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Flowering legumes as pollen and nectar-rich habitats for bees: preference of bee pollinators to different forage species

A. Kirilov[1]*, I. Nikolova[1], N. Georgieva[1] and R. Mladenova[2]

[1]Institute of Forage Crops, Pleven (Bulgaria)
[2]Syngenta Bulgaria LTD
*e-mail: kirilovatanas@hotmail.com

Abstract. The intensive use of pesticides in agriculture over the last decades has led to the destruction of a great part of the population of wild bee - pollinators. The objective of the study was to determine the period of flowering and the preference of the bees for different species of flowering leguminous crops. Crops of six (6) species of intensively flowering forage crops were selected: alfalfa (*Medicago sativa*), sainfoin (*Onobrychis viciaefolia*), birdsfoot trefoil (*Lotus corniculatus* L.), forage peas (*Pisum sativum* L.), phacelia (*Phacelia tanacetifolia* Benth) and cocksfoot (*Dactylis glomerata* L). The most prolonged period of flowering was observed in sainfoin (38 days), followed by birdsfoot trefoil, phacelia and cocksfoot. Considerably higher density of bee pollinators was found in sainfoin. The flowering of alfalfa is longer in its first regrowth and shorter in the second. The largest number of wild bees - pollinators appeared in sainfoin and the second largest number in alfalfa. Birdsfoot trefoils are characterized by the lowest attendance of bees. Bees were not found in peas and cocksfoot. The highest density of honeybees (*Apis mellifera)* was found in Phacelia. Their number is influenced by weather conditions.

Keywords. Alfalfa – Sainfoin – Birdsfoot trefoil – Phacelia – Bees pollinators.

Les légumineuses en floraison en tant qu'habitats riches en pollen et nectar pour les abeilles: préférence des abeilles pollinisatrices par rapport aux différentes espèces fourragères

Résumé. *L'utilisation intensive de pesticides dans l'agriculture au cours des dernières décennies a conduit à la destruction d'une grande partie des abeilles sauvages - pollinisatrices. L'objectif de l'étude était de déterminer la période de floraison et la préférence des abeilles vers les différentes espèces de fleurs des légumineuses. Six (6) espèces de cultures fourragères à fleurs intensives ont été sélectionnées - luzerne (*Medicago sativa*), sainfoin (*Onobrychis viciaefolia*), lotier (*Lotus corniculatus *L.), pois fourragers (*Pisum sativum *L.), phacélie (*Phacelia tanacetifolia *Benth) et dactyle (*Dactylis glomerata *L). La plus longue période de floraison a été observée pour le sainfoin (38 jours), suivie par le lotier, la phacélie et le dactyle. Une densité considérablement plus élevée d'abeilles pollinisatrices a été trouvée dans le sainfoin. La floraison pour la luzerne est plus longue au premier cycle et plus courte au deuxième. Le plus grand nombre d'abeilles sauvages pollinisatrices se produit dans le sainfoin et d'autre part dans la luzerne. Le lotier se caractérise par la présence plus faible d'abeilles. Les abeilles sont introuvables dans les pois et le dactyle. La plus forte densité d'abeilles (*Apis mellifera*) a été trouvée dans la phacélie. Leur nombre est influencé par les conditions météorologiques.*

***Mots clés.** Luzerne – Sainfoin – Lotier – Phacélie – Abeilles pollinisatrices.*

I – Introduction

The intensification of crop production and the use of large amounts of fertilizers and plant protection products in recent decades have led to the destruction of a large part of the wild bee pollinators (Carreck and Williams, 2002). The creation of strips of flowering annual and perennial legumes in the field can improve the habitat conditions and increase the biodiversity and abundance of pollinators. The density of the bees is affected by the presence of mass flowering crops (Dochkova *et al*., 1981, a, b; Westphal *et al*., 2003). The aim of the experiment was to determine the period of flowering and the preference of the bees for different species of

flowering leguminous crops, including sainfoin, birdsfoot trefoil, alfalfa, peas, phacelia, cocksfoot and a mixture of legumes with a view to preserving the biodiversity of pollinators in terms of agricultural production.

II – Materials and methods

The experiments were conducted in 2014 and 2015 in the experimental field of the Institute of Forage Crops – Pleven, Bulgaria. The six flowering fodder crops were subjects of monitoring and comparisons, including three perennial legumes – alfalfa *(Medicago sativa),* sainfoin *(Onobrychis viciaefolia)* and birdsfoot trefoil *(Lotus corniculatus* L.*),* two annual legumes – forage peas (*Pisum sativum* L.) and phacelia (*Phacelia tanacetifolia* Benth), and a single grass – cocksfoot (*Dactylis glomerata* L). A mixed crop included phacelia, alfalfa, sainfoin, red clover and cocksfoot at a ratio of 0.25 of the seeds sown in an area of 600 m^2. The crops were grown without the use of fertilizers and plant protection products.

During the vegetation period each trial on forage crops was marked at the beginning and at the end of the flowering stage and the corresponding length in days was calculated. The bee pollinators were counted during full flowering of the legumes in appropriately sunny (no more than half of the sky is covered with clouds) and warm days (15-20 to 30°C) between 11 am and 15 pm. The number of pollinators was reported by "cutting" with entomological bags. The samples from 1m^2 were taken of the diagonals of the area in four replications.

III – Results and discussion

In meteorological terms the two years are significantly different (Table 1). In 2014 the average daily temperatures during the growing season were lower than those in 2015. The total rainfall in 2014 was about 50 liters more per m^2 compared to that in 2015, which reflected on the humidity, which was higher in 2014 compared to 2015.

Table 1.Temperatures, precipitation and humidity during the period from April to July 2014 and 2015 in the region of Pleven

	Average daily temperature (°C)		Humidity		Rain, mm	
	2014	**2015**	**2014**	**2015**	**2014**	**2015**
April	14.9	12.2	77.0	54	32.3	43.6
May	16.7	18.8	70.0	66	83.0	30.6
June	20.6	21.5	67.0	64	54.3	95.7
July	23.1	25.8	67.0	54	71.8	21.,5
Average	*18.75*	*19.58*	*70.25*	*59.50*	*241.4*	*191.4*

1. Flowering period

The lower daily average temperatures and greater precipitation during the active growing season of the crops are probably the reasons for the long flowering period observed in 2014 (Table 2). It was found that the longest flowering period in 2014 was that of the sainfoin - 38 days, followed by the birdsfoot trefoil, phacelia, cocksfoot and lucerne. This trend continued in 2015, but with a shorter flowering period. Longer flowering was found for the first regrowth of alfalfa in 2015 compared to the second regrowth in 2014.

Table 2. Duration of the phenological stage of flowering

№	Species	Duration of flowering (days)	
		2014	2015
1.	Sainfoin	38	23
2.	Field pea	13	12
3.	Birdsfoot trefoil	21*	20*
4.	Alfalfa	16*	25**
5	Cocksfoot	18	14
6.	Phacelia	21	20

Note: * - second regrowth; ** - first regrowth.

2. Bees density and species composition

The results on the types and numerical composition of the wild bees - pollinators are presented in Table 3 and in Fig. 1. Bees were not observed in the cocksfoot and peas and they were not subject to consideration and discussion. The pollinating insects in the sainfoin are the most numerous and varied. The species composition is represented by seven identified species. The results are consistent with those established by Donchev (1978). The dominant species with the highest representation was *Halictus quadricinctus* (35.5%). High rates were also presented by *E. Longicornis* (19.1%) and *A. falsifica* (18.6%), followed by subdominant types *A. dorsata* (10.6%) and *B. Terrestris* (6.6%). *Bombus sylvarum* has the least representation among the crops.

The results on the number of wild bees in alfalfa have shown that it is also a preferred crop after the sainfoin with seven identified species. A higher number of bees were observed in alfalfa in 2014, when the second regrowth was monitored and lower than the first regrowth in 2015. Probably the different weather conditions in which they formed two saplings had an impact not only on the duration of flowering, but also on the number of bees in both regrowth.

The mixed species treatment was less preferred by the bee pollinators, probably due to the different periods of flowering of legumes and the correspondingly small number of flowers per area unit. Of the six identified species of bees the one with the highest representation was *H. quadricinctus* (34.5%). Dominant types, exceeding 15%, were *A. dorsata* (22.7%) and *A. falsifica* (17.6%), and sub-dominant – *E. Longicornis* and *B. terrestris*.

The number of bees in birdsfoot trefoil was the smallest. Three types of bees were monitored (*A. dorsata*, *B. sylvarum* and *E. longicornis*). Of these, *E. Longicornis* had the highest number.

The frequent rainfall and lower daily average temperatures during the vegetation period in 2014 affected the number of bees' pollinators. Higher air temperatures in 2015 had a favorable impact on the attendance of flowering legumes by pollinators.

Table 3. Number and composition of species of wild bees in legumes of the study, pcs./ 1m^2

Family Apidae	Sainfoin				Alfalfa				Mixed crops		Birdsfoot trefoil	
	2014	2015	Av.	%	2014	2015	Av.	%	2015	%	2014	%
Andrena dorsata	2.4	4.5	3.5	10.6	2.7	2.0	2.4	8.6	2.7	22.7	0.3	15.8
Andrena falsifica	3.1	9.0	6.1	18.6	0.6	4.2	2.4	8.8	2.1	17.6	0.0	0.0
Bombus sylvarum	0.4	1.4	0.9	2.8	1.3	0.7	1.0	3.7	0.3	2.5	0.3	15.8
Bombus terrestris	0.5	3.8	2.2	6.6	0.0	1.1	0.6	2.0	1.0	8.4	0.0	0.0
Eucera longicornis	7.8	4.6	6.2	19.1	13.0	5.5	9.3	33.9	1.7	14.3	1.3	68.4
Halictus maculatus	0.6	3.7	2.2	6.6	11.3	3.6	7.5	27.3	0.0	0.0	0.0	0.0
H.quadricinctus	5.3	17.8	11.6	35.5	2.1	6.4	4.3	15.6	4.1	34.5	0.0	0.0
Total	2062	2094	57		2063	2061	50		2044	127	2024	

3. Density of honeybee *Apis mellifera* L

The honeybee *Apis mellifera* L. is a constant and multiple pollinator of sainfoin, birdsfoot trefoil, alfalfa and phacelia. The highest density of this species was found in phacelia (21.3/m^2), followed by sainfoin (16.4). The smallest representation of honeybees was seen in birdsfoot trefoil (1.7). Alfalfa occupies an intermediate position (13.2). Bees of this type open only from 1.1 to 2.6% of the visited flowers (Dochkova *et al*., 1981 a, b). During the two years of the experiment the phacelia was visited primarily by the honeybee.

The percentage of bees - pollinators in the forage crops varies primarily as the prevalent type is *Apis mellifera* in sainfoin (33.5%), followed by alfalfa (32.6%) – Fig. 1. Among the phacelia crops we found only honeybees, which absent in birdsfoot trefoil. In the mixed crops the species occupy an intermediate position with 12.5% participation.

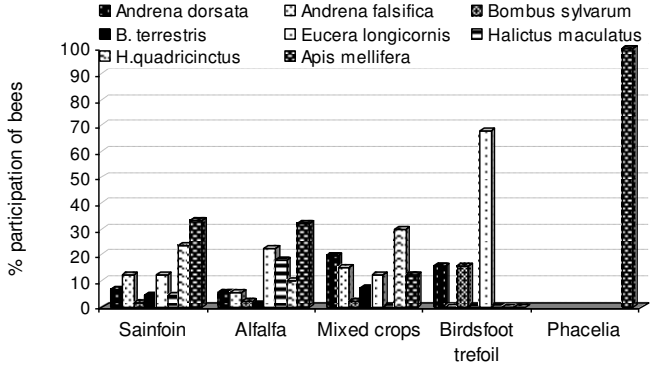

Fig. 1. Ratio of bee pollinators in different forage crops.

IV – Conclusions

The duration of flowering is the longest in sainfoin, followed by birdsfoot trefoil and alfalfa. The period of flowering of alfalfa is longer in the first regrowth and shorter in the second.

The largest number of wild bees occurred in sainfoin and then in alfalfa. The birdsfoot trefoil was characterized by the lowest attendance of bees and the mixed crops occupied an intermediate position. The highest density of *Apis mellifera* was established in phacelia. Their number is influenced by weather conditions. Sainfoin, alfalfa and phacelia are suitable flowering plants to create stripes with a long flowering period as habitats for bees - pollinators.

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References

Dochkova B., Atanasov N., Vasileva E.,1981a. Bee pollinators (Himenoptera: Apoidea) on alfalfa in the region of Pleven. I. Species composition and abundance. In: *Plant Science* 18(1), p. 102-108.

Dochkova B., Atanasov N., Vasileva E.,1981b. Bee pollinator (Hymenoptera: Apoidea) on alfalfa in the region of Pleven. IV. Intensity of pollination. In: *Plant Science* 18(4), p. 140-145.

Donchev K., 1978. Studies on the entomofauna of sainfoin and opportunities to control of the most economically important pests. PhD thesis, Sofia, 1978.

Carreck N.L., Williams I.H., 2002. Food for insect pollinators on farmland: insect visits to flowers of annual seed mixtures. In: *Journal of Insect Conservation* 6(1), p. 13-23.

Westphal C., Steffan-Dewenter I. and Tscharntke T. 2003. Mass flowering crops enhance pollinator densities at a landscape scale. In: *Ecology Letters*, 6, p. 961-965.