A COMPARISON OF INSECT PEST COLONIZATION ON WHITE CABBAGE CULTIVARS

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Abstract: The experiments were carried out in 2002 and 2003. Twenty-two cv. of white cabbage were sown in 2002 and eighteen cv. of white cabbage were sown in 2003. In both years, observations were done and the occurrence of the cabbage aphid *Brevicoryne brassicae* L., small white butterfly *Pieris rapae* L., large white butterfly *P. brassicae* L., diamondback moth *Plutella xylostella* L. and cabbage moth *Mamestra brassicae* L. were determined. The results show that the lowest number of aphids was noted on cv. Hurricana and Vestri and also the development of aphids on these cultivars was very weak. The results from 2003 show that the cultivar most preferred by cabbage aphids was Lenox. The diamondback moth *P. xylostella* L., small white butterfly *P. rapae* L., large white butterfly *P. brassicae* L., and cabbage moth *M. brassicae* L. were not very numerous in either year, although a higher number was noted in 2002. The highest number of caterpillars and pupae of diamond moth were observed on cv. Hurricana, Kalorama and Bartolo. In the year of the most intensive occurrence, the eggs of the white butterfly *P. rapae* L were the most numerous on cv. Lenox and the least numerous on cv. Balaton and Kamienna Głowa. Egg clusters of the large white butterfly *P. brassicae* L. and cabbage moth *M. brassicae* L. were mainly noted in 2002, and then only on some cultivars. The greatest number of eggs clusters of *P. brassicae* was observed on cultivars Masada and Sitton, and of *M. brassicae* on cultivars Kronos and Langendijker.

Key words: cabbage cultivars, *Brevicoryne brassicae,* lepidoptera pests

INTRODUCTION

White cabbage is one of the most economically important vegetable in Poland. Several pests attack cabbage and can cause serious economic losses. The most important pests affecting late cabbage are the mealy cabbage aphid *Brevicoryne brassicae* L. (Jankowska and Wiech 2004), diamondback moth *Plutella xylostella* L. (Jankowska 2005), other lepidoptera pests, such as the small white butterfly *Pieris rapae* L., large white butterfly *Pieris brassicae* L., cabbage moth *Mamestra brassicae* L. (Jankowska 2006), flea beetles *Phyllotret*a spp. (Jankowska 2002–2003) and thrips (Pobożniak 2005; Pobożniak and Wiech 2005). Detailed information on the occurrence of thrips are presented by Pobożniak and Wiech (2004) and Pobożniak (2005). Integrated Pest Management (IPM) is the most desirable approach for control, and host plant resistance is considered to be a major component of IPM. The aim of the study was to compare the infestation by some important pests on the different late cultivars of white cabbage. This paper presents the results of field studies which were done to determine the occurrence of the cabbage aphid *B. brassicae* L., small white butterfly *P. rapae*, large white butterfly *P. brassicae*, diamondback moth *P. xylostella* and cabbage moth *M. brassicae*.

MATERIALS AND METHODS

The experiments were carried out in 2002 and 2003 at the Agricultural Experimental Station in Mydlniki near Cracow on typical brown soil with pH 6.5 and C_{org} content 1.8%.

In 2002, twenty-two cultivars of white cabbage were studied. The early cultivars were: Eton F_1, mid-late: Vestri F_1. The late cultivars were: Amtrak F_1, Ancoma F_1, Atria F_1, Azan F_1, Balaton F_1, Bartolo F_1, Galaxy F_1, Hurricane F_1, Impala F_1, Kamienna Głowa F_1, Kalorama F_1, Kronos F_1, Langendijker F_1, Lennox F_1, Masada F_1, Saratoga F_1, Stilon F_1, Theras F_1, Zerlina F_1. The very late cultivar was: Donar F_1. In 2003, only eighteen cultivars were sown, because the following cultivars were not available: Donar F_1, Kalorama F_1, Langendijker F_1 and Stilon F_1. The method of randomized blocks with four replications was used. In each replication, two rows of the same cv. of cabbage were planted in random order. Fifteen plants were planted in each row and spaced about 0.45 m apart. The distance between rows was 0.5 m. The plots belonging to the successive replications were separated by a 1.5 m wide footpath. In 2002, cabbage was planted on 10 June and in 2003 on 3 June. No insecticides were used during the experiments, and weeds were removed mechanically and manually. Observations were carried out from the begin-

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ning of July, in two weeks intervals. During the analyses, 20 plants of each cultivar (5 from replication) were inspected. During each inspection, winged and wingless forms of the cabbage aphid (*B. brassicae*), and eggs and larvae of the butterflies (*P. rapae*, *P. brassicae*, *M. brassicae*) and larvae and pupae of DBM (*P. xylostella*) were counted. The method of direct observation, *i.e.* counting of mummies present in aphid colonies, was used to asses the degree of parasitization. The number of parasited aphids informs us about the activity of the parasite and is regarded to be a reliable estimation of their field efficiency (Barczak 1992). The Duncan multiple test ($\alpha < 0.05$) was used for the statistical analysis of the results.

RESULTS AND DISCUSSION

Several factors are involved in the insects' search for a host plant: visual stimuli such as colour and intensity of the reflected light, tactile stimuli experienced when a body of the insect touches the surface of a plant, and finally chemical stimuli including both odours and tastes. Crucifer-feeding specialist usually respond to glucosinolates (GS) and some of the breakdown products, *e.g.*, isothiocyanates (ITC) (Schoonhoven 1972; van Loon *et al*. 1992; Pivnick *et al*. 1994; Pawar and Lawande 1995; Gabryś 1999; Renwick and Lopez 1999). The analysis carried out by Gow-Chin Yen and Que-King Wei (1993), Ciska *et al*. (1994) suggest that some cultivars contain more of these substances than others. Therefore, the attractiveness of different cultivars varies for pests.

In both years, cabbage aphid (*B. brassicae*) infestation on plants was observed. Winged specimens invade cabbage vegetables from other environments *e.g*. rape, and colonize these vegetables. All observed vegetables were colonized in the same term. In 2002, when the aphids were not very numerous, there was no significant difference in the number of aphids and no significant differences in the cultivars aphids chose to land on (Table 1). The observed colonies were not very numerous, and the average number of aphids per 5 plants was from 9.75 on Zerlina to 30.63 on Ancoma. In 2003, a much higher number of aphids was noticed. The greatest number of migrants was observed on Lennox: 16.75 winged forms/5 plants (Table 2). The rest of the cultivars were not as infested by winged aphids. Significant differences were found between the number of winged aphids on cv. Lennox in comparison to cv. Atria, Bartolo, Eton, Galaxy, Huricana, Kronos and Vestri. On these cultivars, the recorded number of migrants was from 6.75 to 5.25 winged form/5 plants. In the case of some cultivars, the low number of

Table 1. The comparison of the occurrence of cabbage pests on different late cultivars of white cabbage in 2002

Cultivars	Mean number per 5 plants								
	Cabbage aphid *Brevicoryne brassicae*			*Pieris rapae*		*Plutella xylostella*	*Mamestra brssicae*		
	winged aphids	total aphids	parasitization [%]	eggs	larvae	larvae and pupae	egg clusters	eggs	larvae
Ancoma	1.75 a	30.63 ab	11.4	2.13 ab	0.63	4.50 abcd	0.13	1.25	0.13
Amtrak	1.25 a	9.88 a	20.2	1.00 ab	0.75	3.50 abcd	0	0	0.75
Atria	1.50 a	15.00 a	9.2	0.88 ab	0.50	5.13 bcd	0	0	0.13
Azan	1.75 a	20.75 ab	8.4	1.88 ab	0.38	5.38 bcd	0	0	0.89
Balaton	0.88 a	17.25 ab	9.4	0.63 a	0.13	3.63 abcd	0.13	0.75	0.38
Bartolo	2.75 a	23.38 ab	11.3	1.38 ab	0.88	6.38 cd	0	0	0.23
Donar	1.75 a	22.38 ab	3.9	1.75 ab	0.13	3.38 abc	0.13	0.75	0.38
Eton	2.50 a	22.13 ab	5.7	1.25 ab	0.25	2.88 ab	0	0	0.62
Galaxy	1.75 a	12.50 a	10	0.75 a	0	4.13 abcd	0.13	0.75	0.50
Hurricana	1.25 a	50.50 b	2.7	0.75 a	0.50	6.63 d	0	0	0.63
Impala	1.25 a	16.38 a	11.5	2.00 a	0.50	4.38 abcd	0.13	1.00	0.38
Kalorama	1.88 a	21.63 ab	4.6	1.38 ab	0.38	6.50 cd	0	0	0.18
Kamienna Głowa	2.63 a	18.25 ab	7	0.75 a	0.75	4.13 abcd	0	0	0.50
Kronos	1.38 a	12.00 a	19.8	1.25 ab	0.75	4.75 bcd	0.50	12.80	0.13
Langendi-jker	1.38 a	20.75 ab	12	1.50 ab	0	4.63 abcd	0.40	8.90	0.50
Lennox	2.63.a	25.13 ab	8.5	2.50 b	0.25	5.38 bcd	0.25	4.40	0.63
Masada	1.88 a	20.75 ab	7.2	1.00 ab	0.50	6.25 cd	0	0	2.00
Saratoga	2.00 a	10.50 a	8.3	2.00 ab	0.25	4.13 abcd	0.25	5.00	0.63
Stilon	1.00 a	23.25 ab	14.5	1.00 ab	0.75	4.88 bcd	0	0	0.13
Theras	0.88 a	11.88 a	9.4	1.38 ab	0.88	5.00 bcd	0	0	0.50
Vestri	0.88 a	7.88 a	9.5	0.88 ab	0.63	4.50 abcd	0.13	3.13	0.63
Zerlina	1.25 a	9.75 a	2.6	0.88 ab	0.25	1.63 a	0.13	1.75	0.38

Means followed by the same letter are not significantly different ($\alpha < 0.05$)

Table 2. The comparison of the occurrence of cabbage pests on different late cultivars of white cabbage in 2003

Cultivars	Mean number per 5 plants								
	Cabbage aphid *Brevicoryne brassicae*			*Pieris rapae*		*Plutella xylostella*	*Mamestra brssicae*		
	winged aphids	total aphids	parasitization [%]	eggs	larvae	larvae and pupae	egg clusters	eggs	larvae
Ancoma	8 ab	263.50 a	11.4	1.00 a	0.50	0.50 a	0	0	0
Amtrak	15 ab	265.75 a	8,1	1.00 a	0.25	3.00 abc	0	0	0
Atria	6.25 a	110.50 a	9.3	0.25 a	1.00	0.75 ab	0.25	4.5	0.25
Azan	11.50 ab	301.50 a	13.4	0.25 a	0.50	1.75 ab	0	0	0
Balaton	8.00 ab	130.00 a	4.4	0 a	0.25	0.50 a	0	0	0
Bartolo	5.25 a	120.25 a	13.3	1.00 a	0.50	1.75.ab	0	0	0.50
Eton	6.50 a	80.25 a	3.7	0.50 a	0.50	1.25 ab	0.25	3.80	0
Galaxy	6.75 a	224.50 a	9	0.25 a	0	3.25 bc	0	0	0
Hurricana	5.50 a	50.25 a	4.5	0.25 a	0.50	1.25 ab	0	0	0
Impala	11.25 ab	68.25 a	1.8	0.25 a	0	1.50 ab	0	0	0.75
Kamien-na Głowa	7.25 ab	378.75 a	13.9	0.75 a	0.75	2.75 abc	0	0	0
Kronos	6.25 a	123.50 a	9.24	0.50 a	0.25	4.25 c	0	0	0.50
Lennox	16.75 b	50.00 a	2	0.25 a	0	2.25 abc	0	0	0.75
Masada	9.50 ab	116.00 a	4.1	0.25 a	0	0.50 a	0	0	0
Saratoga	10.50 ab	335.75 a	3.9	0 a	0.50	1.00 ab	0	0	0
Theras	11.25 ab	49.50 a	7.4	0.50 a	0	1.75 ab	0	0	0
Vestri	5.25 a	22.50 a	3.3	0 a	0.25	2.75 abc	0	0	0
Zerlina	8.00 ab	55.25 a	2.7	0 a	0.75	1.50 ab	0	0	0

Means followed by the same letter are not significantly different ($\alpha < 0.05$)

recorded migrants was accompanied by a low total number of cabbage aphids. This was noticed for example, in the case of cv. Vestri, Zerlina and Hurricana. It was also sometimes noted, that a relatively low number of flying aphids was accompanied by a significantly higher total number of aphids. This is what happened on the Kamienna Głowa cultivar, for which only 7.25 migrants/5 plants was noticed, while the total number of cabbage aphids was the highest in comparison to the other cultivars and equalled 378.5 aphids/5 plants. The opposite situation was observed for Theras and Impala cultivars, where a higher number of migrants was noticed despite the low total number of aphids. Based on these data, it can be assumed that despite the fact that some cultivars were more attractive for the flying migrants, those cultivars did not created the appropriate conditions for the development of cabbage aphids. On the other hand, some cultivars had a low infestation of winged aphids but created favourable conditions for their development. Other authors also confirmed that on some four-leaf cultivars not preferred by the migrants, the later development of aphids was very high (Ellis and Hardman 1985; Jankowska and Wiech 2004).

In both years of the research study, the number of aphids on plants was reduced by the parasited *Diaeretiella rapae* (M'Intosh). It is the most important natural enemy decreasing the number of cabbage aphids (Jankowska and Wiech 2003). The percentage of parasitisation varied between cultivars (Table 1, 2) and oscillated from 2.6 to 20.2% in 2002, and from 1.8 to 13.9% in 2003.

Five *Lepidoptera* species were noted during the study: the diamondback moth *P. xylostella*, small white butterfly *P. rapae*, large white butterfly *P. brassicae*, cabbage moth *M. brassicae* and caterpillars of the Silver Y moth *P. gamma P. brassicae* was mainly noted in 2002, but was not very numerous. Egg clusters were found only on some cultivars: Azan (56 eggs), Donar (20), Impala (40), Masada (70), Saratoga (29), and Silton (80). In 2003 only one batch (19 eggs) was found on cv. Azan. The occurrence of eggs and larvae of *P. rapae* and *M. brassicae* are presented in table 1 and 2. *Pieris rapae* was observed in each season and occurred on all studied cultivars (Table 1, 2.). In 2002, a very low number of *P. rapae* was noticed and no significant differences in numbers between cabbage cultivars were found. The infestation was greater in 2002.

The cabbage moth *M. brassicae* was the most numerous in 2002. The greatest number of eggs was found on Kronos (12.8 egs/5 plants), on Langendijker (8.9 eggs/ 5 plants), Saratoga (5) and Vestri (3.13). On the remaining cultivars, the number of eggs was from 1.75 to 0.0 (Table 1). The number of eggs was not comparable with the number of recorded caterpillars of the cabbage moth. For example, only 0.13 caterpillars/5 plants were found on cv. Kronos (Table 1). The greatest number of caterpillars; equal to 0.89 caterpillars/plant was found on cv. Atria. In 2003, cabbage moths were not very numerous and caterpillars were found only on 5 cultivars (Table 2).

In 2002, the greatest numbers of larvae and pupae of the diamondback moth *P. xylostella*, were observed on cultivars Hurricana, Kalorama, Bartolo and Masada. The

average number of larvae and pupae were correspondingly 6.63, 6.5, and 6.38 and 6.25 specimens/5 plants. The lowest number; only 1.63 specimens/5 plants was noticed on cv. Zerlina. On the remaining cultivars, this number was from 5.38 to 2.88 specimens/5 plants. As was the case with other butterflies, the intensity of the occurrence of diamondback moths in the following year, here being the year 2003, was lower. The results from the 2002–2003 analysis were not similar (Table 2, 3).

Significant differences in the relative resistance of the cultivars were observed with respect to the different pests, and no single cultivar was resistant to all pest species. Radcliffe and Chapman (1965, 1966) stated similar results when studying the resistance of 21 cultivars to cabbage aphid and three lepidopterous pest as well as cabbage rot fly. Brett and Sullivan (1974) summarized a series of experiments carried out over a seven year period on pest range of cruciferous crops, including 37 cabbage cultivars. High levels of resistance Various cabbage cultivars were found to have high levels of resistance to eight different insect species, although no single cultivar possessed resistance to all pests. Kunicki and Łuczak (2001) and Łuczak and Osmański (2006) observed different susceptibility to pest infestation of various broccoli cultivars.

CONCLUSIONS

1. Significant differences in the relative resistance of the cultivars were observed with respect to the different pests. No single cultivar was resistant to all species.
2. The most intensive occurrence of cabbage aphids *B. brassicae* was noticed in 2003, with different intensity on particular cabbage cultivars. The lowest number of aphids was noticed on cv. Hurricana and Vestri and also the development of aphids on these cultivars was very weak. The results from 2003 show, that the cultivar most preferred by cabbage aphids was cv. Lenox, although a very high number of pests was not noticed. Despite the fact that there was not a very intensive flight of migrants on Kamienna Głowa, it had the highest total number of cabbage aphids.
3. The highest number of caterpillars and pupae of the diamondback moth *L. xylostella* were observed on cv. Hurricana, Kalorama and Bartolo.
4. In the year of the most intensive occurrence, the eggs of the small white butterfly *P. rapae* were the most numerous on cv. Lenox and the least numerous on cv. Balaton and Kamienna Głowa.
5. Egg clusters of the large white butterfly *P. brassicae* and cabbage moth *M. brassicae* were mainly noted in 2002, and only on some cultivars. The greatest number of eggs clusters of *P. brassicae* was observed on cultivars Masada and Sitton, and of *M. brassicae* on cultivars Kronos and Langendijker.

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POLISH SUMMARY

PORÓWNANIE ZASIEDLENIA ODMIAN KAPUSTY BIAŁEJ PRZEZ SZKODNIKI

Badania prowadzono w latach 2002–2003 na terenie Stacji Doświadczalnej Katedry Ochrony Roślin w Mydlnikach koło Krakowa. Obserwacjami objęto 22 odmiany (w 2002 roku) i 18 odmian (w 2003 roku) kapusty białej. Podczas obu sezonów obserwowano występowanie na roślinach: mszycy kapuścianej *Brevicoryne brassicae* L., bielinka rzepnika *Pieris rapae* L., bielinka kapustnika *Pieris brassicae* L., piętnówki kapustnicy *Mamestra brassicae* L. oraz tantnisia krzyżowiaczka *Plutella xylostella* L. Mszyca w większym nasileniu występowała w roku 2003. Najsłabiej zasiedlane były odmiany Hurricana i Vestri, a najliczniej odmiana Lennox. Mimo niewielkiej liczby mszyc uskrzydlonych na odmianie Kamienna Głowa, stwierdzono na niej największą ogólną liczbę mszyc. W roku 2002 sytuacja kształtowała się inaczej. Największą liczbę gąsienic i poczwarek tantnisia krzyżowiaczka obserwowano na odmianach Hurricana, Kalorama i Bartolo, a najmniejszą na odmianie Berlina. Najwięcej jaj bielinka rzepnika obserwowano na odmianie Lennox, a najmniej na odmianach Balaton i Kamienna Głowa. Pojedyncze złoża jaj bielinka kapustnika i piętnówki kapustnicy obserwowano głównie w 2002 roku, tylko na niektórych odmianach. Najwięcej złóż jaj bielinka kapustnika znaleziono na odmianach Masada i Sitton, a piętnówki kapustnicy na odmianach Kronos i Langendijker.