JOURNAL OF PLANT PROTECTION RESEARCH
Vol. 44, No. 2 (2004)

THE INFLUENCE OF WEEDING TREATMENTS IN RED BEET CROP ON SPECIES COMPOSITION OF APHIDOPHAGOUS *SYRPHIDAE* IN COLONIES OF *APHIS FABAE* SCOP.

Andrzej Wnuk, Maria Pobożniak

Agricultural University, Department of Plant Protection
29 Listopada 54, 31-425 Kraków, Poland
e-mail: awnuk@ogr.ar.krakow.pl; mpobozniak@ogr.ar.krakow.pl

Accepted: April 19, 2004

Abstract: The experiments were carried out in red beet crop (cv. Czerwona Kula) from 1995 to 2000. The aim of investigations was to determine the influence of mechanical weeding frequency on the species composition of aphidophagous *Syrphidae* in colonies of *Aphis fabae* Scop. in four treatments differing in ground coverage by weeds. No direct influence of weeds in red beet cultivation on species composition of aphidophagous *Syrphidae* in colonies of *Aphis fabae* Scop was observed. The dominant species occurred in all combinations. Their number depended on the number of aphids on plants, which was higher on plots maintained weed-free. The number of aphids feeding on plant was indirectly influenced by the degree of weediness, which also had influence on the occurrence of syrphid larvae. The percentage of some species (*Episyrphus balteatus*) was higher on plots kept weed-free while the percentage of other species belonging to genus of *Sphaerophoria* was higher on plots not weeded.

Key words: red beet, weeds, black bean aphid, aphidophagous *Syrphidae*

INTRODUCTION

The variety of plants in agrocenosis is an important factor influencing the occurrence of pests and their natural enemies (Lipa 1974). The crop with weeds can be considered as an intercropped cultivation. In many cases, the intercropped cultivation reduces the number of pests and increases the efficiency of beneficial organisms (Van Emden and Dąbrowski 1994; Wiech 1993). The weeds can provide the places for hiding, development of alternative hosts for beneficial insects and the source of pollen for predators and parasitoids (Van Emden 1965; Van Emden and Wiliams 1974; Syme 1976). However, the weeds can not negatively affect the cultivated plants, so the degree of the soil coverage by weeds should be strictly controlled for particular crop.

The influence of weediness of red beet cultivation on the occurrence of beet fly (*Pegomyia betae* Curt.), black bean aphid (*Aphis fabae* Scop.) and their natural enemies was analysed in the research conducted by Pobożniak (1998; 2000; 2003), Pobożniak and Wnuk (2003) and Wnuk and Pobożniak (1999).

The aim of this work was to determine the influence of mechanical weeding frequency on the species composition of aphidophagous *Syrphidae* in colonies of *Aphis fabae* Scop.

MATERIAL AND METHODS

The experiments were carried out on red beet plots (*Beta vulgaris* L.) cv. Czerwona Kula located at the Agriculture Experimental Station in Mydlniki near Cracow and under laboratory conditions at the Department of Plant Protection, Agricultural University in Cracow during 1995–2000.

The method of randomized blocks of four treatments as: A, B, C and D, differing in the degree of weediness of particular combinations in four replicates was applied. No chemical treatments were applied and weeds were removed mechanically. In the combination A plots were continuously maintained weed-free, in B weeds were removed three times, in C weeds were removed twice and in combination D weeds were not removed, but only cut to the height of the cultivated plants. Until the end of thinning, the plots were kept weed free in order to protect the crop plants. The information about the dates of sowing, thinning and weeding in particular years is presented in table 1.

The data on the occurrence of *A. fabae* Scop. on red beet was established based on the systematic analysis of 25 plants randomly selected along the diagonal of each plot. The counting started with finding of first aphids and continued until the population of aphids disappeared. Under low population density aphids were counted accurately, while in case of large colonies the estimation method described by Goos (1966) was used.

In the analysed colonies of black bean aphid, syrphid larvae and pupae were counted. Larvae in the second and third stage of development and pupae were reared to receive the adults for identification to species. Reared *Syrphidae* were classified into the domination classes according to scale given by Petryszak (1982).

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

Table 1. Agricultural treatments in red beet cultivation (Mydlniki, 1995–2000)

Year	Date of sowing	Date of thinning	Combination B			Combination C	
			date of weeding				
			I	II	III	I	II
1995	20 IV	3 VI	23 VI	7 VII	19 VII	24 VI	14 VII
1996	15 V	4 VI	15 VI	3 VII	21 VII	15 VI	21 VII
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

RESULTS AND DISCUSSION

In the colonies of black bean aphids (*A. fabae* Scop.) on red beet crop, over 700 syrphid larvae and pupae were found. Over 500 larvae in the second or third stage of development were reared. Because many larvae died during the rearing, 22.3% of collected larvae could not be identified (Tab. 2). Among the dead and not identified larvae, the most dominant were *Sphaerophoria*, about 6% of all reared *Syrphidae*.

Among the *Syrphidae* emerged during 1995–2000, the dominant were following species: *Episyrphus balteatus* (Deg.), *Sphaerophoria scripta* (L.), *Sphaerophoria menthastri* (L.) (Tab. 2). Comparison of species composition of *Syrphidae* population in the analysed combinations shows that for some species, the percentage in combination kept weed-free is different from that in combination not weeded. Thus, *E. balteatus* (Deg.) was the most numerous in the combination kept weed-free. This number decreased along with the increase of the degree of weediness, i.e. greater degree of weediness of plots, lower numerousness of *E. balteatus* (Deg.). The percentage of all species belonging to the *Sphaerophoria* was the greatest in the combination not weeded: just opposite as in the case of *E. balteatus*.

Over the years of observations and in all combinations, the most numerous species *was*: *E. balteatus* followed by *S. scripta*. The other species of *Syrphidae* in colonies of *A. fabae* were dominant only in some years and in some combinations (Tab. 3). The species composition of *Syrphidae* varied over the years. The number of species varied from 2 to 5, while the same species of predators were occurring almost in all combinations.

The numbers of *Syrphidae* larvae in colonies of aphids in particular combinations were different. Their numerousness was growing along with the number of aphids and not with the degree of weediness (Tab. 4). Lower degree of weediness was accompanied by greater colonies of aphids affecting large number of predators in these colonies. This was especially true in the case of popular *E. balteatus*, probably because the number of eggs is greater in the larger aphid colonies. Such relationships were found by Wnuk and Starmach (1977) during the research work on the relationship between the numerousness of *A. fabae* colonies and the number of eggs of *E. balteatus* (Deg.), *Metasyrphus corollae* (F.) and *S. vitripennis* Meig. According to Bańkowska (1964), species from genus *Sphaerophoria* are the most characteristic for meadow biotops, which can explain the high percentage of these species in the material collected from aphid colonies occurring on the plots with higher weediness.

Among the collected 8 species of *Syrphidae*, the most numerous was eudominant *E. balteatus* (Deg.) over all years of observations and on plots of all combinations. The second eudominant: *S. scripta* (L.) occurred in all treatments, except 1995 year. The larvae of other syrphid species feeding in colonies of black bean aphid on red beet were found only in some years and in some combinations. However, it should be noted that colonies of *A. fabae* on red beet are less numerous on sugar beet and fodder beet and this fact increase their attractiveness for aphidophagous *Syrphidae* laying eggs. *E. balteatus* is considered as one of the most important predator of *A. fabae* on beet (Bombosch 1963; Lyon 1971; Malinowska 1973; Wnuk and Gospodarek 1999). The opinions about importance of other species vary. Among species

Table 2. Species composition of *Syrphidae* reared from larvae feeding in colonies of black bean aphid *Aphis fabae* Scop on red beet with different degree of soil coverage by weeds (Mydlniki, 1995–2000)

Combination	Plots kept weed free (A)		Weeds removed three times (B)		Weeds removed twice (C)		No weeds removed (D)		Total	
Species of *Syrphidae*	number	%	number	%	number	%	number	%	number	%
Episyrphus balteatus (Deg.)	119	58.3	92	53.4	25	33.8	16	26.2	252	49.3
Sphaerophoria scripta (L.)	18	8.8	22	12.8	9	12.1	10	16.4	59	11.5
Sphaerphoria menthastri (L.)	7	3.4	11	6.4	7	9.5	2	3.3	27	5.3
Sphaerophoria rueppelli (L.)	5	2.5	2	1.2	3	4.0	2	3.3	12	2.3
Syrphus vitripennis Meig.	2	1.0	5	2.9	3	4.0			10	2.0
Syrphus ribesii (L.)	15	7.4	7	4.1	1	1.4	4	6.6	27	5.3
Metasyrphus corollae (L.)	6	2.9	2	1.2	1	1.4	–	–	9	1.8
Platycheirus clypeatus Meig.	–	–	1	0.6	–	–	–	–	1	0.2
Unidentified larvae	32	15.7	30	17.4	25	33.8	27	44.2	114	22.3
(including genus *Sphaerophoria*)	(8)	(3.9)	(12)	(7.0)	(4)	(5.4)	(6)	(9.8)	(30)	(5.9)
Total	204	100.0	172	100.0	74	100.0	61	100.0	511	100.0

Table 3. Evaluation of domination of aphidophagous *Syrphidae* occurring in colonies of *Aphis fabae* Scop. on red beet based on their percentage: eudominants– >10% (+++); dominants– 5.1%–10.0% (++); subdominants–2.1%–5.0% (+) (Mydlniki, 1995–2000)

Combinations	Plots kept weed free (A)						Weeds removed three times (B)						Weeds removed twice (C)						No weeds removed (D0					
Species of *Syrphidae*	95	96	97	98	99	00	95	96	97	98	99	00	95	96	97	98	99	00	95	96	97	98	99	00
Episyrphus balteatus (Deg.)	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++
Sphaerophoria scripta (L.)		++	+++	+++	++		++	+++	+++	+++	+++				+++	+++	+++	+++		+++	+++	+++	+++	+++
Sphaerphoria menthastri (L.)			+++	+					++	++	++					+++	++				+++		+++	
Sphaerophoria rueppelli (L.)	+	++					++	++					+++	++					+++	++				
Syrphus vitripennis Meig.					+	++				+	++					+++								+++
Syrphus ribesii (L.)				+++	+	+++				+	++	+++				+						++		
Metasyrphus corollae (L.)				++	+			+++						+										
Platycheirus clypeatus Meig.								++																

Table 4. Selected data on the occurrence of *Aphis fabae* Scop., aphidophagous *Syrphidae* and degree of soil coverage by weeds (Mydlniki, 1995–2000)

Year	1995				1996				1997			
Combinations	A	B	C	D	A	B	C	D	A	B	C	D
Number of aphids/25 plants	1107.5 a	462.5 ab	460.0 ab	125.0 b	5072.5 a	4450.0 a	3302.5 ab	2905.0 b	7762.5 a	5400. 0 b	1077.5 c	1680.0 c
Number of syrpihd larvae/25 plants	7.3 a	3.5 ab	1.3 b	0.8 b	20.3 a	22.3 a	12.5 b	13.5 b	7.5 b	16.7 a	0.5 c	1.0 c
Number of reared syrphid species	2	2	2	2	3	5	3	3	3	3	2	3
Mean soil coverage by weeds [%]	0.0 d	33.0 c	64.5 b	86.5 a	0.0 d	10.7 c	25.2 b	61.0 a	0.0 d	11.0 c	39.2 b	66.0 a

Year	1998				1999				2000			
Combinations	A	B	C	D	A	B	C	D	A	B	C	D
Number of aphids/25 plants	29427.5 a	15410.0 b	8142.5 c	6562.5 c	3397.5 a	2655.0 ab	1442.5 b	722.5 c	5335.0 a	4327. 0 bc	2310.0 c	2115.0 c
Number of syrpihd larvae/25 plants	18.8 a	10.8 ab	6.3 bc	3.5 c	12.0 a	7.8 ab	4.3 bc	1.3 c	3.8 a	2.5 ab	1.3 b	0.8 b
Number of reared syrphid species	5	5	5	3	5	5	3	3	3	3	2	3
Mean soil coverage by weeds [%]	0.0 d	28.4 c	47.7 b	73.4 a	0.0 d	19.9 c	39.5 b	75.7 a	0.0 d	19.3 c	30.7 c	50,2 a

Values followed by the same letter do not differ at level of significance (Duncan's multiple test)
Combinationss: A – plots kept weed free, B – weeds removed three times, C – weeds removed twice, D – no weeds removed

limiting *A. fabae* on beets the most often quoted by Bombosh (1963) are: *S. ribesii* (L.), *S. vitripennis* Meig. and *M. corollae* (F.).

The comparison of our results with data presented by other authors is difficult because of death rate occurring during rearing of larvae and differences in conditions during the development of *Syrphidae* on red beet, fodder and sugar beet, where greater area of leaves creates better development conditions for aphids and larvae of predators.

CONCLUSIONS

1. No direct influence of weeding treatments in red beet crop on species composition of aphidophagous *Syrphidae* in colonies of *A. fabae* Scop was observed.
2. The same dominant species of *Syrphidae* were occurring in all treatments. Their number was affected by density of aphids on crop plants, which was higher on plots kept weed-free. The density of aphids feeding on plant was indirectly influenced by the degree of weediness, which also had influence on the occurrence of syrphid larvae.
3. The percentage of some species (*E. balteatus*) was higher on plots kept weed-free while the percentage of other species belonging to genus of *Sphaerophoria* was higher on plots not weeded.

REFERENCES

Bańkowska R. 1964. Studien über die Paläarkitschen Arten der Gattung Sphaerophoria St. Farg. Et Serv.(*Diptera, Syrphidae*). Ann. Zool., 22, 15: 285–353.

Bombosch S. 1963. Untersuchungen zur Vermehrung von *Aphis fabae* Scop. in Samenrubenbestanden unter besonderer Berucksichetigung der Schwebfliegen (*Diptera, Syrphidae*). Z. angew Ent., 52: 105–141.

Emden van H.F. 1965. The role of uncultivated land in the biology of crop pests and beneficial insects. Sci. Hort., 17: 121–136.

Emden van H.F., Dąbrowski Z.T. 1994. Biodiversity and habitat modification in pest management. Insect Sci. Applic., 15, 6: 605–620.

Emden van H.F., Williams G.F. 1974. Insect stability and diversity in agro-ecosystems. Ann. Rev. Entomol., 19: 455–475.

Goos A. 1966. Metodyka ilościowego określania nasilenia mszyc w doświadczeniach polowej oceny insektycydów. Ekologia Polska, Ser. E, Z. 4: 351–355.

Lipa J.J. 1974. Pożyteczna rola chwastów w integrowanych programach ochrony roślin. Ochrona Roślin nr 2: 6–7.

Lyon J.P. 1971. Les Syrphides (Dipteres) predateurs des Pucerons de la Betterave. Parasitica 27: 103–111.

Malinowska D. 1973 Larwy bzygowatych (*Diptera*) w koloniach mszyc na niektórych roślinach uprawnych. Pol. Pismo Entomol., 4: 607–619.

Petryszak B. 1982. Ryjkowce (*Coleoptera, Curculionidae*) Beskidu Sądeckiego. Rozp. hab. UJ. 68: 1–204.

Pobożniak M. 1998. Occurrence of *Aphis fabae* Scop. and *Syrphidae* on garden beet in relation to a weeding frequency. Aphids and Other Homopterous Insects, PAS: 133–138.

Pobożniak M. 2000. The influence of weeds on egg laying by *Pegomyia betae* Curt. on red beet (*Beta vulgaris* L.). Proceedings of the XV th Czech and Slovak Plant Protection Conference, Brno, September 12-14: 407–408.
Pobożniak M. 2003. Influence of weeding frequency on occurrence of *Aphis fabae* Scop. IOBC/WPRS Bulletin 26 (3): 345–553.
Pobożniak M., Wnuk A. 2003. Occurrence of black bean aphid (*Aphis fabae* Scop.) and coccinellid beetles (*Coccinellidae*) on red beet in relation to coverage of crop by weeds. J. Plant Protection Res., 43 (4): 27–35.
Syme P.A. 1975. The effect of flowers on the lonevity and fecundity of two native parasites of the European pine scot moth in Ontario. Environ. Entomol., 4: 337–340.
Wiech K. 1993. Wpływ współrzędnej uprawy późnej kapusty z koniczyną białą i fasolą szparagową na występowanie szkodliwej i pożytecznej entomofauny. Zesz. Nauk. AR w Krakowie, Rozprawa habilitacyjna 177: 1–74.
Wnuk A., Gospodarek J. 1999. Occurrence of aphidophagous *Syrphidae* (*Diptera*) in colonies of *Aphis fabae* Scop., on its various host plants. Annals Agric. Sci. – Series E – Plant Protection 28 (1/2): 7–15.
Wnuk A., Pobożniak M. 1999. Influence of weeds on occurrence of black bean aphid (*Aphis fabae* Scop.) and aphidophagous *Syrphidae* on red beet (*Beta vulgaris* L.). Scientific works of the Lithuanian Institute of Horticulture and Lithuanian University of Agriculture 18 (3): 266–275.
Wnuk A., Starmach M. 1977. Wpływ wielkości kolonii mszyc na składanie jaj przez drapieżne bzygowate (*Diptera, Syrphidae*). Zesz. Nauk. AR w Krakowie 125: 199–207.

POLISH SUMMARY

WPŁYW ZACHWASZCZENIA BURAKA ĆWIKŁOWEGO NA SKŁAD GATUNKOWY MSZYCOŻERNYCH *SYRPHIDAE* ŻERUJĄCYCH W KOLONIACH *APHIS FABAE* SCOP.

Doświadczenia prowadzono w latach 1995–2000 na buraku ćwikłowym (*Beta vulgaris* L.) odmiany Czerwona Kula. W doświadczeniu uwzględniono cztery kombinacje różniące się między sobą stopniem zachwaszczenia poletek. Celem podjętych badań było określenie jaki wpływ ma różna częstotliwość mechanicznych zabiegów odchwaszczających na skład gatunkowy mszycożernych *Syrphidae* żerujących w koloniach *Aphis fabae* Scop. W trakcie prowadzonych badań nie stwierdzono wyraźnego wpływu stopnia zachwaszczenia buraka ćwikłowego na zmiany w składzie gatunkowym bzygowatych. Dominujące gatunki: *Episyrphus balteatus* Deg. oraz *Sphaerophoria scripta* (L.) występowały we wszystkich kombinacjach. O ich liczebności decydowała liczba mszyc na roślinach, a ta była większa tam gdzie nie było chwastów. Pośrednio więc stan zachwaszczenia decydował o liczbie żerujących mszyc na roślinach, co również miało wpływ na występowanie larw *Syrphidae*. Niektóre ze stwierdzonych gatunków bzygowatych większy udział miały na poletkach bez chwastów (*E. balteatus*), natomiast gatunki z rodzaju *Sphaerophoria* na zachwaszczonych poletkach.

Book Review

Pernezny, K., Roberts, P.D., Murphy, J.E. Goldberg, N.P. (Eds.). 2003.
Compendium of Pepper Diseases. APS Press – The American Phytopathological Society.
St. Paul, Minnesota, USA. 62 pp. & 122 figs. ISBN 089054-300-3

Peppers belong to the family *Solanaceae* and the genus *Capsicum* includes 25 species, five of which have been domesticated: *C. annuum, C. baccatum, C. pubescens, C. chinense* and *C. frutescens*.

In the "Introduction" (p. 1–3) it is stressed that pepper fruit is consumed worldwide as a fresh vegetable or dehydrated for use as a spice, being the most important spice commodities in the world.

The book covers all categories of diseases, damages and disorders affecting pepper plants and fruits during vegetation and post harvest period. Descriptions of diseases, damages and disorders are supported by 122 color photographs very helpful in recognizing symptoms and diagnosing causative agents.

Part I. "Diseases caused by infectious agents" (p. 5–49) includes following chapters in which over hundred causative agents are described according to the following scheme: symptoms, casual organism, diseases cycle and epidemiology, control.

Chap. 1. "Diseases caused by bacteria" (p. 5–9) describes diseases caused by *Clavibacter michiganensis, Xanthomonas campestris, Ralstonia solanacearum, Pseudomonas syringae*.

Chap. 2. "Diseases caused by fungi and oomycetes (p. 9–23) describes diseases caused by: *Colletotrichum* spp., *Cercospora capsici, Macrophomina phaseolina, Choanephora cucurbitarum, Rhizoctonia* spp., *Fusarium solani, Stemphylium* spp., *Botrytis cinerea, Phytophthora capsici, Oidiopsis sicula, Sclerotium rolfsii, Verticillium* spp., *Sclerotinia sclerotiorum*.

Chap. 3 "Diseases caused by viruses" (p. 23–40) describes over seventy virus diseases caused by species belonging to the following virus genera: *Alfamovirus, Fabavirus, Potyvirus, Comovirus, Luteovirus, Begomavirus, Nepovirus, Tobamovirus,* and many others.

Chap. 4 "Postharvest diseases and disorders" (p. 40–49) covers diseases caused by microorganisms such as *Erwinia carotovora, Alternaria* spp., *Botrytis cinerea, Rhizopus stolonifer;* by parasitic plants such as *Cuscuta* spp. ; and by parasitic nematodes, such as *Meloidogyne* spp., *Belonolaimus longicaudatus*, *Pratylenchus penetrans*, *Rhadopholus similis* and many others.

Part II "Damage caused by arthropods" (p. 50–52) covers such pests as aphids, mites, thrips, bugs, and whiteflies. Among them are: *Myzus persicae, Polyphagotarsonemus latus, Frankliniella occidentalis, Thrips tabaci, Lygus* spp., *Trialeurodes vaporariorum* and *Bemisia tabaci*.

Part III "Abiotic and physiological disorders" (p. 53–55) describes abnormal fruit shape, color spotting, fruit cracking, salt injury and other that lower quality of fruits.

Part IV "Herbicide injury" (p. 56–58) describes symptoms caused by accidental application of herbicides or due to soil carryover of their residues.

Part V "Nutritional disorders" (p. 59–60) provides advices on proper use o fertilizers and microelements such as nitrogen, potassium, phosphorus, calcium, magnesium, sulfur, iron and manganese.

Each chapter contains pertinent literature and good subject index (p. 61–63) that facilitates easy use of that very interesting book that I recommend to all persons concerned with plant protection.

Jerzy J. Lipa
Institute of Plant Protection, Poznan, Poland