Influence of flowering strips on the (functional) biodiversity in apple orchard

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Abstract

Influence of flowering strips in inter-rows in apple orchard on the predators, parasitoids, pollinators, pests and other selected insect groups was observed using transect count during the 2013-2014 seasons. Inter-rows with flowering plants were more attractive to beneficial organisms (Syrphidae, Tachinidae, Hymenoptera parasitoids…) as well as to pests and Rhopalocera with comparison of conventional grass-covered rows.

Keywords: biodiversity, flowering strips, pests, natural enemies, apple orchard

Introduction

Long-term usage of broad-spectrum insecticides has led to suppression of natural enemies of pests (Solomon *et al*., 1999) and also to the development of pest resistance to many active substances. Insect pest outbreaks happen more often. In integrated pest management (IPM) the core idea is to use several different methods of pest control. These methods are synergistic, when used correctly. Dominant pest species in orchards in Europe are represented by aphids and tortricids, which can be controlled without any harm to beneficials (Blommers, 1994). Natural enemies are effective enough to control minor pests (Solomon *et al*., 1999), however the beneficial have to be supported by appropriate measures. One of the ways how to enhance activity of predators and parasitoids is to increase diversity of plant species (Andow, 1991). This can be done easily by sowing of "the flowering strips". Higher plant species diversity influences natural enemies due to more favourable microclimate (Dyer & Landis, 1996). It provides insects with alternative food sources, such as honeydew, nectar and pollen (Winkler *et al*., 2006), which are essential for some predator and parasitoid species. Flowering strips are established usually in inter-rows. Commercial seed mixtures are available on the market; on the other hand, local mixtures can be more favourable.

Material and Methods

The trial was located in IPM apple orchard in the centre of the Czech Republic (GPS: 49°57'53.494"N 15°29'46.247"E). Pesticide were applied during the whole season when needed. The two different flowering plant mixtures were sown in inter-rows in the spring 2012 (mixture 1) and in the spring 2013 (mixture 2) at seeding rate 32 kg/ha. Inter-rows with grass sown in spring 2012 were used as a control. Mowing was done monthly, except of the middle part between tractor wheels, which was cut only once per season before harvest. Selected insect species or insect groups such as pollinators, natural enemies and pests were evaluated using transect count every week from plant flowering to a crop harvest (from June 12 to August 21 in 2013 respective from May 31 to August 28 in 2014). Each variant was replicated 3x (inter-rows), in the inter-row only insects feeding on the plants in belt 2m wide and 100 m long were count (total 600 m^2/variant). The density of flowering plants which were currently in bloom was estimated during each transect session using scale from 0.5 (rare) to 3 (dense).

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Results

Development of vegetation - intensity of flowering during the seasons is marked in figures 1-2. In the control only blooms of *Achillea millefolium* L. (17.7.2013 – density 0.5) and *Lotus corniculatus* L. (13.-17.7.2013 and 18.6.-15.8.2014 – density 0.5; 24.7.2013 – density 2) were observed. *Leontodon hispidus* L. germinated from the soil seed bank (in mixture 1 and 2), as well as *A. millefolium* (in mixture 2 and control) and *L. corniculatus* (in control). In spring 2015 in both mixtures grasses started to become dominant over dicotyledons and almost no flowering plant species was found. The whole inter-row was cut, but the effect was poor and grasses started dominating again. It was caused probably due to high nitrogen content, which was fixed by Fabaceae in the soil in previous year. Dominant tendency of grasses was observed already in 2014 in mixture 1.

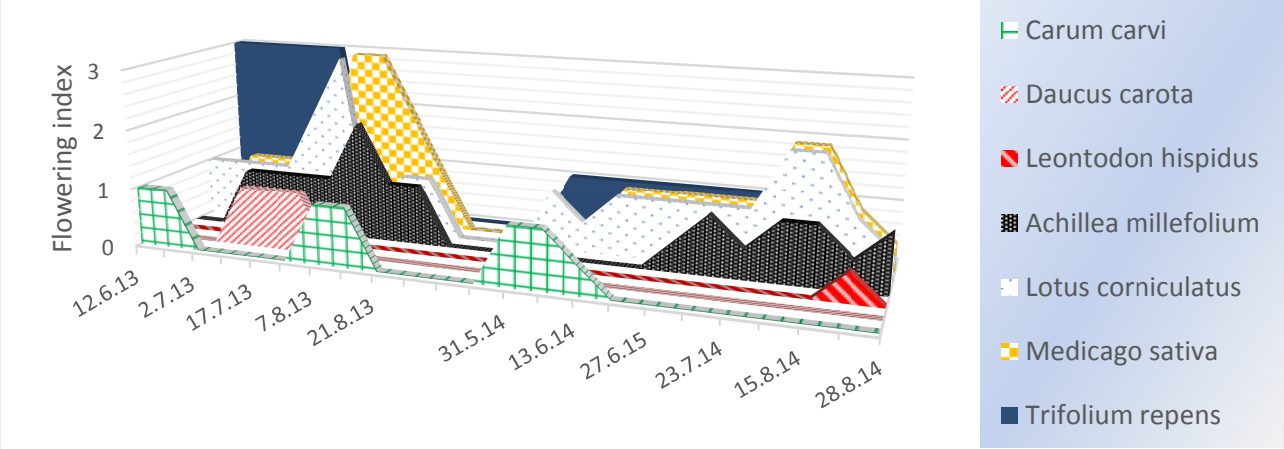

Figure 1: Flowering plat density 2013-2014 – mixture 1.

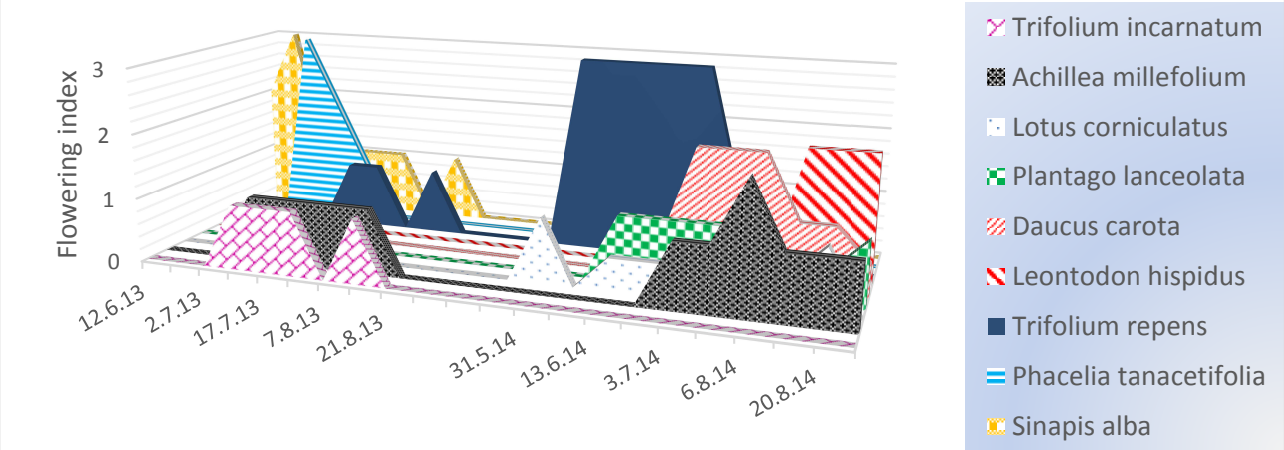

Figure 2: Flowering plat density 2013-2014 – mixture 2.

Occurrence of beneficial insects - the most abundant species or families were *Apis mellifera* L., Syrphidae and *Bombus* spp. (figure 3). Abundance of the beneficials depends on the year course and blooming density. Thus the abundance was very low in the control, because almost no flowering plants were present. About 75 % of Syphidae belonged to the aphidophagous species (e.g. *Episyrphus balteatus* de Geer, *Sphaerophoria scripta* L.), 30 % of Tachinidae were represented by *Leskia aurea* Fall. – parasitoid of *S. myopaeformis* larvae. *Coccinella septempunctata* L. was the most numerous species of Coccinellidae. Abundance of Coccinellidae as well as Aphidiinae was linked to the abundance of aphids on Fabaceae.

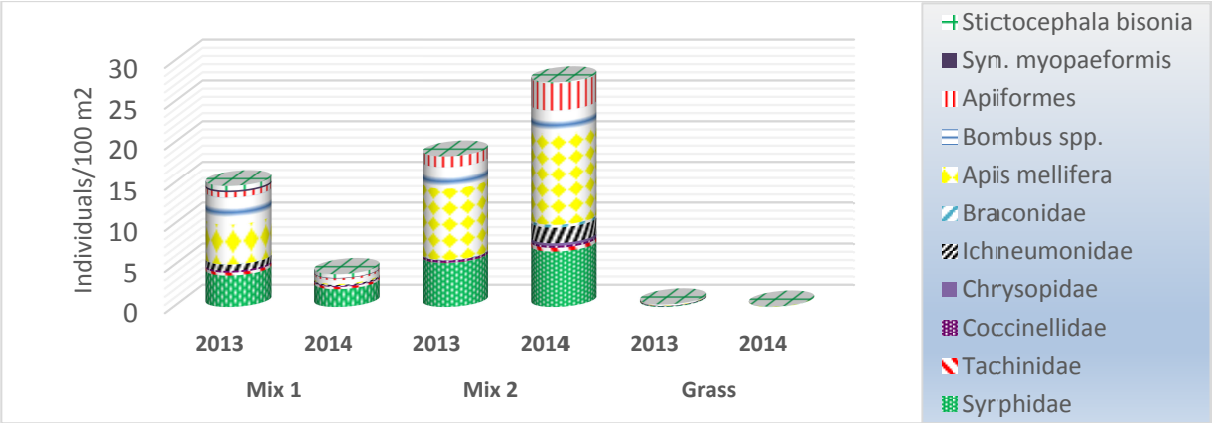

Figure 3: Comparison of flowering mixtures with grass inter-row (average number of individuals of beneficial organisms and pests per 100 m^2 in one term of assessment).

Occurrence of pests - only 2 species of pests were observed: *Stictocephala bisonia* Kopp & Yonke and *Synanthedon myopaeformis* Bork. Both species were found only in flowering strips. *S. bisonaria* was observed on Fabaceae plants and *S. myopaeformis* on flowers of *Medicago sativa* L. Flower buds of *Sinapis alba* L. were damaged by *Meligethes aeneus* F.

Occurrence of Rhopalocera - Rhopalocera serve as bio-indicators of the environmental quality. 16 species of Rhopalocera adults were observed in total, 9 species of them had suitable host plants for larvae in inter-rows (table 1). Sixteen species were observed in mixture 1, nine in mixture 2 and three in the control. Lastuvka (2008) has divided Czech orchards by number of Rhopalocera species into 3 groups: 1) low quality habitats - less than 8 species, 2) average habitats - 9-30 species, 3) high quality habitats - more than 31 species. The number of species was underestimated due to a short length of transects, nevertheless we can assign both tested mixtures a group 2, whilst control mixture a group 1.

Table 1: Comparison of flowering mixtures with grass inter-row (average number of individuals of Rhopalocera per 100 m^2 in one term of assessment).

Family	Species	Mix 1		Mix 2		Grass	
		2013	2014	2013	2014	2013	2014
Nymphalidae	*Aglais urticae*	0,02	0,18	-	-	-	-
	Araschnia levana	0,02	0,03	-	-	-	-
	Argynnis sp.	-	0,02	-	-	-	-
	*Coenonympha pamphilus**	0,06	0,06	-	0,02	-	0,03
	Inachis io	-	0,03	0,03	-	-	-
	Isoria lathonia	0,02	-	-	-	-	-
	*Maniola jurtina**	0,06	0,12	-	-	-	-
	Vanessa atalanta	0,02	-	-	-	-	-
	*Vanessa cardui**	-	0,03	-	-	-	-
Pieridae	*Gonepteryx rhamni*	0,06	-	0,03	-	-	-
	Pieris sp.*	0,33	-	0,06	-	-	-
	*P. brassicae**	0,04	0,05	-	0,02	-	-
	*P. napi**	0,02	0,03	-	-	-	-
	*P. rapae**	0,54	0,42	0,22	0,18	0,02	-
Lycaenidae	*Lycaenidae* spp.*	0,04	0,17	0,08	0,17	-	0,02
	*Polyommatus icarus**	0,43	0,08	0,08	0,03	-	-
Hesperiidae	*Thymelicus* sp.*	-	0,02	-	0,05	-	-
Total		**1,63**	**1,23**	**0,50**	**0,45**	**0,02**	**0,05**

* = host plants of larvae were presented in inter-rows

Discussion

Flowering strips increase the number of species as well as populations of predators and parasitoids, respective animals and plants diversity in the orchards and they have to be an integral part of organic and IP orchards technology (principle of sustainable agriculture). Nevertheless the strips alone cannot solve all the problems with pests (e.g. *Cydia pomonella* L., *Aphis pomi* de Geer and *Dysaphis plantaginea* Pass.) and it is desirable to combine them with common pest management practices. Any time the pest populations exceed the economic threshold, and so chemical treatment has to be used, we should consider using the selective ones first.

The positive influence of flowering plants on the abundance of natural enemies confirmed in this study has been known for a long time (Andow, 1991). However, a lot of effort has to be made to find suitable seed mixtures for different soil and climate conditions, and to optimize operational cutting management guaranteeing the longevity of flowering plants in inter-rows during the life time of the orchard.

For example 2 or more different seed mixtures in one orchard, where every second row is made of the mixture of Fabaceae and other plant species to fix nitrogen and to create organic matter, and the rest made of 1 or more different flowering plant seed mixtures could be established. It should be preferred sowing the seed mixtures within 2 years or in the spring and autumn to enhance the germination of more plant species in the mixture. It is necessary to remove the cut organic matter from inter-row under the trees (nutrients reduction) to avoid the competition of grasses.

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