PSZCZELNICZE ZESZYTY NAUKOWE
Rok XLIV 2000

BEES IN THE MONITORING OF THE ENVIRONMENT'S CONTAMINATION: II. EVALUATION OF POSSIBILITIES OF USING BEES IN THE MONITORING OF THE ENVIRONMENT'S CONTAMINATION IN THE NEIGHBOURHOOD OF BIG INDUSTRIAL FERTILIZER PLANTS

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Received - 25 April 2000

Summary

The research was conducted in 1995 and 1996 in the apiary belonging to the Division of Apiculture, which was located in the direct neighbourhood of big chemical industrial fertilizer plant in Puławy.

The purpose of the research was to determine whether on terrain of that type there is a possibility of using bees to obtain pollen loads for the needs of monitoring of the environment's contamination. The purpose was also to determine a minimal number of colonies a monitored apiary located on terrain poor in a pollen flow, like close to an industrial plant, has to be made of. The obtained results indicate that in the described circumstances bees can be used to obtain pollen loads for the needs of monitoring of the environment's contamination. A monitored apiary should contain at least four colonies. Also small colonies placed in mating hives can be applied, what can reduce costs in a significant way

Keywords: monitoring, pollen load, factory.

INTRODUCTION AND REVIEW OF LITERATURE

Industrial terrain is exposed to numerous contaminants, and like urban terrain, it requires a careful monitoring of contamination (Celli et al. 1995, Haarmann 1997). A pollen loads is a good initial material for that research, since it is brought to a nest from terrain that is penetrated by bees (Muszyńska 1995).

However, a question whether bees, which live close to a big industrial fertilizer plant on terrain that is naturally devastated, are able to gather enough pollen loads, still remains to be answered. At the same time, if the answer to

this question were positive, it would be necessary to determine the number of colonies in a monitored apiary located in the environment of that type. It is allowed to assume that on this terrain, like in case of the one rich in pollen load, the number of colonies in a monitored apiary cannot be accidental (Muszyńska, Warakomska 1999).

The purpose of the present research was to explain both above-mentioned problems.

MATERIALS AND METHODS

The present study is the second part of the research published earlier (Muszyńska, Warakomska 1999). The results of the previous study involve an apiary located on terrain, which is rich in pollen loads. The studies were conducted simultaneously, but in an apiary located in the direct neighbourhood of the chemical fertilizer plant, which is 10 km away from Puławy. The location of the experiment had not been so far described in detail, it was however known that there was a fallow land all around the plant and a mixed forest behind it. It is also known that although the plant has applied certain protections, the environment is still exposed to industrial emissions , and vegetation's size is a lot smaller (Warakomska, oral information),

The studies were conducted in 1995 and 1996. In both years, little colonies placed in polystyrene four-frame mating hives were used to gather pollen loads. They had Carniolan queens that were inseminated and laying eggs. The brood occupied an area that was not less than two honeycombs. In these colonies, bees tightly covered all four honeycombs.

Pollen loads were gained with the help of exterior traps, which were designed especially for the needs of that study (Muszyńska, Warakomska 1999). The number of colonies, which pollen was obtained from, was not constant. However, in each period of gathering the monitored apiary consisted of at least 3 colonies.

In both years each sample of a pollen load was gathered from one honeybee colony for a period of at least 5 days, because within the next few days the species composition of pollen in pollen loads may change (Poulsen 1973, Mercuri, Grandi 1990, Reissberger, Crailsheim 1997). In the year 1995 gathering of pollen was begun at the following dates: July 17, July 27, August 23, September 1, September 17, whereas in 1996: August 20, August 27, September 2. In 1995, within the first 5 periods of gathering 21 samples of pollen, whereas in 1996, within 3 periods of gathering 11 samples of pollen were obtained.

Pollen loads from consecutive periods of gathering were taken from individual bee colonies, dried to the constant weight, carefully mixed, and then from each mixed sample a 4-gram weighed portions were was prepared.

The pollen analysis was executed on the basis of Zander's palinological typology (1931-51) and accordingly to Warakomska's method (1985).

The results of that analysis became the basis for evaluating the species composition of the total sample. The total sample was determined by adding species of pollen found in samples, which were gathered from each colony in a given period of time. The species composition of collective samples, which were made up by incomplete number of samples, but arranged in different combinations, was also determined in the same way.

RESULTS

In both years of studies and in each period of gathering, the amount of pollen loads, which were obtained from individual colonies living in a monitored apiary, exceeded in most cases 4 grams. However, it is very important to be emphasised that there were a few cases, in which individual colonies gathered less than 4 grams of pollen within 7 days. (It happened by of the unfavourable weather, which limited the number of bee flights). Then the time of gathering pollen loads was prolonged by a few days. It is necessary to think that 4-gram samples of pollen loads are also sufficient for chemical studies, supposed to determine whether the samples contained toxic substances like heavy metals and means used to protect plants (K u b i k et al. 1992).

1. The evaluation of the species composition of pollen loads, obtained from individual bee colonies in the consecutive years of the research.

The weather conditions during the consecutive years of the research were presented in detail in the earlier publication. The comparable years differed from each other as regards the weather system. The above mentioned differences occurred especially clearly as far as the amount of rains is concerned (M u s z y ń s k a , W a r a k o m s k a 1999).

It is necessary to admit that the above mentioned differences as regards the weather system are the reason why the species composition of pollen in pollen loads, which were obtained at the same time of the consecutive years, is not the same. For example 58 species of pollen altogether were found in the total sample of pollen loads, which were gathered at the beginning of September in 1995 and 1996. However, 50 species (which is as much as 86%) were found in all total sample within only one year of the research. This also agrees with the conclusions presented by G r o m i s z (1993).

The number of pollen species found in a total sample of pollen loads, which were gathered by a bee colony in the same period of time during the consecutive years of the research, was different. This is presented in the table number 1.

Table 1.

The year of the research and a degree of diversity of pollen loads sample as regards the species composition of pollen
(in the same period of gathering: August 23 - September 2)
Rok badań, a stopień zróżnicowania próby obnóży pyłkowych pod względem składu gatunkowego pyłku (w tym samym okresie zbioru 23.08 - 02. 09)

	The year of the research - Rok badań	
	1995	1996
The total number of samples obtained in a given period of time Ogólna liczba próbek obnóży uzyskanych w badanym okresie	8	11
The average number of pollen species found in one sample of pollen loads Średnia liczba gatunków pyłku stwierdzona w jednej próbie obnóży	20	9
The number of species found in one sample of pollen loads - a range Liczba gatunków stwierdzona w jednej próbie obnóży - przedział	14 - 27	4 - 12

The share of given species of pollen found in samples of pollen loads, which were collected in the same period from individual honeybee colonies, also differs significantly. This is presented in the table number 2.

Table 2.

The share of a few selected species of pollen in pollen loads, which were obtained from different honeybee colonies during the same period of time
Udział kilku wybranych gatunków pyłku w obnóżach uzyskanych w tym samym okresie od różnych rodzin pszczelich

In the year 1995 - Rok 1995			
The date of the gathering. Termin zbioru.	The number of pollen loads samples. - Liczba próbek obnóży.	The pollen species. Gatunek pyłku.	The percentage share of pollen in pollen loads (range). Procentowy udział pyłku w obnóżach (przedział).
17.07	5	Sisymbrium Loeselii-stulisz Loesela	0-87
27.07	3	Rumex - sorrel-szczaw	0-19
07.08	5	Rumex - sorre l- szczaw	0.23-14
23.08	5	Taraxacum - dandelion type -typ mniszka	3-21
01.09	3	Taraxacum - dandelion type -typ mniszka	1-29
In the year 1996 - Rok 1996			
20.08	4	Sisymbrium Loeselii-stulisz Loesela	12-93
27.08	4	Sisymbrium Loeselii-stulisz Loesela	84-93
02.09	3	Sisymbrium Loeselii-stulisz Loesela	0-88

2. The estimation of the relationship between the number of colonies, which the samples of pollen loads come from, as well as the way of their combination, and the percentage share of pollen species in the collective sample.

The conducted studies indicate that the number of pollen species in a collective sample of pollen loads, which were collected in the monitored apiary in a given period of time, remains in a close connection with two

factors. These factors are: the combination of a colony that pollen loads come from and the number of samples that created the collective sample. This is shown in the table number 3.

Table 3

The estimation of the relationship between the share of pollen species in a collective sample of pollen loads, and the number of samples that created that collective sample, as well as the selection of these samples
Ocena zależności między udziałem gatunków pyłku, a liczbą rodzin i sposobem ich kombinacji przy tworzeniu zbiorczej próby obnóży pyłkowych

Year Rok	Date Termin	The total number of the colonies*. Ogólna liczba rodzin.	The number of species in the total sample (100%). Liczba gatunków w próbie całkowitej 100%.	The relationship between the number of samples, which were taken into consideration while creating the collective sample of pollen loads, and the percentage share of pollen species. Liczba rodzin i sposób ich kombinacji przy tworzeniu zbiorczej próby obnóży, a procentowy udział gatunków pyłku					
				2		3		4	
				Range Przedział	Average Średnio	Range Przedział	Average Średnio	Range Przedział	Average Średnio
1995	17.07	5	31	38-87	63	64-96	81	96-100	98
	27.07	3	23	82-91	87	-	-	-	-
	07.08	5	27	62-85	75	81-96	87	85-100	90
	23.08	5	32	59-87	73	78-93	82	87-93	89
	01.09	3	34	85-94	90	-	-	-	-
1996	20.08	4	18	50-94	74	77-100	86	-	-
	27.08	4	16	68-81	77	68-93	71	-	-
	02.09	3	19	53-100	75	-	-	-	-

* from which the samples pollen loads where collected in order to create the collective sample.
* z których pozyskiwano próbki obnóży dla utworzenia próby zbiorczej.

When pollen loads collected by only two colonies were taken into consideration, than in a collective sample that was created by them (depending on what colony the samples came from) 38-94% (in the year 1995) and (50-100%) of the total number of pollen species were found in the total sample.

However, when the collective sample was made up of pollen loads collected by 4 honeybee colonies (depending on the arrangement of the samples) from 85 to 100% of the total number of species were found in the total sample. It is also confirmed by the values indicating the average percentage share of pollen species in the average collective sample, which was made up of pollen loads coming from the specific number of colonies in relation to the total collective sample. It is very important to point out that during the individual periods of time these values were not the same. The range indicating the percentage share of pollen species in the collective sample was also different (table 3).

DISCUSSION AND CONCLUSIONS

The presented results indicate that even on terrain that is naturally devastated and located close to a factory, bees are able to provide pollen loads for the use of the monitoring research of the environment's contamination. On industrial terrain, as well as on terrain that is rich in a pollen flow, the species composition of plants providing bees with pollen can differ significantly during the following years too. The number of plants species being worked by bees may be different in consecutive years. However, as far as the needs of the monitoring of the environment's contamination are concerned, it does not pose an essential problem - which was already emphasised in the previous publication (Muszyńska, Warakomska 1999). From the monitoring's point of view the species composition of pollen loads is not important, but it is necessary for them to contain pollen coming from all or almost all entomophilous plants that bloom on given terrain during the time of gathering.

The results of the present studies indicate that also on terrain that is poor in a pollen flow, the individual bee colonies can differ significantly as regards the preferences for specific species of plants (table 2), which confirm the results provided by other authors (Ortiz, Polo 1992). As it was affirmed, differences in the amount of collected pollen loads can also occur. The previous studies that were focused on terrain rich in a pollen flow have been confirmed (Wille et al. 1985). This is the reason why it is necessary to determine the number of colonies, which is optimal from a monitored apiary's point of view, as far as terrain poor in pollen loads is concerned. The optimal number of colonies means the smallest number, which is able to provide such a sample of pollen loads that is made up of pollen coming from all or almost all currently blooming entomophilous plants. As it was emphasised before (Muszyńska, Warakomska 1999), the number of an apiary has an essential influence on the costs of gathering pollen loads.

The studies, whose were presented in this publication, were conducted in the neighbourhood that was poor in pollen flow. The obtained results indicate that in that neighbourhood the monitored apiary should number at least four colonies.

It should be emphasised that little colonies placed in mating hives can be used to obtain pollen loads for the needs of monitoring of the environment's contamination. They are easy to create and do not require considerable expenditures. If their condition deteriorates - what can occur on terrain that is strongly contaminated (Bromenshenk et al. 1991) - their replacement does not cost much.

On the basis of the conducted studies it can be affirmed that:

1. In the vicinity of big factories, in spite of the considerable environment's contamination, it is feasible to obtain pollen loads with the help of bees.

2. An apiary, which is destined to obtain pollen loads for the needs of monitoring of the environment's contamination in the vicinity of industrial regions should number at least four colonies.

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PSZCZOŁY W MONITORINGU SKAŻEŃ ŚRODOWISKA PRZYRODNICZEGO: II. LICZEBNOŚĆ PASIEKI MONITORINGOWEJ W POBLIŻU DUŻEGO ZAKŁADU PRODUKCYJNEGO

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Streszczenie

Badania prowadzono w latach 1995 i 1996 w pasiece Oddziału Pszczelnictwa ISK, ustawionej w bezpośrednim sąsiedztwie dużego chemicznego zakładu produkcyjnego w Puławach.

Celem badań było ustalenie czy na tego typu terenie istnieje możliwość wykorzystania pszczół do pozyskiwania obnóży pyłkowych na potrzeby monitoringu skażeń środowiska. Dążono też do określenia minimalnej liczby rodzin z jakiej musi składać się pasieka monitoringowa zlokalizowana na terenie przyfabrycznym ubogim w pożytki pyłkowe. Uzyskane wyniki świadczą o tym, że w opisanych warunkach pszczoły mogą być wykorzystywane do pozyskiwania obnóży pyłkowych na potrzeby monitoringu skażenia środowiska. Pasieka monitoringowa powinna liczyć nie mniej niż cztery rodziny pszczele. Tworzyć ją mogą także małe rodzinki osadzone w ulikach weselnych, co znacznie obniży koszty jej prowadzenia.

Słowa kluczowe: monitoring, obnóża, zakład przemysłowy.