

## EXPLOITATION OF RAPE FLOW BY BEE COLONIES IN STATIONARY AND MIGRATORY APIARY

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### S u m m a r y

The aim of the study conducted in 2009 - 2011 was to estimate the differences in the nectar and pollen oilseed rape flow exploitation by bee colonies kept in the stationary apiary (permanently located on the rape field) and in the migratory apiary. The migratory apiary was transferred to the rape field at the appropriate time and situated on the same area as the stationary apiary. Every study year, 8 bee colonies per apiary, in two apiaries of different types (stationary and migratory apiary), were prepared. The colonies from the migratory apiary were placed on the rape field when about 10% of rape flowers were blooming. During that time, bottom pollen traps were inserted into the hives of both apiaries. The pollen loads were collected every day, separately from each colony. After the end of the flow season, honey was extracted separately from each colony. The honey was weighed and samples were taken for the palynological analysis. The weather conditions were monitored during the whole study period.

The average harvest of pollen loads from one bee colony during one day, was similar in both apiaries. The content of *Brassica napus* pollen was significantly higher in the pollen loads harvested from the migratory apiary. Despite the fact that the amounts of honey extracted from both apiaries were similar, the microscopic pollen analysis showed significantly higher percentage content of rape pollen in the honey from the migratory apiary. The results confirmed that placing the migratory apiary in the winter rape field at the time when about 10% of flowers were blooming resulted in a better exploitation of the rape flow by the bee colonies from this apiary in comparison to the colonies from the stationary apiary.

**Keywords:** stationary apiary, migratory apiary, winter rape, *Brassica napus* var. *oleifera*, pollen loads, honey, pollen analysis.

### INTRODUCTION

Winter rape is one of the most important main nectar sources in Poland. Sugar yield from 1 ha of crops reaches 120 kg. While the pollen yield can be even higher, up to 160 kg/ha (Kołtowski, 2002).

Beside the honey production, obtaining the pollen loads significantly improves the economical results of apiaries (Pidek, 1988, Cichoń and Wilde, 2002). In Poland, the increase in the amount of the obtained pollen loads to over 2 kg/colony, significantly decreases the amount of the extracted honey

(Bratkowski and Wilde, 2002). However, a new study suggested that commercial selection for high pollen yield, which makes the high pollen harvest possible, should not affect honey yield (Wilde et al., 2011). Other studies have shown that pollen loads production is less influenced by the course of weather conditions than by the honey production (Wilde et al., 2002). In the regions with poor early spring flows of *Salix*, *Acer* or *Taraxacum officinalis*, pollen collection needs to be started at the beginning of the winter rape flowering period (Wilde et al., 1994). What is more, these studies had

shown that the biggest amounts of pollen loads were obtained when the pollen load traps were inserted into the hives directly after placing the colonies on the flowering winter rape field.

In Poland, the flowering period of winter rape falls on the beginning of May. Therefore the period between the end of the bees' wintering (usually at the turn of March and April) and the occurrence of winter rape flow is too short to allow optimal preparation of bee colonies to the flow exploitation. That is why it is crucial to take measures of improving spring colony development during that time (Skubida et al., 2008), and at the later stage, proper management of the colonies structure needs to be conducted. Beside the abovementioned conditions, the exploitation of the flow is also influenced by the distance between the apiary and the flow source (Wilde, 2008). This was supported by the fact that when bees were transported to the vicinity of the winter rape field from the relatively close distance of 1 km, the amount of obtained honey increased, on the average, by 175%. In bad weather conditions the amount of obtained honey increased even by nearly 300% (Bobrzecki, 1973).

In the beekeepers opinion, for good exploitation of honey flow and for obtaining pure unifloral honeys, bee colonies should be transported to the honey flow field when 10 to 30% of flowers bloom. This way scout bees exploring the apiary's surroundings can then pass on the information that in the vicinity an intensive and plenteous source of flow is present. Thanks to that, great majority of foragers can then concentrate on the exploitation of this particular flow. The literature data concerning this issue are very poor. Only Jabłoński (1998) indicated the necessity of transporting the bee colonies to the crops of interest to beekeepers at the appropriate time, i.e. at the beginning of the plants' flowering period, when about 10% of flowers bloom. Bees placed on the field at an earlier time, when penetrating the area, can find a different source of nectar flow

(e.g. orchards, dandelion), especially when the weather is good. Bees will use the new source as long as it will supply them with the flow, omitting the plants that bloomed later (e.g. winter rape).

The aim of the study was to evaluate the differences between the exploitation of the nectar and pollen rape flow by the bee colonies in the stationary apiary (permanently located on the rape field) and in the migratory apiary - placed on the field at the right time, i.e. when about 10% of rape flowers bloomed.

## MATERIAL AND METHODS

The studies were conducted in the Research Institute of Horticulture, Apicultural Division in Puławy, Poland, in 2009-2011 on the several-hectare field of winter rape cultivated in the Agricultural Experimental Unit in Puławy - Kepa of the Institute of Soil Science and Plant Cultivation in Puławy, Poland.

For the experiment, 8 colonies of *Apis mellifera caucasica* honeybees per apiary, in two types of apiaries, were prepared. Colonies of similar strength, set in the Wielkopolski hives (frame size 360 x 260 mm), had sister queens in the F1 generation and had no clinical symptoms of any diseases. First apiary - stationary, was permanently situated in Puławy in a vicinity of the winter rape field. While the migratory apiary was localized in Nasiłów at a distance of about 10 km from the experimental rape field.

Every year before the experiment brood area was measured two times. At the same time the colonies' strength was estimated (number of combs covered by bees). First measurements were taken during the first routine inspections (2009 - 1 April, 2010 - 13 April, 2011 - 12 April); the second ones were taken 21 days later (2009 - 22 April, 2010 - 4 May, and 2011 - 6 May). During the inspections, when necessary, new frames with light colored combs or with comb foundation were inserted into the colonies. To optimally prepare the colonies for exploitation of the rape flow, the management procedures for equalizing

the colonies' strengths (rotation of brood combs) were conducted and the combs with supplies were detached. This stimulated the spring development of colonies.

Bee colonies from the migratory apiary were transferred to the field at the time when about 10% of rape flowers were blooming: in 2009 - 27 April, in 2010 - 4 May, and in 2011- 5 May. The migratory apiary was situated in the same area as the stationary apiary. At that time, the bottom pollen traps were inserted into the hives. The first collections of pollen were carried out 3 days after inserting the pollen traps. After that, pollen loads were collected every day in the afternoon (between 14.00 and 15.00). Periods of pollen loads collections in each of the study years were related with the rape flowering duration. In 2009 lasted from 30 April to 22 May (23 days); in 2010 - from 7 May to 23 May (17 days); and in 2011 - from 8 May to 24 May (17 days). The pollen loads collected from each colony were poured from the traps' drawers into plastic bags marked with the collection date, apiary type, and colony's number, and weighed. From every portion of pollen loads samples were taken to prepare microscopic sections for the palynological analysis. The rest of pollen loads was frozen.

When the rape flow ended, honey was extracted separately from every colony. The honey was weighed and samples were taken for the palynological analysis. Extraction of honey was carried out on the following dates: 2009 - 24 May, 2010 - 25 May, 2011 - 27 May. The honey was taken only from combs located in the upper hive body, above the queen excluder.

During the study atmospheric conditions were monitored. Air temperature and humidity were measured every two hours from 10.00 to 18.00, and the readings of total precipitation were taken daily at 8.00.

Botanical origin of the honey and pollen samples was determined using the palynological analysis. Analyses of pollen loads and honey were performed separately for each colony and separately for the extraction date. The total number of pollen

loads samples from the stationary apiary were 456. The same number of samples were taken from the migratory apiary. Total number of honey samples from the stationary and migratory apiaries were the same, 24.

Before conducting the analysis, each sample of pollen loads was thoroughly mixed. Then, samples of about 20 g were put into screw-capped plastic containers and next about 20 ml of distilled water were added. The containers were capped and left for several hours for the pollen loads to soften. To speed up the softening, containers were intensively shaken from time to time. After obtaining a homogeneous suspension, a small portion was transferred with a pipette on a labeled microscope slides doing regular smears. The slides with smears were then left for few minutes to dry. The dried smears with a drop of glycerol-water solution (1:1) were covered with a cover slip. Pollen analyses of the collected material were performed using the biological microscope Olympus BX41 under magnification 400x. In each microscopic slide, in successive view fields of the microscope, all the pollen grains of each plant species were counted separately, until the total number of 300 grains was exceeded. The results were recorded in a table of the MS Excel spreadsheet file. The percentage content of every pollen type was calculated.

Pollen analysis of honey was performed according to the methodology recommended by the International Commission of Bee Botany and International Honey Commission (Louveau et al., 1978).

The results were statistically analysed using STATISTICA 10 software. The two-way ANOVA was used for statistical calculations. Duncan's multiple range test was applied to determine significant differences between the means. For all analyses,  $p$ -value  $< 0.05$  was considered significant.

## RESULTS

Despite the fact that the apiaries were situated in distant locations, all bee colonies had similar flow conditions (*Salix* spp., *Acer* spp., and various *Prunus* spp.) from early spring, so their spring development was similar. No significant differences in the measured parameters (brood area and the number of combs covered by bees) were found between groups (Tab. 1).

The weather conditions, particularly temperature during the winter rape flowering period, had the highest influence on the amount of collected pollen loads, irrespective of the apiary type (Fig. 1). The average mass of pollen loads collected by one colony during one day in both apiaries was similar (Tab. 2). The lowest amounts of pollen were collected by bee colonies in 2009. In the stationary apiary, the average mass of pollen loads collected daily by one colony was 30.7 g, while in the migratory apiary 33.3 g. In 2010, these amounts were higher in comparison to the previous year. The best results were observed in 2011 when in both apiaries the average amounts of pollen loads collected daily by one colony were similar and amounted to over 100 g (Tab. 2).

In 2009, pollen loads were collected for 22 days. The average mass of pollen collected per one colony during that time in

the stationary apiary, amounted to 706.6 g while in the migratory apiary 765.6 g. In 2010, the period of pollen collection was shorter, only 17 days. Despite that, the average pollen production in the apiaries was higher. In the stationary apiary, one colony collected 850.2 g of pollen loads and in the migratory apiary one colony collected 907.9 g of pollen loads. 2011 was the record year for the pollen collection. The collection period also lasted for 17 days but during that time one colony of the stationary apiary provided, on average, 1862.6 g of pollen loads, and the average for the migratory apiary was 1765.4 g of pollen loads per colony. These high results of 2011, resulted in the following amounts of the average mass of pollen loads collected during the whole study period: the stationary apiary 1139.8 g of pollen loads per one colony, and the migratory apiary 1146.4 g of pollen loads per one colony.

Microscopic analysis was done of the pollen load samples collected during the three years of the experiment. The analysis of the combined data from all 3 study years showed that the average percentage content of *Brassica napus* pollen was significantly higher in the pollen loads from the migratory apiary and amounted to 29.4%, while in the stationary apiary

Table 1.

Biological state of bee colonies from the stationary and migratory apiary before the winter rape flowering period

Year	Group (n)	Brood area (dm <sup>2</sup> )				Number of combs covered by bees			
		Measurement I		Measurement II		Measurement I		Measurement II	
		Average	SD	Average	SD	Average	SD	Average	SD
2009	M* (8)	9.1	2.0	45.2	10.0	7.6	1.2	13.6	2.6
	S* (8)	9.9	4.1	47.0	10.7	7.1	1.1	13.1	1.1
	p - value**	0.76		0.76		0.31		0.55	
2010	M* (8)	37.6	10.4	57.8	13.5	8.6	0.7	15.2	0.7
	S* (8)	32.9	4.1	55.3	8.3	8.7	0.7	15.0	2.0
	p - value**	0.13		0.68		0.78		0.76	
2011	M* (8)	23.7	6.0	62.4	11.4	7.4	0.7	17.0	0.7
	S* (8)	24.9	7.4	65.0	16.7	7.2	0.7	17.0	2.0
	p - value**	0.69		0.66		0.78		1.0	

\* M - migratory apiary, S - stationary apiary

\*\* ANOVA test, p < 0.05

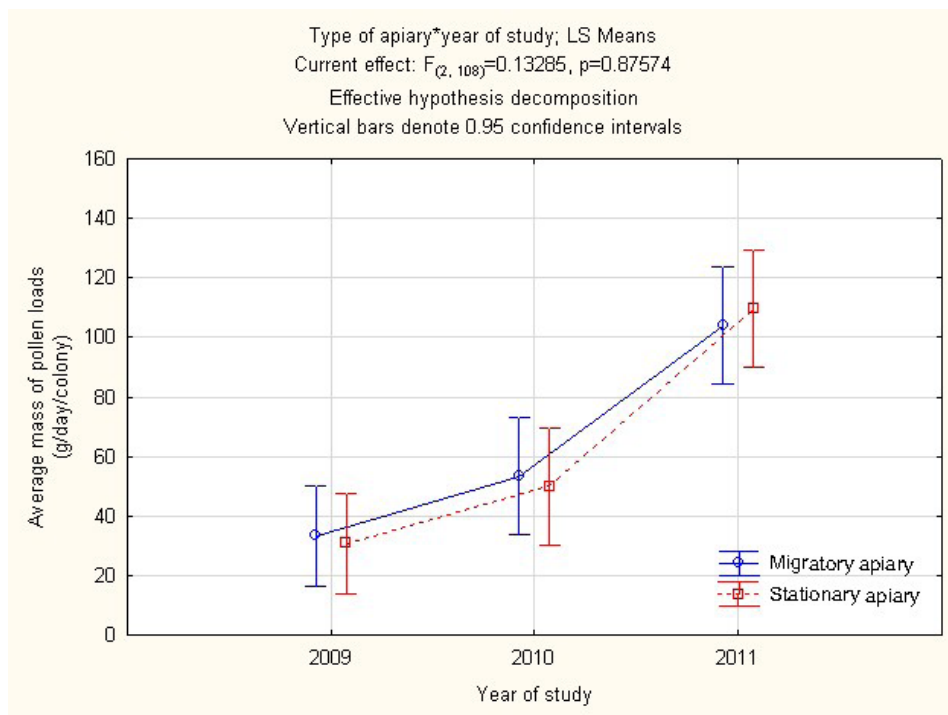


Fig. 1. Interaction between the type of apiary, year of the research and the average mass of pollen loads (g/day/colony).

Table 2.

Comparison of the analysed parameters between the stationary and migratory apiary in the individual study years

Analysed parameter	Group	2009			2010			2011			Total	
		n	Average	SD	n	Average	SD	n	Average	SD	Average	SD
Mass of pollen loads (g/day/colony)	M*	184	33.3	13.9	136	53.4	28.5	136	103.8	65.0	60.3	49.0
	S*	184	30.7	15.2	136	50.0	28.8	136	109.5	69.8	59.9	53.4
	p-value**	0.84			0.80			0.67			0.96	
% of rape pollen in pollen loads	M*	184	38.8	13.0	136	22.3	13.0	136	23.9	12.2	29.4	14.8
	S*	184	28.3	9.2	136	23.7	13.9	136	12.6	11.4	22.3	13.0
	p-value**	0.009			0.71			0.009			0.002	
Honey production (kg/colony)	M*	8	5.6	2.5	8	1.8	1.4	8	4.2	2.9	3.8	2.8
	S*	8	4.2	3.9	8	1.1	1.3	8	5.5	2.7	3.5	3.3
	p-value**	0.33			0.60			0.43			0.70	
% of rape pollen in honey	M*	8	69.7	21.3	8	39.7	7.7	8	73.8	12.6	60.2	21.2
	S*	8	67.9	20.1	8	24.9	15.4	8	48.9	17.0	45.4	25.3
	p-value**	0.82			0.08			0.007			0.003	

\* M - migratory apiary, S - stationary apiary

\*\* ANOVA test,  $p < 0.05$

Red colour indicates significant differences.

22.3% (Tab. 2). The same interrelation was shown in 2009 and in 2011. Only in 2010, when the content of *B. napus* pollen in the pollen loads from the migratory apiary was 22.3% and in the stationary apiary 23.7%, the differences between groups were not statistically significant. The interaction between the study year and the apiary type did not influence the average percentage of *B. napus* pollen in pollen loads. Nonetheless, worse weather conditions in 2010 resulted in comparable exploitation of rapeseed pollen flow in both types of apiaries (Fig. 2).

During microscopic analysis in the collected pollen loads from stationary and migratory apiaries, apart from *B. napus*, pollen grains of other plants were found: *Aesculus hippocastanum*, *Salix*, *Malus* type, *Prunus* type, *Taraxacum* type, *Acer*, *Quercus*, *Rubus* type, *Frangula*, *Juglans regia*, *Trifolium repens* type, *Pinus*, Ranunculaceae, and others.

Assessment of honey productivity conducted every year, showed very low

and similar honey productions in both apiaries (Tab. 2). The lowest average honey production per one colony was found in 2010 (below 2 kg). In the remaining two years, the production of honey was running at a level of 5 kg per one bee colony. The three-year average amount of honey extracted from one bee colony in the stationary apiary was 3.5 kg and in the migratory apiary 3.8 kg. There was no interaction between the year of the research, the type of apiary, and the honey production (Fig. 3).

The microscopic pollen analysis of the honey samples showed a significantly higher percentage content of *Brassica napus* in honey obtained from the colonies of the migratory apiary (Tab. 2). The three-year average of the *B. napus* pollen content in the honey samples from the stationary apiary was 45.4% while from the migratory apiary 60.2% (45% - the lower limit of the *Brassica napus* pollen content in rape honey according to the Polish Standard PN-88/A-77626, 1998). In 2010 and

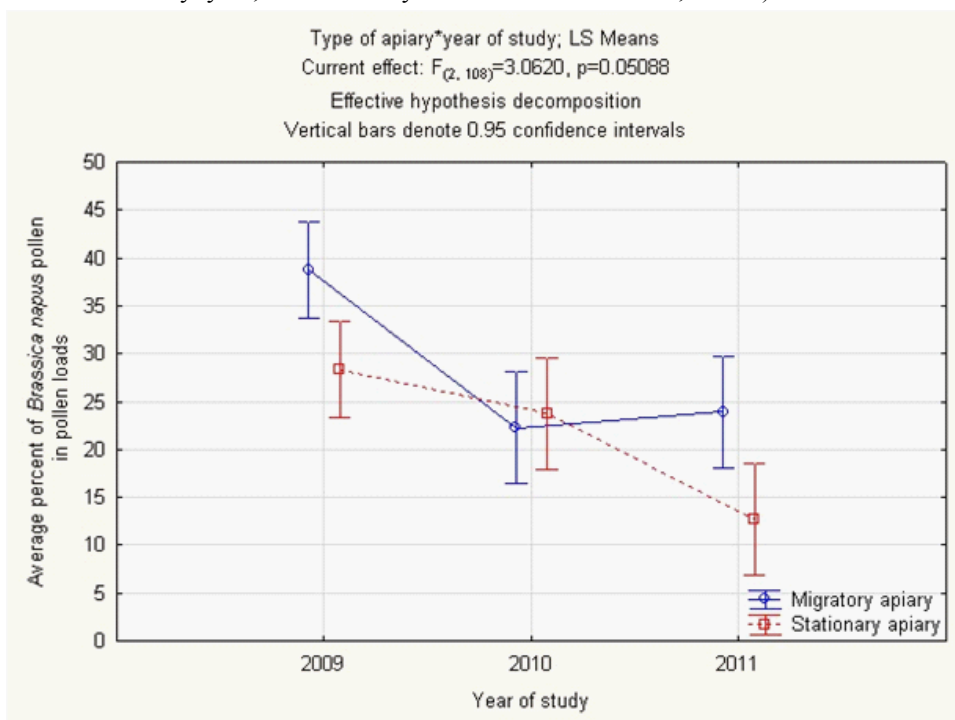


Fig. 2. Interaction between the type of apiary, year of the research, and the average percent of *Brassica napus* pollen in pollen loads.

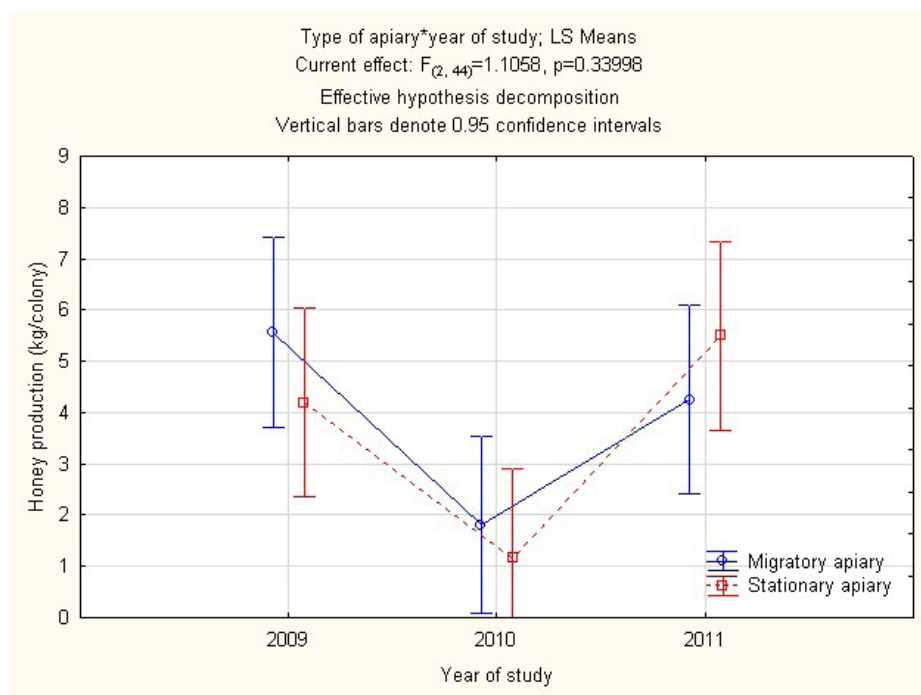


Fig. 3. Interaction between the type of apiary, year of the research, and the honey production (kg/colony).

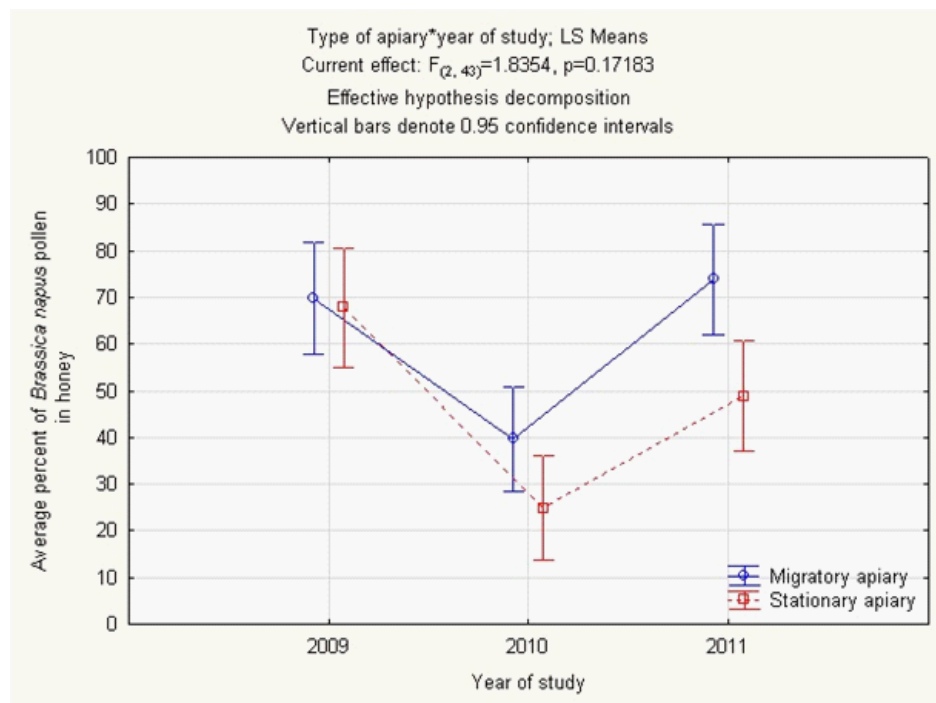


Fig. 4. Interaction between the type of apiary, year of the research, and average percent of *Brassica napus* pollen in honey.



2011, statistically significant differences between apiaries were found. The honey samples from both apiaries did not differ significantly regarding the percentage content of *B. napus* pollen in 2009 only. The average contents of rape pollen in the honey samples from both groups were very similar: the stationary apiary 67.9%, the migratory apiary 69.7%. No influence of the interaction was found between the year of the research and type of apiary on the average percent of *B. napus* pollen in honey (Fig. 4).

## DISCUSSION

The results obtained during the studies supported the reports of Jabłoński (1998). Placing the migratory apiary on the rape field at a time when about 10% of rape flowers were blooming resulted in better exploitation of the rape flow in comparison to the stationary apiary permanently placed on the rape field. Significantly higher percentage content of *Brassica napus* pollen in the pollen loads and honey from the migratory apiary was noted. This implies that bees from the migratory apiary exploited the flow better, but in case of bad weather conditions (like in 2010) exploitation of rapeseed pollen flow by bee colonies from a migratory apiary can be worse, when compared to a stationary apiary. On the basis of the obtained results, it can be assumed that where other honey flow exploitation is concerned, e. g. *Robinia*, *Tilia*, *Fagopyrum* or *Calluna* the interrelation would be similar. Undoubtedly, the results of the study should be implemented in the apiaries transported to the fields of entomophilous plants (e. g. orchards or berry shrubs) for proper pollination.

The collected data confirmed the previous observations of Wilde et al. (2002), that the production of pollen loads is less dependent on the weather conditions than the production of honey. During this experiment, the winter rape florescence usually occurred under conditions of lower temperatures and periodic rainfall. Despite that, the average mass of pollen loads collected by one bee colony amounted to

1.1 kg, while the average honey production in that time reached only from 3 to 4 kg. Thus, as reported by Pidek (1988), obtaining the pollen loads resulted in a financial increase for the apiaries. According to the data reported by Bobrzecki (1973) and Wilde (2008), under the weather conditions in which the studies were conducted, better exploitation of the flow was presumably influenced by the short distance between the apiaries and the winter rape field.

## CONCLUSIONS

1. The results supported the view that placing bee colonies on the honey flow field when at least 10% of the flowers are blooming, results in better exploitation of pollen flow and allows obtaining honey with a higher percentage of the main pollen thus increasing the chance of obtaining unifloral honey.

2. Transferring the migratory apiary to the rape field when about 10% of the flowers were blooming did not increase the total amount of pollen and honey collected by the bee colonies in comparison to the mass of pollen and honey collected by the colonies from the stationary apiary.

3. Bad weather conditions caused a worse exploitation of rapeseed pollen flow by bee colonies from the migratory apiary.

4. On the basis of the obtained results, it can be assumed that in a case of exploiting other flow plants e.g. *Robinia*, *Tilia*, *Fagopyrum*, *Calluna*, the interrelation would be similar.

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## WYKORZYSTANIE POŻYTKU RZEPAKOWEGO PRZEZ RODZINY PSZCZELE W PASIECE STACJONARNEJ I WĘDROWNEJ

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### S t r e s z c z e n i e

Celem badań prowadzonych w latach 2009 - 2011 było sprawdzenie różnic w wykorzystaniu nektarowego i pyłkowego pożytku rzepakowego przez rodziny pszczele z pasieki stacjonarnej (usytuowanej stale na tym terenie) i wędrownej - przywiezionej na pożytek w odpowiednim terminie i ustawionej na tym samym terenie co pasieka stacjonarna. W związku z tym w każdym roku trwania doświadczenia przygotowywano w dwóch typach pasiek (stacjonarnej i wędrownej) po 8 rodzin pszczelek. Rodziny pszczele z pasieki wędrownej przywożono na plantację w momencie zakwitnięcia ok. 10% kwiatów rzepaku. W tym czasie zakładano dennicowe poławiacze pyłku. Obnóży pyłkowe odbierano codziennie, oddzielnie z każdej rodziny pszczelej. Po zakończeniu

pożytku odwirowywano miód oddzielnie z poszczególnych rodzin, ważono go i pobierano próbki potrzebne do wykonania analizy pyłkowej. W trakcie prowadzenia badań monitorowano warunki atmosferyczne.

Stwierdzono, że średnia masa obnóży pyłkowych zbieranych przez jedną rodzinę pszczał w ciągu jednego dnia, w obu pasiekach, była zbliżona. Udział pyłku rzepaku był istotnie wyższy w obnóżach pochodzących z pasieki wędrownej. Mimo podobnych zbiorów miodu w obu pasiekach, mikroskopowa analiza pyłkowa wykazała istotnie wyższy procentowy udział pyłku rzepaku w miodzie pozyskanym z rodzin pszczelich z pasieki wędrownej. Wyniki jednoznacznie wskazują, że przywiezienie pasieki wędrownej na plantację rzepaku ozimego w czasie, gdy około 10% kwiatów było rozwiniętych, miało wpływ na lepsze wykorzystanie pożytku rzepakowego przez rodziny pszczele.

**Słowa kluczowe:** pasieka stacjonarna, pasieka wędrowna, rzepak ozimy, *Brassica napus* var. *oleifera*, obnóże pyłkowe, miód, analiza pyłkowa.