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Enhancing the Biodiversity of Insects Pollinators through Flowering Grass Strips

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Abstract

The extensive use of plant protection products in agricultural practice and obtaining high and top quality yields results in decline of a major part of the natural regulators and the insects-pollinators. The reduction in their numbers in agricultural areas poses a threat for the pollination of entomophilous plants on global scale. The objective of this study was to establish areas of flowering varieties of grass mixes, ensuring proper habitats and food source for the pollinators of agricultural crops. The tests showed that the plant varieties in the grass mixes blossomed in the period April to June (1.5-2 months), providing varying species of pollinators, depending on the plants species. In the different-coloured layers of the grass mixtures: white, purple and yellow, the following pollinators were determined: *Apis mellifera* L., *Megachile* sp., *Halictus scabiosae* Rossi, *Lasioglossum xanthopus* Kirby, *Melita leporita*, *Andrena flavipes* Panzer., *Macropis europaeae* Warn., *Anthidium manicatum* L., *Ceratina cucurbitina* Rossi and *Ceratina* sp.

Keywords: flowering grass mixtures, pollinators of agricultural crops

1. Introduction

Bees are considered as major pollinators of crops worldwide. Approximately 35% of the food for human consumption is directly or indirectly dependent on pollination by insects, which improves the yields of agricultural plants (Watanabe, 1994; Delaplane & Mayer, 2000). The preservation of the pollinators is a serious challenge in the last decades. Most significant factors impacted bees behavior proved to be human activities, loss of essential habitats due to the decrease of natural areas with flowering plant varieties, extensive use of insecticides for pests control, as well as climate change (Goulson, 2013; Vanbergen, 2013; Kerr et al., 2015; IPBES, 2016). It is demonstrated (Maurizio, 1950; Mattila & Otis, 2006; Naug, 2009) decline of pollen quantity leads to change in biochemical composition of the nectar of the intensively cultivated crops and results in loss of bee families. Bees decline causes significant losses in agriculture, since more than 90 % of the crops need pollinators or pollen carriers for cross-pollination (Proctor et al., 1996; Nabhan & Buchmann, 1997; Roubik, 1995; Klein et al., 2007; Ollerton et al., 2011; Kevan & Phillips, 2001; Aizen & Harder, 2009). In this respect, the value of bee honey, produced in the EU, amounts to approximately 140 million euro (Moritz et al., 2010), while the value of pollination for the European agriculture is estimated at 20 billion euro (Gallai et al., 2008).

One of the main priority in current Common Agricultural Policy of the European Union regarding efficient use of natural resources is the establishment of various habitats of flowering grass strips. They prove to be a permanent food source for the insects pollinators, providing the necessary nectar and pollen from spring until autumn. It is reported (Carvell et al., 2007; Decourtye et al., 2010), that the flowering varieties, suitable for incorporation in the grass mixes, are Phacelia (*Phacelia* spp.), clover (*Trifolium* spp.) and the varieties in the *Brassicaceae* family. With respect to the colour range, bees differentiate among over 300 colours, with preference to yellow and blue coloured plants, but find easiest the purple coloured plants. The objective of this study is to investigate development and self-maintenance of two kind flowering plant strip, which will ensure the attraction of pollinators prior to the blossoming of the respective crops.

2. Methods

The study is conducted at the Educational Experimental and Implementation Facility of the Agricultural University, Plovdiv in the period 2013-2015. Two types of grass mixes were chosen for the study: Laitamag (Hungary) and Agricultural University, Plovdiv with two types of sowing (Autumn and Spring). The Laitamag Mix is composed of the following plant varieties: white mustard (*Sinapis alba* L.) (5%), white clover (*Trifolium repens* L.) (5%), Phacelia (*Phacelia tanacetifolia* Bentham) (5%), crimson clover (*Trifolium incarnatum* L.) (10%), egyptian clover (*Trifolium alexandrinum* L.) (10%), red clover (*Trifolium pretense* L.) (20%), wild oats (*Avena sativa* L.) (5%), alfalfa (*Medicago sativa* L.) (10%), buckwheat (*Fagopyrum esculentum* Moench) (15%) and sainfoin (*Onobrychis viciifolia* Scop.) (15%). The mix, proposed by the Agricultural University contains white mustard (*Sinapis alba* L.) (10%), white clover (*Trifolium repens* L.) (30%), Phacelia (*Phacelia tanacetifolia* Bentham) (25%), buckwheat (*Fagopyrum esculentum* Moench) (15%), coriander (*Coriandrum sativum* L.) (20%).

The studied grass mixes are sown in the following variants: Variant I: Laitamag (autumn sowing), Variant II: Agricultural University (autumn sowing), Variant III: Laitamag (spring sowing) and Variant IV: Agricultural University (spring sowing). The sowing rate for both mixtures is 20 kg/ha, and the depth of sowing is 1.0-1.5 cm. The test area is 420 m^2 (6 × 70 m). The autumn sowing is performed on October 29, 2013, and the spring on March 18, 2014. Before and after sowing, the soil surface is rolled. The sowing density and species ratios is recorded per m^2, based on a sampling plot. For the season 2015, no sowing is performed and only self-sowing variants were observed (Variant II and Variant IV). In order to determine the species of the pollinators, standard entomological methods are used (mowing with entomological sack and yellow plates). In April-July samples are collected every 7-10 days, as total of 100 swaths are made in each variant and collected insects are placed in plastic bags, then taken to the laboratory and species are counted and determined.

3. Results and Discussion

After sowing of grass mixtures in autumn 2013 (Variant I and Variant II) and spring 2014 (Variant III and Variant IV), seeds germinated and developed during spring of 2014 and 2015. Observations on pollinators started at around flowering period of species, in April. Ten species of pollinators in total are observed, number and species diversity is higher in 2014 variants—349 pcs in the Variant II, followed by Variant I—224 pcs., and the Variant III and Variant IV—19 and 55 pcs, respectively (Figures 1 and 2). In 2015 only variants with local seed mixture overwintered (Variant II and Variant IV) and less number and species variety were recorded in them: Variant II—120 pcs, and in Variant IV—75 pcs. (Figures 1 and 3).

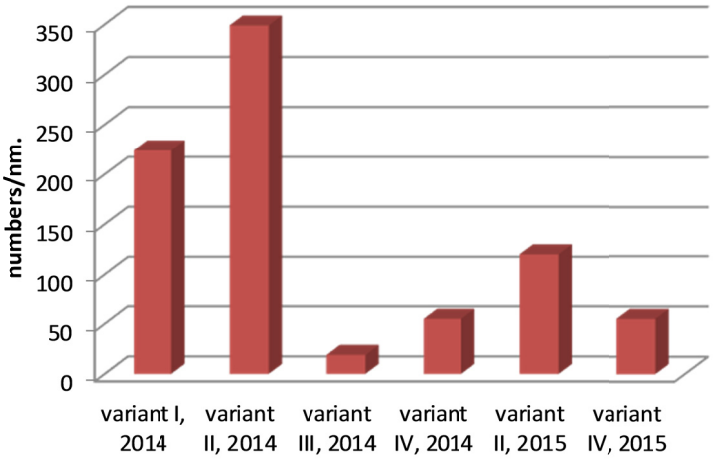

Figure 1. Number of pollinators in the grass mixes in 2014 -2015

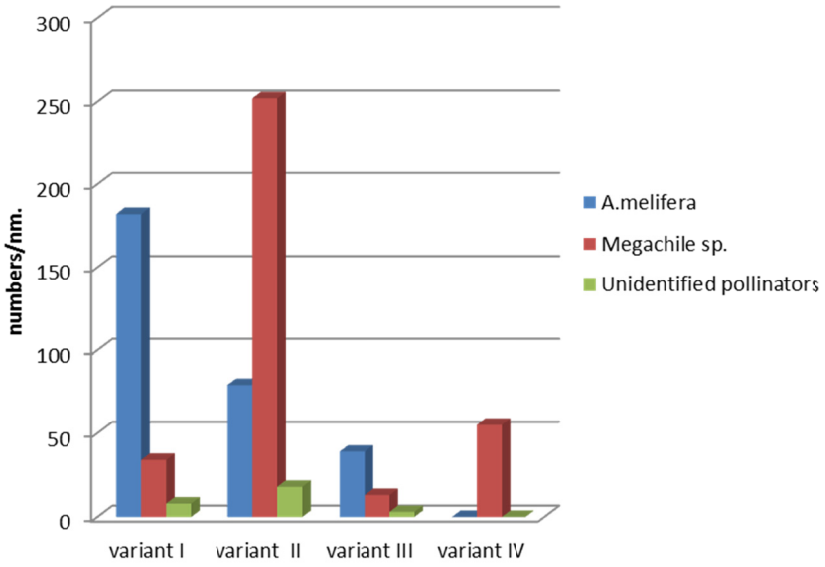

Figure 2. Number of pollinators and species diversity in 2014

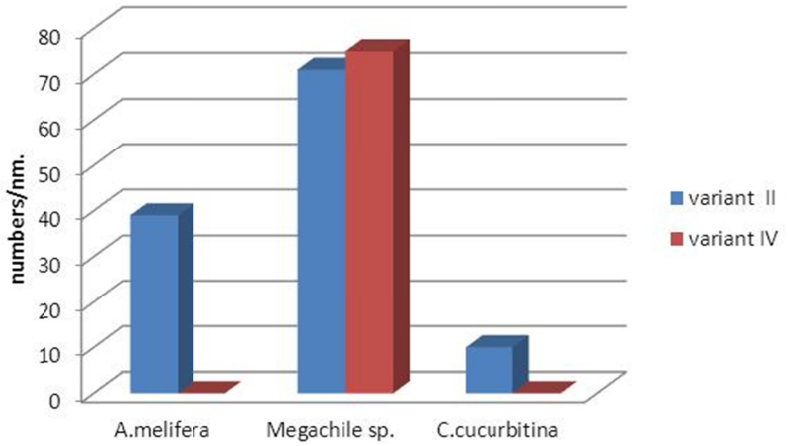

Figure 3. Number of pollinators and species diversity in the grass mixes in 2015

In the autumn sowing (Variant I and Variant II) the blossoming of the plant varieties in the grass mix was observed in the period April-June, with a duration of 60-63 days. The first pollinators in 2014 appeared in the end of April and the beginning of May. In Variant I white mustard was the first to blossom (02.04-08.05), forming a single-level blossoming of predominantly yellow colour. From the end of April (28.04) and until the end of May (28.05) the blossoming varieties were Phacelia (*Phacelia* sp.) and crimson clover (08.05-28.05), thus resulting in two levels in the grass mix: top purple layer and lower red layer. The Egyptian and white clovers blossomed from 28.05 until 04.06, giving the white colour in the mix. The following pollinators were determined therein: *Apis mellifera* L., *Megachile* sp., *Halictus scabiosae* Rossi, *Lasioglossum xanthopus* Kirby, *Melita leporita*, *Andrena flavipes* Panzer and *Ceratina* sp.

The extensive occurrence of pollinators in Variant I was determined in the second half of May, when Phacelia (*Phacelia* sp.) blossoms for a long period of time attracting the honey bee (*Apis mellifera* L.) with its purple flowers, as the number of the said insect was the highest—182, followed by the *Megachile* sp. species—34, which prefer the white colour of the white clover and coriander. Single specimens were found of the following species: *Halictus scabiosae* Rossi, *Lasioglossum xanthopus* Kirby, *Melita leporita*, *Andrena flavipes* Panzer and *Ceratina* sp. (Table 1)

In Variant II the earliest blossoming was that of the purple-coloured Phacelia (*Phacelia* sp.). The white clover and coriander blossom at the end of May, accounting for the white colour in the grass mix. The following insects

were isolated: *Apis mellifera* L., *Megachile* sp., *Halictus scabiosae* Rossi, *Lasioglossum xanthopus* Kirby, *Macropis europaeae* Warn., *Anthidium manicatum* L., *Ceratina cucurbitina* Rossi and *Ceratina* sp. The predominant species was that of the genus *Megachile* sp with a total of 252 pcs. The presence of the genus *Megachile* in the grass mixes in the second field was the result of the white colour, provided by the white clover and coriander. The purple flowers of Phacelia (*Phacelia* sp.) attract mainly honey bee (*Apis mellifera* L.). Therefore it was the second largest species with a total of 79 insects. The other pollinators were not observed significantly.

In the case of the spring sowing (Variant III and Variant IV) blossoming started in the second decade of May and lasted until the end of June for a total of 40 days. The largest number of pollinators was determined in the first decade of June.

In Variant III of the varieties, included in the grass mix: White mustard, Phacelia (*Phacelia* sp.) and various types of clovers (crimson, Egyptian and white), the white mustard (19-20.05) was again the earliest to blossom, but 47 days later, compared to the autumn sowing (Variant I). The blossoming of Phacelia (*Phacelia* sp.) started on 27 May and lasted until 26 June. These two varieties formed the two-level the grass mix: bottom yellow level and top predominantly purple level. All clovers (crimson, Egyptian and white) blossomed in second half of June, as the predominant colours in the mix were red and white. During the mass blossoming, the field was coloured in these colours. The following insect species were identified: *Apis mellifera* L., *Megachile* sp. and *Macropis europaeae* Warn. The predominant species was *Megachile* sp., with a total of 13 representatives.

In Variant IV the predominant plant variety was coriander blossoming from the second decade until the end of June (18.06 to 30.06). Its white flowers attract predominantly species from the genus *Megachile* sp. and a total of 55 insects were reported.

Table 1. Pollinator species in the grass mixtures in 2014-2015

2014			
Variant I Laitamag(autumn sowing)		Variant II Agrarian university (autumn sowing)	
Species	Total number	Species	Total number
Apis mellifera L.	182	*Apis mellifera* L.	79
Megachile sp.	34	*Megachile* sp.	252
Halictus scabiosae Rossi	1	*Halictus scabiosae* Rossi	4
Lasioglossum xanthopus Kirby	1	*Lasioglossum xanthopus* Kirby	1
Melitta leporita	3	*Macropis europaeae* Warn.	3
Andrena flavipes Panzer	1	*Anthidium manicatum* L.	7
Ceratina sp.	2	*Ceratina cucurbitina* Rossi	1
		Ceratina sp.	2
Variant III Laitamag (autumn sowing)		Variant IV Agrarian university (spring sowing)	
Species	Total number	Species	Total number
Apis mellifera L.	3	*Megachile* sp.	55
Megachile sp.	13		
Macropis europaeae Warn.	3		
2015			
Variant II self-sowing Agrarian university (autumn sowing)		Variant IV self-sowing Agrarian university (spring sowing)	
Species	Total number	Species	Total number
Apis mellifera L.	39	*Megachile* sp.	75
Megachile sp.	71		
Ceratina cucurbitina Rossi	10		

In order seed mixtures to be applicable for farmers for long-term use, it was important to investigate the duration of their self-maintenance (self-sowing and repeated flowering). Self-sowing observed in Variant II and Variant IV, only. These plots formed grass cover after over-wintering, in 2015. Dominated species were white clover and Phacelia (*Phacelia* sp.) and flowering observed from the beginning of May and until July. They formed two coloured layers in the grass plots—white and purple.

The following species were observed in Variant II: *Apis mellifera* L., *Megachile* sp. and *Ceratina cucurbitina* Rossi. *Apis mellifera* L. was attracted by the purple flowers of Phacelia (*Phacelia* sp.) and *Megachile* sp.—by the white colour of the clover.

Only species of the genus *Megachile* sp were observed in Variant IV. In both variants, predominant insect was genus *Megachile* sp. (Variant II—71 insects, Variant IV—75 insects), due to their attraction of the dominant white colour in the grass mixture (Table 1).

The mixtures of autumn sowing are more suitable to put near autumn crops, in order to ensure flowers early spring. For the spring field crops, the mixtures with spring sowing are more appropriate to ensure proper presence of pollinators. The varieties Phacelia (*Phacelia* sp.), White mustard, coriander and white clover enable the possibility for self-sowing in the summer-autumn period.

The purple colour in the grass mix is provided by Phacelia and mostly attracts honeybees. The white colour of white mustard, coriander, Egyptian and white clover attracts predominantly species of the genus *Megachile*.

The establishment of a plantation of Phacelia, along the agricultural areas, may be used for reproduction and preservation of the pollinators during plant-protection activities in agricultural crops.

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