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OCCURRENCE OF BLACK BEAN APHID (*APHIS FABAE* SCOP) AND COCCINELLID BEETLES (*COCCINELLIDAE*) ON RED BEET IN RELATION TO COVERAGE OF CROP BY WEEDS

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Abstract: The experiments were carried out on red beet (cv. Czerwona Kula) from 1997 to 2000. Four combinations differing in ground coverage by weeds were analyzed. During the whole observation period, the greatest numbers of aphids were noticed on the plots kept weed free, while the lowest numbers of aphids were found on the plots where the weeds were not removed and exceptionally, in 1997, on the plots weeded twice. Over the years of observations, the greatest numbers of larvae and adult of *Coccinellidae* were found on the plots kept weed free, where the bean aphids were the most numerous. Among the four species of adult coccinellid beetles found in the colonies of black bean aphids, the most dominant was *Coccinella septempunctata* L.

Key words: red beet, weeds, black bean aphid, coccinellid beetles

INTRODUCTION

The employment of natural elements of environment to limit the occurrence of pests and to increase the efficiency of beneficial organisms forms one of the integrated methods (IPM).

Weeds are the main and natural element of the agricultural environments. Their usefulness and potential applications in the agricultural ecosystems are stressed by numerous researches such as Boczek (1984) and Lipa (1974; 1980). The weeds perform various functions in agricultural ecosystems, as for example contributes to the expansion of the useful organisms. Among the pests limiting the development of black bean aphid, coccinellid beetles play the significant role (Hurej 1984; Weismann and Vallo 1963).

MATERIAL AND METHODS

Experiments were carried out on red beet plots (*Beta vulgaris* L.) cv. Czerwona Kula in Mydlniki near Cracow, in the years 1997–2000. The method of randomized blocks with four replicates was applied. Each plot had area of 16 m^2 (4 m × 4 m). No chemical treatments were applied and the weeds were removed mechanically.

Four combinations were included in the experiments (A, B, C and D), differing in the degree of ground coverage by weeds. The different coverage of plots by weeds was obtained by using appropriate frequency of weeding on particular plots. In combination A plots were continuously kept weed-free during the whole vegetation season, in B weeds were removed three times, in C weeds were removed twice and in combination D weeds were not removed. Until the end of thinning, the plots were kept weed free in order to protect the beets. The information about the dates of sowing, thinning and weeding in particular years is presented in table 1.

Table 1. Agricultural treatments in red beet cultivation (Mydlniki, 1997–2000)

Year	Date of sowing	Date of thinning	Combination B			Combination C	
			date of weeding				
			1st	2nd	3rd	1st	2nd
1997	17 IV	26 V	18 VI	11 VII	7 VIII	4 VII	7 VIII
1998	7 IV	12 V	19 V	14 VI	10 VII	10 VI	17 VII
1999	6 IV	18 V	24 V	17 VI	12 VII	11 VI	19 VII
2000	10 IV	20 V	27 V	20 VI	19 VII	14 VI	26 VII

The aphids and coccinellid beetles (larvae and adults) were counted twice a week on 25 plants randomly selected from each plot along its diagonal. The analyses were started when the first aphids were found and continued until the population of aphids disappeared. When the number of aphids was low, aphids were counted accurately, while in case of large colonies the estimation method was used described by Goos (1966). The adult *Coccinellidae* were identified based on Bielawski (1959).

The analyses of soil coverage by weeds were carried out according to the estimation method described by Rola (1964). The species of weeds occurring on plots of combination B, C and D were analyzed using the methodology given by Parylak (1994).

The Duncan's multiple test was used for statistical analysis of the results.

The correlation coefficients between the degree of the soil coverage by weeds and the number of aphids, between the degree of the soil coverage and the number of coccinellid beetles and between the number of aphids and the number of coccinellid beetles were calculated (Elandt 1964).

RESULTS

The rate of occurrence of *Aphis fabae* Scop. on red beet varied over the years of observations (Figs. 1, 2).

In 1997, the first colonies of black bean aphid were noticed in the first decade of June, while in other years it was in the third decade of May. Over the years, in the

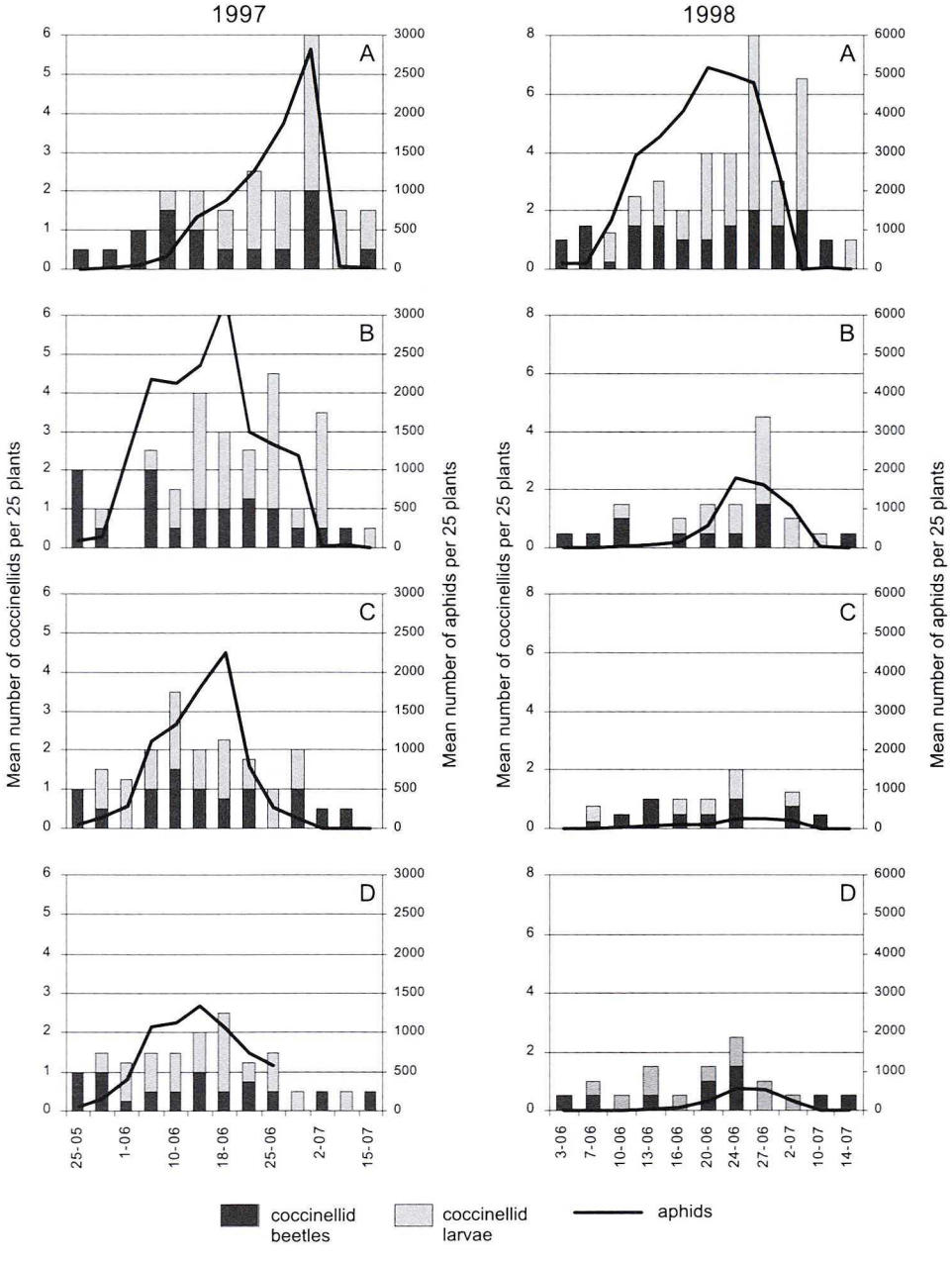

Fig. 1. Occurrence of *Aphis fabae* Scop. and coccinellid larvae and beetles (*Coccinellidae*) on red beet (Mydlniki 1997–1998)

A – plots kept weed free, B – weeds removed three times, C – weeds removed twice, D – no weeds removed

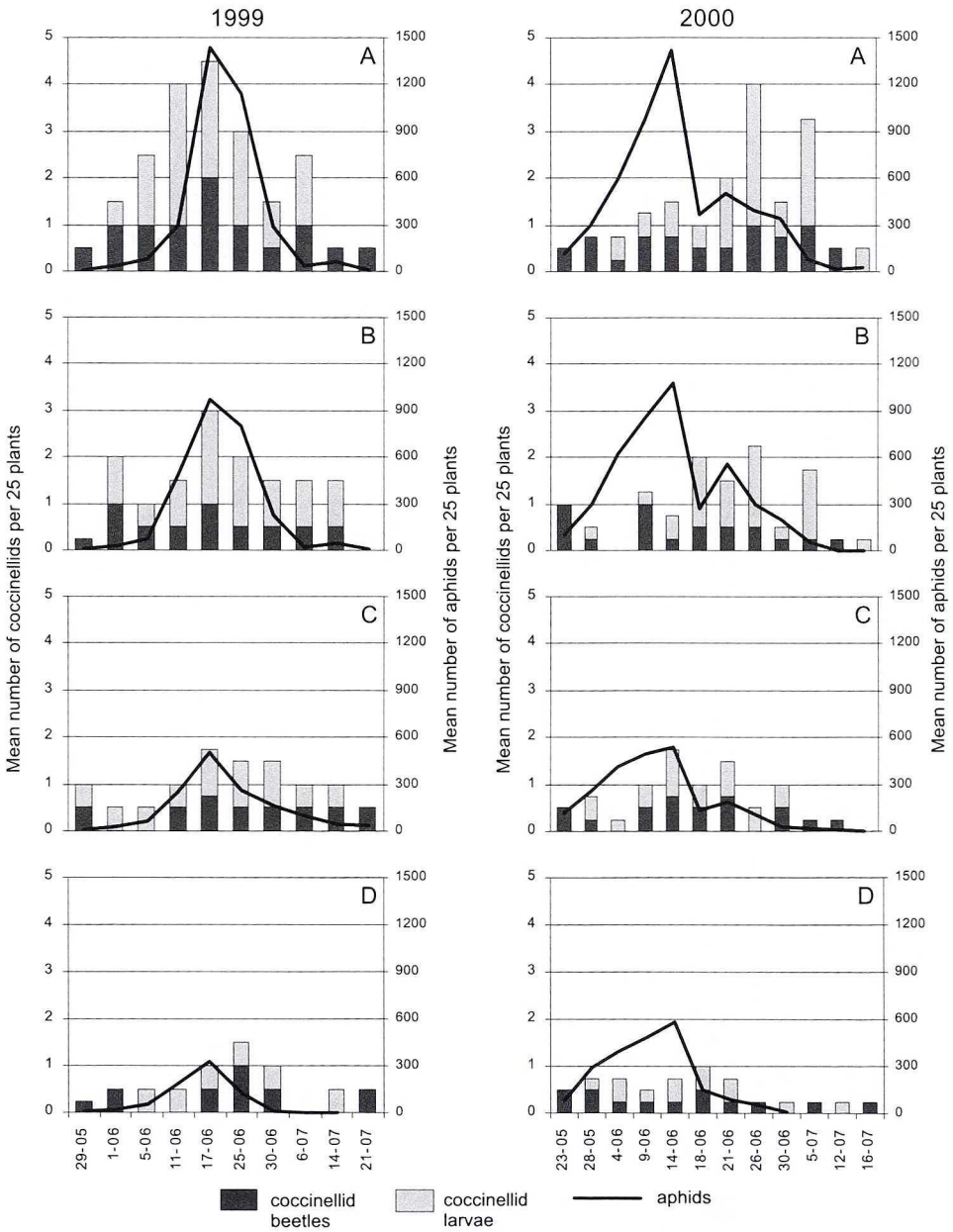

Fig. 2. Occurrence of *Aphis fabae* Scop. and coccinellid larvae and beetles (*Coccinellidae*) on red beet (Mydlniki 1999–2000)
note – see figure 1

first period of observations, the development of black bean aphid was occurring similarly in all combinations. However, after a few days, the differences in the number of aphids were noticed. On the plots of combination A (continuously kept weed free), the fastest increase of aphids was noticed. On the plots of combination C and D (weeded twice and not weeded), after the initial increase of the number of aphids, the stabilization at a lower level was recorded (Figs. 1, 2). Along with greater ground coverage by weeds, the more distinctive differences in number of aphids on plots of particular combinations were seen (Tab. 2, Figs. 1, 2). After the period of the dynamic development of bean aphids, a severe decrease was recorded. Over the years of observations, aphids disappeared first in combinations C (weeded twice) and D (not weeded), and then in the remaining combinations (Figs. 1, 2). During the whole period of the development of bean aphids, over the years of observations, the greatest numbers of aphids were noticed on plots kept weed free (A), while the lowest number on plots not weeded (D) and exceptionally, in 1997, on the plots weeded twice (C) (Tab. 3).

The data on the occurrence of larvae and adult of *Coccinellidae* are presented on figures 1, 2. Over the years of observations, the first adults of coccinellid beetles were observed together with the first aphids, while the first coccinellid larvae were noticed a few days later. Only in 1999, in combination weeded twice (C), the larvae were found together with the adult beetles. This fact emphasis the role of coccinellid beetles in reduction of black bean aphid during their initial period of the development, i.e. during formation of the first colonies. The development of predators was tightly correlated with the development of their prey (Tab. 4). The number of adults was increasing together with the number of aphids, sometimes with slight delay. It was even more notable in the case of larvae. The greatest numbers of predators were noticed during the period of the most numerous occurrences of bean aphids (Figs. 1, 2). Over the years of observations, the greatest number of predators was noticed on the plots of combinations kept weed free (A), where the aphids were also the most numerous. On plots with greater ground coverage by weeds, the number of black bean aphid was lower, as well as decreasing number of predators was noticed (Tabs. 2, 3). The mean number of aphids per one predator in the particular combinations is given in table 3. During the whole observation period 430 adult beetles were collected from colonies of black bean aphid on red beet cultivation. Four species were found: *Coccinella septempunctata* L., *Coccinella quinquepunctata* L., *Propylaea quatuordecimpunctata* (L.) and *Adalia bipunctata* (L.). The most dominant species in all combinations was *C. septempunctata* L. – 78.1% to 85.2% of the collected material (Tab. 5).

Table 2. Average ground coverage by weeds in % in period of occurrence of *Aphis fabae* Scop. (Mydlniki, 1997–2000)

Combination	1997	1998	1999	2000
A – plots kept weed free	0	0	0	0
B – weeds removed three times	11.0	28.4	19.9	19.3
C – weeds removed twice	39.2	47.7	39.5	30.7
D – no weeds removed	66.0	73.4	75.7	50.2

Table 3. The number of coccinellid larvae and beetles in colonies of *Aphis fabae* Scop. on red beet (Mydlniki, 1997–2000)

Combination	Total number of aphids	Total number of coccinellid		Sum	Ratio predators/ aphids*
		beetles	larvae		
		1997			
A – plots kept weed free	31.050 c	34	50	84 a	1:462
B – weeds removed three times	21.600 b	22	30	52 ab	1:361
C – weeds removed twice	4.310 a	18	12	30 ab	1:175
D – no weeds removed	6.720 a	20	22	44 b	1:225
		1998			
A – plots kept weed free	11.7710 c	63	92	155 a	1:593
B – weeds removed three times	61.640 b	43	63	106 ab	1:288
C – weeds removed twice	32.570 a	35	38	73 b	1:357
D – no weeds removed	26.250 a	28	36	64 b	1:410
		1999			
A – plots kept weed free	13.590 c	34	50	84 a	1:318
B – weeds removed three times	10.620 cb	21	36	57 ab	1:323
C – weeds removed twice	5.770 b	16	25	40 ab	1:287
D – no weeds removed	2.890 a	16	12	28 ab	1:83
		2000			
A – plots kept weed free	21.340 b	29	41	70 a	1:100
B – weeds removed three times	17.310 ab	19	29	48 ab	1:133
C – weeds removed twice	9.240 a	19	18	37 ab	1:300
D – no weeds removed	8.460 a	13	12	25 ab	1:150

*when the max. number of predators was recorded
Note: values followed by the same letter do not differ at 5% level of significance (Duncan's multiple test)

Table 4. Correlation coefficient (for average values, Mydlniki, 1997–2000)

Tested relationship	Correlation coefficient r
Degree of the ground coverage by weeds vs. the total number of black bean aphid	–0.383*
Degree of the ground coverage by weeds vs. the number of coccinellid beetles	–0.276*
Number of black bean aphid vs. the number of coccinellid beetles	0.622*

$r_{teor.\ p=0.05} = 0.2008$
$r_{teor.\ p=0.01} = 0.2619$
* relationship significant for p = 0.01

The average degree of the ground coverage by weeds in combinations not weeded (D) was from 50.2% in 2000 to 75.7% in 1999 and caused significant decrease in the total number of aphids as well as beetles in comparison to the combinations kept weed free (Tab. 3). The calculated correlation coefficient shows that greater ground cover by weeds was associated with the lower number of aphids, larvae and coccinellid beetles (Tab. 4). The composition of species found on the plots with weeds was very similar. The most dominant species were: *Galinsoga parviflora* Cav., *Chenopodium album* L., *Cirsium arvense* (L.) Scop., *Amaranthus retroflexus* L., *Agropyron repens* L. and *Echinochloa crus-galli* L.

Table 5. Number and percentage of particular species of coccinellid beetles in colonies of black bean aphid (Mydlniki, 1997–2000)

Species	Combinations							
	A – plots kept weed free		B – weeds removed three times		C – weeds removed twice		D –no weeds removed	
	number	%	number	%	number	%	number	%
Coccinella septempunctata L.	125	78.1	83	79.0	75	85.2	65	84.4
Coccinella quinquepunctata L.	7	4.4	2	1.9	1	1.1	2	2.6
Adalia bipunctata (L.)	16	10.0	13	12.4	9	10.2	5	6.5
Propylaea quatuordecimpunctata (L.)	12	7.5	7	6.7	3	3.5	5	6.5

DISCUSSION

During the observations carried out in the years 1997 – 2000, the greatest numbers of aphids were noticed on the plots of combinations kept weed free, while the presence of weeds on the plots of other combinations, including the species creating the suitable environment for the development of *A. fabae* Scop. (*C. album* L., *C. arvense* (L.) Scop.) always caused the decrease of the number of the aphids on the beet plants. It corresponds with the results obtained by Smith (1976), who observed a small number of *Brevicoryne brassicae* L. on weeded plots of Brussels sprouts despite the presence of cruciferous weeds. Also Horn (1981) and Wnuk and Pobożniak (1999) noticed that the number of aphids decreases along with greater greatest cover of ground by weeds, reaching its minimum on the plots where the weediness is higher. Wiech (1993) found that *B. brassicae* L. was less numerous in intercropping system of cabbage with white clover and beans. The significant role of coccinellid beetles in limiting the number of aphids in various environments was also stressed by Hagen (1974) and Hodek (1970).

During the observations, the coccinellid beetles emerged in the red beet crop at the moment when aphids were not numerous and hard to notice. Also Hurej (1984) observed the similar effect in the colonies of black bean aphid on sugar beet, when adults of coccinellid beetles were finding and destroying the small colonies of aphids. The clear time synchronization between the occurrence of larvae and adults of coccinellid beetles and the development of aphids was noticed. The greater number of beetles in their colonies was recorded in treatment with more numerous aphids. This number was also influenced by the presence of weeds and this is the reason why the maximum was recorded in the combination without weeds, where the greatest occurrence of black bean aphid was noticed. On the other hands the lowest number of predators was observed on combinations with weeds, although the blooming weeds were the source of food, which was found many times during the analysis.

The species composition of beetles was nearly the same as noticed by other authors in colonies of black bean aphid on beets (Hurej 1984; Weismann and Vallo 1963). Over the years of observations, the most dominant species was *C. septempunctata* L. The role of this species in limiting the population of black bean aphid in beet cultivation is also stressed by Hurej (1984) and Weismann and Vallo (1963).

CONCLUSIONS

1. The presence of weeds in the red beet cultivation had influence on the population of black bean aphid, which was the most numerous on the plots without the weeds and less numerous on the plots not weeded and on the plots weeded twice.
2. The greatest numbers of predatory larvae and beetles were noticed in combinations kept weed free, where the black bean aphid was the most numerous.
3. Among the four species found in the colonies of black bean aphid in the red beet crop, *C. septempunctata* L. was the most dominant.

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POLISH SUMMARY

WYSTĘPOWANIE MSZYCY BURAKOWEJ (*APHIS FABAE* SCOP.) ORAZ BIEDRONEK (*COCCINELLIDAE*) NA BURAKU ĆWIKŁOWYM W ZALEŻNOŚCI OD ZACHWASZCZENIA POLA

Do doświadczeń prowadzonych w latach 1997–2000 w Stacji Doświadczalnej w Mydlnikach koło Krakowa wykorzystano rośliny buraka ćwikłowego (*Beta vulgaris* L.) odmiany Czerwona Kula. W doświadczeniu uwzględniono cztery kombinacje różniące się między sobą stopniem zachwaszczenia poletek. We wszystkich latach badań największą liczbę mszyc stwierdzono na poletkach kombinacji bez chwastów. Najmniej mszyc stwierdzono na poletkach nie odchwaszczanych i wyjątkowo w 1997 roku na poletkach kombinacji dwukrotnie odchwaszczanej. We wszystkich latach obserwacji największą liczbę larw i postaci dorosłych biedronek stwierdzono w kombinacji bez chwastów, gdzie mszycy burakowej było najwięcej. Z czterech stwierdzonych gatunków biedronek dominował gatunek *Coccinella septempunctata* L.