29 Listopada 54, 31-425 Kraków, Poland
e-mail: ewojcie@ogr.ar.krakow.pl
[2]Polish Academy of Sciences, Strata Mechanics Research Institute
Reymonta 27, 30-059 Kraków, Poland
e-mail: mlynar@img-pan.krakow.pl

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Abstract: In the experiments the lifetime, survival and feeding preferences of *Sitona lineatus* L. on the various broad bean cultivars were investigated. The measures of the injured disks were performed by means of automatic image analysis. This method led to reduction of time required for the measures. Based on these experiments it can be suggested that Hangdown Zielony was the most preferable and suitable cultivar for the *S. lineatus* adults from all tested broad bean cultivars. The largest injured disk surface, the longest life and the highest survival of *Sitona* weevils were recorded on this variety.

Key words: *Sitona lineatus* L., broad bean, feeding preferences

INTRODUCTION

Sitona spp. adults are very important pests of pea, broad bean and horse bean seriously injuring plants especially at early stages, up to four true leaves (Czerniakowski and Czerniakowski 1994; Nielsen 1990; Wnuk and Wiech 1996). The pea weevil – *Sitona lineatus* L. is the most abundant species feeding on different leguminous plantations (Śledź and Kordan 1994; Wiech 1979). Weevils cause the crop losses through the direct feeding as well as increase the penetration fungus infection into the injured tissues (Smith et al. 1988).

Wnuk and Wiech (1980; 1983) investigated the feeding preferences of *S. lineatus* on the pea cultivars. They found out that pea cultivars were attacked and accepted in various degrees.

Apart from the information on *S. lineatus* feeding preferences on pea in the literature there are no specific data concerning these preferences on broad bean. There-

fore, the aim of present work was to estimate the lifetime, survival and feeding preferences of *S. lineatus* adults on the various broad bean cultivars.

MATERIALS AND METHODS

The experiment on the weevils feeding preferences

During the three-year laboratory observations (1998, 1999, 2000) the feeding preferences of *S. lineatus* on broad bean cultivars were examined. In this experiment 4 tests in 1998, 8 tests in 1999 and 6 tests in 2000 were done (Tab. 2).

Every year in May, twice a week, the leaf disks from three broad bean cultivars were put into the Petri dishes covered with wet filter paper. In each dish 3 leaf disks were placed (one for every cultivar). Thirty Petri dishes were used for each test. Generally 1,620 leaf disks (18 mm diameter; cut out from the 3rd or 4th broad bean true leaves) from three broad bean cultivars – Windsor Biały, Hangdown Biały and Hangdown Zielony were tested.

Sitona weevils, collected from the perennial leguminous plants, were starved in the laboratory for 24 hours and then, single individuals were placed to each Petri dish mentioned above. The experiment was carried out at 22°C and natural photoperiod (L15:9D). After 24 hours broad bean disks were collected and dried.

When all tests had been finished the leaf disks were scanned by means of Hewlett Packard IVc scanner device.

Measurement of injured disks

The samples of 30 leaf disks from every broad bean cultivar were placed on the scanner and digitalized as a bitmap into a computer memory. Typical scanned images are shown in the figures 1a, b, c.

The image analysis algorithm consists of the threshold operation followed by opening by reconstruction and closing by reconstruction (Serra 1982). This sequential filtering was performed in order to remove all unwanted noises. The obtained, binary images (Fig. 3) were the basis to the automatic measurements of the losses of leaf disks area. Unfortunately, the scanning has not been done immediately after the feeding experiments. This led the specimen of leaves to dry. Therefore we could not use a disk surface to determine the losses of the leaves. In order to describe this value we used the shape coefficient (Wojnar and Majorek 1994) defined as:

$$k = \frac{L^2}{4\pi S}$$

where: L: perimeter of the object, *S:* surface of the object.

The interpretation of this coefficient is following: k is equal to1 for a circle, and it grows when the figure is different from the circle.

In the table 1 the typical values of k coefficient, calculated for the objects taken from the figure 2, are listed. Shape coefficients for three broad bean cultivars examined in different days of experiments are shown in table 2. Figure 3 shows distribution of the shape coefficients grouped for each year of experiment.

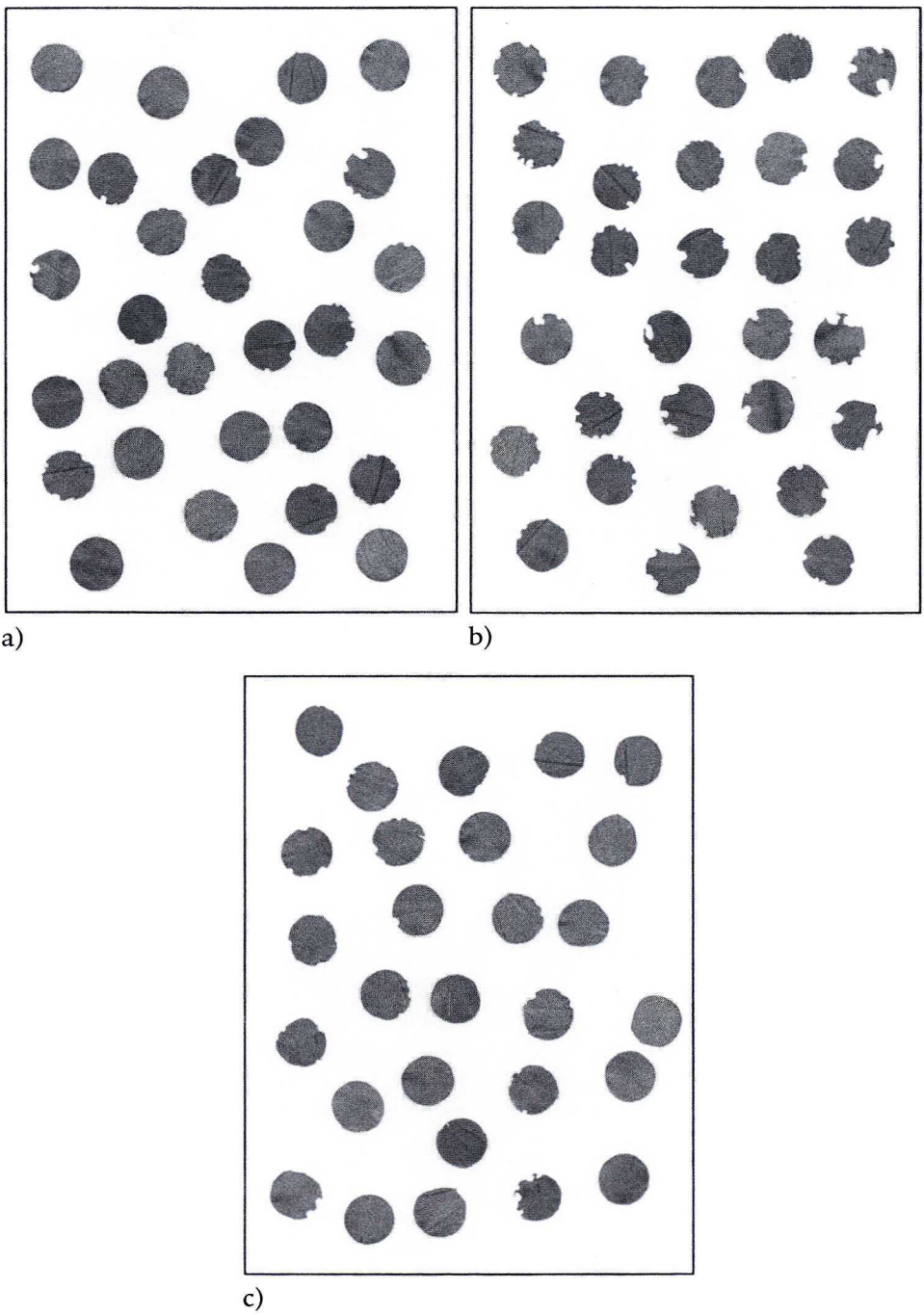

Fig. 1. Images of leaf disks for Windsor Biały (a), Hangdown Zielony (b) and Hangdown Biały (c). Populations examined on May 20th, 2000

Table 1. Values measured for objects (leaves) from figure 2

Object number	Surface [mm^2]	Perimeter [mm]	Shape coefficient
1	197.32	56.20	1.274
2	243.72	67.20	1.475
3	185.56	71.80	2.211
4	215.68	58.40	1.258
5	235.52	61.00	1.257
6	195.44	63.80	1.657
7	235.56	63.80	1.375
8	216.20	64.60	1.536
9	209.80	58.20	1.285
10	205.80	61.00	1.439
11	241.32	61.00	1.227
12	209.40	62.20	1.470
13	216.36	63.20	1.469
14	216.00	63.00	1.462
15	207.60	57.60	1.272
16	224.04	62.00	1.365
17	213.00	66.60	1.657
18	202.80	67.20	1.772
19	234.16	67.00	1.526
20	241.36	66.60	1.462
21	243.16	72.00	1.697
22	195.00	63.20	1.630
23	187.20	66.00	1.852
24	218.28	60.00	1.312
25	227.68	64.00	1.432
26	226.48	64.20	1.448
27	225.72	64.60	1.471
28	242.84	61.60	1.243
29	221.72	62.20	1.389
30	214.60	66.80	1.655
MEAN	218.31	63.57	1.486

The experiment of the lifetime of *S. lineatus* adults

In the second experiment the influence of the various broad bean cultivars on the lifetime of *S. lineatus* was studied. Weevils collected from the perennial leguminous were placed singly into the Petri dishes and feeding daily with the leaves of selected broad bean cultivar. For each cultivar 10 Petri dishes were estimated. The number of death weevils was counted daily. After the death of all weevils the lifetime and their survival on various broad bean cultivars were recorded.

RESULTS AND DISCUSSION

The results obtained in the first experiment (the weevils feeding preferences) show the significant differences in the losses of disks area of various broad bean cultivars eaten by *S. lineatus* (Tab. 3). Data connected with the losses of disks surface are shown in the tables 1, 2 and 3. The greatest disks damage was observed on the Hangdown Zielony cultivar (mean k=1.351), on the other cultivars this factor

was lower (mean k=1.223 for both) (Tab. 3). This indicates that the range of damage caused by *Sitona* adults depends on broad bean cultivar.

In similar studies Wnuk and Wiech (1983) also found out that from the 10 tested pea cultivars 3 were most preferable by *S. lineatus* adults. However, Tulisalo and Markula (1972) working on 82 pea cultivars did not record the significant differences in the leaves area eaten by *S. lineatus* on the various pea cultivars.

In the second experiment (the lifetime of *S. lineatus* adults feeding on the different broad bean cultivars) it was found that the lifetime varied among the tested cultivars (Tab. 4). The longest *S. lineatus* life was observed on the Hangdown Zielony cultivar (average 63.4 days). On the Windsor Biały and Hangdown Biały cultivars weevils survived 50.4 and 54.8 days respectively.

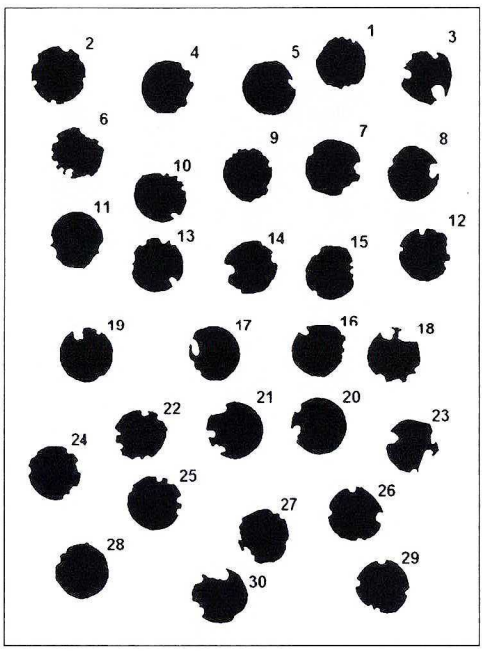

Fig. 2. Binary images of Hangdown Zielony obtained from figure 1b

The survival of *S. lineatus* feeding on the selected broad bean cultivars is shown in figure 4. It was found that on Windsor and Hangdown Biały cultivars 60% and 70% of tested weevils were dead during first 60 days, whereas on Hangdown Zielony

Table 2. Shape coefficients for 3 cultivars of broad bean examined in different days

Date	Hangdown Biały	Hangdown Zielony	Windsor Biały
98-05-05	1.24	1.25	1.23
98-05-06	1.25	1.50	1.27
98-05-12	1.21	1.34	1.21
98-05-13	1.22	1.36	1.19
99-05-05	1.23	1.35	1.24
99-05-06	1.21	1.28	1.21
99-05-11	1.25	1.34	1.22
99-05-12	1.20	1.34	1.21
99-05-17	1.19	1.26	1.20
99-05-18	1.23	1.37	1.21
99-05-24	1.19	1.31	1.19
99-05-25	1.19	1.27	1.19
00-05-20	1.24	1.49	1.22
00-05-21	1.26	1.51	1.29
00-05-26	1.20	1.29	1.19
00-05-27	1.21	1.30	1.21
00-06-01	1.22	1.36	1.23
00-06-02	1.24	1.33	1.25

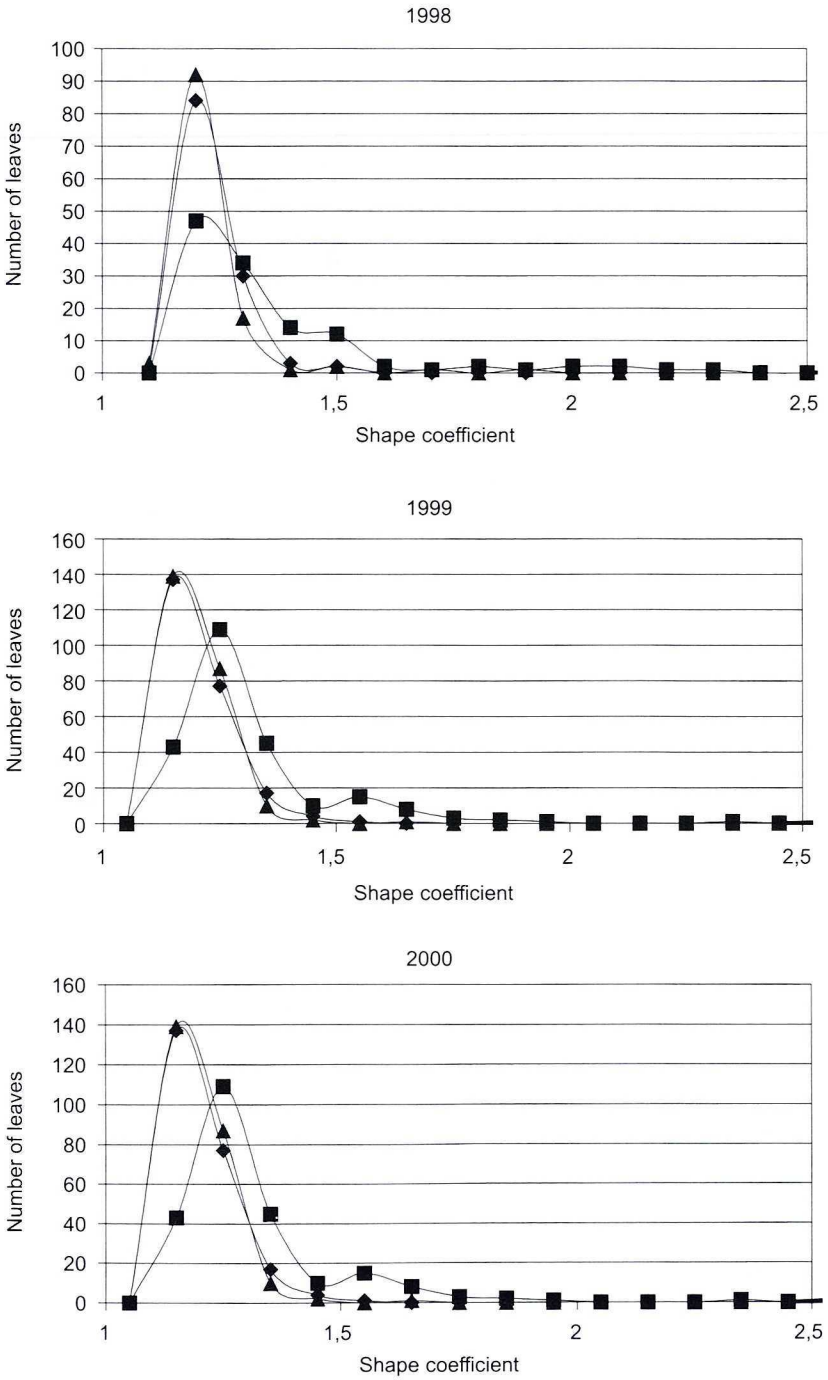

Fig. 3. Distribution of shape coefficients for Windsor Biały (▲), Hangdown Zielony (■) and Hangdown Biały (◆)

Table 3. Shape coefficient for three cultivars of broad bean calculated in each year of experiment

Year	1998	1999	2000	Mean
Hangdown Biały	1.230 a	1.211 a	1.228 a	1.223
Hangdown Zielony	1.363 b	1.315 b	1.380 b	1.353
Windsor Biały	1.225 a	1.209 a	1.232 a	1.222

Note: means followed by the same letter do not differ at 5% level of significance (Duncan's multiple test)

Table 4. The lifetime of *Sitona lineatus* L. adults feeding on the various broad bean cultivars

Broad bean cultivars	Lifetime (in days)	
	Mean	Fluctuations
Windsor Biały	50.4	19–88
Hangdown Zielony	63.4	26–90
Hangdown Biały	54.8	21–85

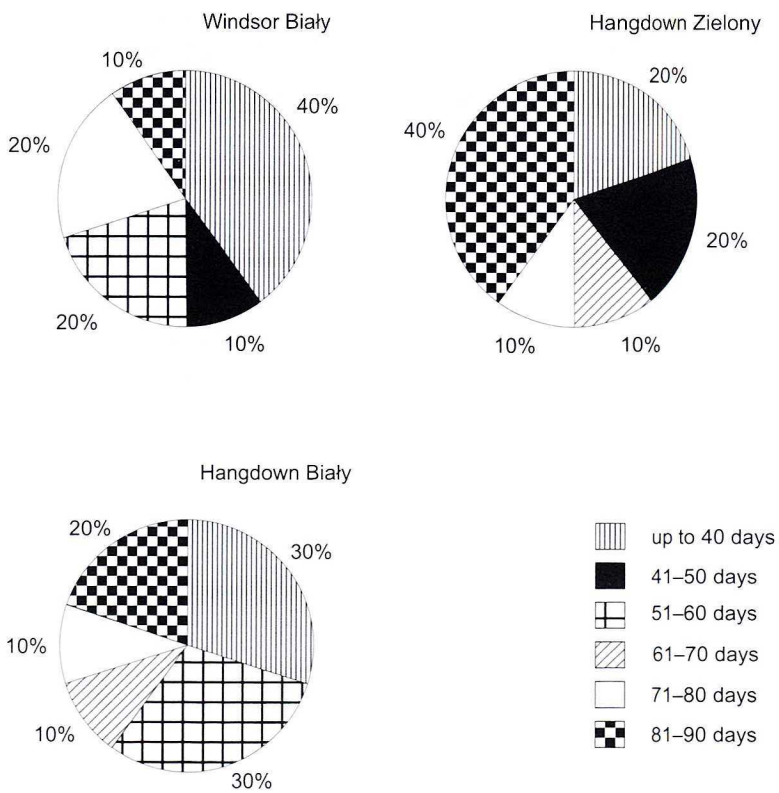

Fig. 4. The survival of *Sitona lineatus* L. feeding on the selected broad bean cultivars

only 40% died. Wnuk and Wiech (1983) in the research on the survival of *S. lineatus* on the pea cultivars observed, that the lifetime of weevils living on the most preferable variety was quite longer than on the least acceptable.

Based on both presented experiments it can be suggested that Hangdown Zielony was the most preferable and suitable cultivar for the *S. lineatus* adults from all tested broad bean cultivars. The largest injured disk surface, the longest life and the highest survival of *Sitona* weevils were recorded on this cultivar.

Finally, it should be mentioned that the measures of the injured by *S. lineatus* disks has been performed by means of automatic image analysis. This method led to reduction of time required for the measures. For example a time necessary to measure the geometrical parameters of the sample of 30 leaf disks (Tab. 1) was calculated in seconds.

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POLISH SUMMARY

PREFERENCJA POKARMOWA OPRZĘDZIKA PRĘGOWANEGO – *SITONA LINEATUS* L. (*COLEOPTERA, CURCULIONIDAE*) ŻERUJĄCEGO NA RÓŻNYCH ODMIANACH BOBU

Celem badań było ustalenie różnic w długości życia, przeżywalności oraz preferencji pokarmowej chrząszczy *Sitona lineatus* L. żerujących na trzech odmianach bobu. Na podstawie przeprowadzonych obserwacji można stwierdzić, że odmiana Hangdown Zielony stanowiła

najbardziej odpowiedni pokarm dla oprzędzików. Uwidoczniło się to zarówno w dużej, zjedzonej powierzchni krążków, jak i w najdłuższym okresie życia oprzędzików żerujących na tej odmianie.

Pomiary dotyczące preferencji pokarmowej oprzędzika polegające na wyznaczeniu powierzchni, obwodów i współczynników kształtu wszystkich uszkodzonych liści prowadzono przy wykorzystaniu metod komputerowej analizy obrazów. Pozwoliło to na znaczną redukcję czasu niezbędnego do wykonania tych pomiarów.