

Effect of intercropping white cabbage with French Marigold (*Tagetes patula nana* L.) and Pot Marigold (*Calendula officinalis* L.) on the colonization of plants by pest insects

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ABSTRACT

In 2003 – 2005 the impact of intercropping white cabbage ‘Bently F1’ with French Marigold (*Tagetes patula nana* ‘Kolombina’) and Pot Marigold (*Calendula officinalis* ‘Promyk’) on the occurrence of pest insects was estimated. On plots where cabbage was intercropped the number of cabbage aphid *Brevicoryne brassicae* L. and flea beetles *Phyllotreta* was significantly lower when compared with control variant (homogenous crop). Intercropping had an effect on the butterfly oviposition too. The lower number of eggs of the small white butterfly *Pieris rapae* L., large white butterfly *P. brassicae* L., cabbage moth *Mamestra brassicae* L. and larvae and pupae of the diamondback moth *Plutella xylostella* L. were observed on plots with *Calendula* and *Tagetes*. Intercropping with Pot Marigold was the most effective pest control on cabbage.

INTRODUCTION

Among the numerous phytophagous insects occurring on different botanical varieties of cabbage including white cabbage, the most important were cabbage aphid *Brevicoryne brassicae* L. (Jankowska and Wiech 2004), flea beetles *Phyllotreta* spp. (Szwejdka 2004), and several *Lepidoptera* pests, such as the small white butterfly *Pieris rapae* L., large white butterfly *Pieris brassicae* L., cabbage moth *Mamestra brassicae* L. (Jankowska 2006), diamondback moth *Plutella xylostella* L. (Jankowska 2005), *Contarinia nasturtii*, and *Delia radicum* (Szwejdka 2004). Each of these pests has the potential of reducing the marketable yield severely or completely destroying the crop. Chemical pest control generates ecological and toxicological problems. One of the alternative proposals to reduce losses from pest attack is intercropping and mixed cropping.

Many studies have shown that vegetative diversity in the form of intercropping can result in reduced pest densities and increases the resistance of the environment (Wiech and Kałmuk 2005). Andow (1991) analysed 209 studies involving 287 pest species. Compared with monocultures, the population of pest insects was lower in 52% of the studies (149 species). Intercropping systems favour the environment because they prevent soil from erosion, and influence soil structure as well. This system demands careful management for success. A very important factor is species assortment, which influences plants growth and yielding and pest population. Therefore, the aim of this investigation was to assess the influence of intercropping cabbage with *Tagetes* and *Calendula* on the infestation of some herbivorous cabbage pests.

MATERIAL AND METHODS

The investigation was carried out in 2003 – 2005 in Mydlniki near Kraków, Poland on brown soil developed on loess. A randomized block design was used in three replications on 10.8 m² plots. The combinations of the experiment included three objects: a homogenous crop of white cabbage 'Bently F₁', cabbage intercropping with *Tagetes patula nana* 'Kolombina' and cabbage intercropping with *Calendula officinalis* 'Promyk'. *Tagetes* and *Calendula* were sown on 22 April in 2003 – 2004, and 24 April in 2005. The cabbage was transplanted in spacing of 67.5 × 40 cm between intercrop rows on 28 May in 2003 and 2004, and 3 June in 2005. No chemical treatments were applied and weeds were removed mechanically. Ten plants were selected and marked from each plot and every week were inspected, and winged and wingless forms of the cabbage aphid *Brevicoryne brassicae* L., flea beetles *Phyllotreta* sp. and eggs and larvae of the butterflies (*Pieris rapae* L., *P. brassicae* L., *Mamestra brassicae* L.) and larvae and pupae of DBM *Plutella*

xylostella L. were counted. The number of plants damaged by swede midge *Contarinia nasturtii* (Kieffer) from each plot was recorded as well. The Duncan multiple test ($p = 0.05$) was used for the statistical analysis of the results.

RESULTS AND DISCUSSION

During the observations carried out in the years 2003 – 2005, plant infestation by the cabbage aphid *B. brassicae* L. differed in accordance to the type of cultivation. All observed combinations were colonized in the same term, but the number of aphids landing on plants differed. More winged aphids and more colonizers were recovered from the plots with cabbage alone than from cabbage intercropped (Table 1). The total number of aphids occurring on plots intercropped with *Tagetes* was 2-7 times less and with *Calendula* was 8-24 times less than in the monoculture (Table 1). In all the years of research the percentage of plants infested by aphids was significantly higher in plots with a homogenous crop of cabbage (Table 1). Many studies have shown that intercropping cabbage with other plants can result in reducing cabbage aphid (Theunissen and Den Ouden 1980, Wiech 1993, Vidal and Bohlsen 1994, Costello 1995, Vidal 1997, Lehmus et al. 1999, Bukovinszky et al. 2003, Kienegger et al. 2003).

Two flea beetle species were noted during the study: *Phyllotreta nemorum* L. and *Phyllotreta atra* Fabr. *P. nemorum* was the dominant flea beetle species in all the years of observation and in every combination. The number of beetles on cabbage plants growing on plots with *C. officinalis* and with *T. patula* was significantly lower compared with the cabbage monoculture (Table 2). Latheef et al. (1984) observed that beetle populations were significantly smaller, and collard foliage was damaged significantly less in intercropped collards than monocropped collards. According to Tahvanainen and Root (1972), the highly odours ragweed *Ambrosia artemisifolia* could be used to repel the flea beetle *P. cruciferae* from a collard crop.

Fewer eggs of the small white butterfly *Pieris rapae* L. (Table 3) and cabbage moth *Mamestra brassicae* L. (Table 4) were observed on intercropped plots. Koehler et al. (1983) studied several medicinal plants and herbs and found that the aforementioned plants, planted near cabbage, reduced the abundance of *P. rapae* on cabbage. Lundgren (1975) noted that adults of *P. rapae* did not lay eggs on cabbage plants in the company of *Salvia horminum*. According to many authors, egg densities of *P. rapae* were not influenced by cropping system (Maguire 1983, Clough et al. 2002). Metspalu et al. (2003) showed that *T. patula* were oviposition repellent to *Pieris brassicae*, but the butterflies laid early eggs on cabbage plants surrounded by *C. officinalis*.

On intercropped plots fewer larvae and pupae of the diamondback moth (*Plutella xylostella* L.) were noted compared with a cabbage monoculture (Table 5). Many studies reported a lower abundance of *P. xylostella* in intercropping system with labiate herbs (Dover 1986), subterranean clover (Finch and Kienegger 1997), strawberry clover (Theunissen and Schelling 1996), white clover (Dover 1986, Wiech 1993), and red clover (Åsman et al. 2001). Compared with homogenous crops, the losses caused by swede midge *Contarinia nasturtii* were also smaller (Table 6).

Table 1. Selected information concerning cabbage aphid (*Brevicoryne brassicae* L.) occurrence on cabbage according to the type of cultivation (2003 – 2005)

Selected information	Type of cultivation		
	Cabbage (homogenous crop)	Cabbage with <i>Tagetes patula</i>	Cabbage with <i>Calendula officinalis</i>
2003			
Mean number of migrants per plant	1.80 b*	0.01 a	0.00 a
Mean number of aphids per plant	44.20 c	5.73 b	0.20 a
% of plants with aphids			
17.06	33.30 b	0.00 a	0.00 a
03.07	50.00 b	10.00 a	33.00 a
2004			
Mean number of migrants per plant	3.00 b	0.90 a	0.40 a
Mean number of aphids per plant	54.60 c	11.30 b	2.30 a
% of plants with aphids			
28.06	64.00 b	30.00 a	26.00 a
09.07	93.00 b	36.00 a	30.00 a
2005			
Mean number of migrants per plant	2.18 b	0.30 a	0.20 a
Mean number of aphids per plant	165.70 c	64.50 b	20.60 a
Mean number of aphids per plant in period of max. infestation	435.90 c	151.90 b	49.30 a
15.07			
% of plants with aphids			
22.06	69.20	19.20	7.50
13.07	100.00	99.00	74.00
10.08	100.00	100.00	80.00

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

Table 2. Occurrence of flea beetles (*Phyllotreta* sp.) on cabbage according to the type of cultivation (2003 – 2005)

Type of cultivation	Mean number of beetles / plant		
	2003	2004	2005
Cabbage (homogenous crop)	9.70 b*	9.70 b	2.40 b
Cabbage with <i>Tagetes patula</i>	0.08 a	0.00 a	0.08 a
Cabbage with <i>Calendula officinalis</i>	0.03 a	0.33 a	0.00 a

* Explanations: see Table 1

Table 3. Occurrence of small white butterfly (*Pieris rapae* L.) eggs and caterpillars on the cabbage according to the type of cultivation (2003–2005)

Type of cultivation	Mean number / plant					
	2003		2004		2005	
	Eggs	Larvae	Eggs	Larvae	Eggs	Larvae
Cabbage (homogenous crop)	5.50 b*	2.75 a	9.60 b	3.20 a	4.00 b	2.00 a
Cabbage with <i>Tagetes patula</i>	4.00 b	2.50 a	3.00 a	1.00 a	1.30 a	2.00 a
Cabbage with <i>Calendula officinalis</i>	1.50 a	1.75 a	2.00 a	2.00 a	1.30 a	1.00 a

* Explanations: see Table 1

Table 4. Occurrence of cabbage moth (*Mamestra brassicae* L.) eggs on the cabbage according to the type of cultivation (2003 – 2005)

Type of cultivation	Mean number / 30 plants					
	2003		2004		2005	
	Egg clusters	Eggs	Egg clusters	Eggs	Egg clusters	Eggs
Cabbage (homogenous crop)	3.50 b*	58.80 b	4.00 b	68.00 b	2.00 b	20.00 b
Cabbage with <i>Tagetes patula</i>	1.50 b	17.50 b	2.50 b	30.00 b	0.00 a	0.00 a
Cabbage with <i>Calendula officinalis</i>	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a

* Explanations: see Table 1

Table 5. Occurrence of diamondback moth (*Plutella xylostella* L.) larvae and pupae on the cabbage according to the type of cultivation (2003 – 2005)

Type of cultivation	Mean number / 30 plants		
	2003	2004	2005
Cabbage (homogenous crop)	13.00 b*	4.80 b	5.30 b
Cabbage with <i>Tagetes patula</i>	9.30 b	1.00 a	0.80 a
Cabbage with <i>Calendula officinalis</i>	3.50 a	0.20 a	0.20 a

* Explanations: see Table 1

Table 6. Occurrence of swede midge *Contarinia nasturtii* (Kieffer) on the cabbage according to the type of cultivation (2003 – 2005)

Type of cultivation	Plants damaged by swede midge (%)		
	2003	2004	2005
Cabbage (homogenous crop)	27.50 b*	16.70 b	3.30 b
Cabbage with <i>Tagetes patula</i>	4.20 a	7.50 a	0.80 a
Cabbage with <i>Calendula officinalis</i>	16.70 b	8.30 a	0.80 a

* Explanations: see Table 1

Diversity of plants in agrocenosis may be an important factor that influences the presence of pests as well as their natural enemies. Jankowska (2007) noted that on plots where cabbage was intercropped with Pot Marigold and French Marigold, cabbage aphid parasitisation by *Diaeretiella rapae* M'Intosh was greater and the percentages of predatory *Syrphidae* to prey were more favourable than on homogenous crops. The combination with Pot Marigold turned out to be the best in this respect.

CONCLUSIONS

1. The number of cabbage aphid *Brevicoryne brassicae* L. and flea beetles (*Phyllotreta*) was significantly lower on plots where cabbage was intercropped with Pot Marigold and French Marigold in comparison with homogenous crops.
2. Intercropping had an effect on the oviposition of the small white butterfly *Pieris rapae* L., large white butterfly *P. brassicae* L., cabbage moth *Mamestra brassicae* L. and diamondback moth *Plutella xylostella* L.
3. Intercropping with Pot Marigold was the most effective in limiting pests on cabbage.

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WPLYW UPRAWY WSPÓLRZĘDNEJ KAPUSTY BIAŁEJ Z AKSAMITKĄ
(*TAGETES PATULA NANA*) I NAGIETKIEM (*CALENDULA OFFICINALIS*)
NA ZASIEDLENIE PRZEZ SZKODLIWĄ ENTOMOFAUNĘ

Streszczenie: W latach 2003 – 2005 oceniano wpływ współrzędnej uprawy kapusty białej ('Bently F₁') z aksamitką niską pełną *Tagetes patula nana* 'Kolombina' i nagietkiem lekarskim *Calendula officinalis* 'Promyk' na występowanie szkodliwej entomofauny. Na kapuście uprawianej współrzędnie z aksamitką i nagietkiem obserwowano istotnie mniej mszycy kapuścianej *Brevicoryne brassicae* L. i chrząszczy pchelek ziemnych *Phyllotreta* w porównaniu z uprawą jednorodną. Uprawa współrzędna wpływała także na składanie jaj przez motyle. Obserwowano tam mniej jaj bielinka rzepnika *Pieris rapae* L., bielinka kapustnika *P. brassicae* L., piętnówki kapustnicy *Mamestra brassicae* L. oraz gąsienic i poczwarek tantnisia krzyżowiaczka *Plutella xylostella* L. Najskuteczniej liczebność fitofagów na kapuście ograniczała uprawa współrzędnie z nagietkiem.

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