RED MASON BEE (*Osmia rufa* L.) AS A POLLINATOR OF RAPE PLANTATIONS

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S u m m a r y

The utility of the red mason bee (*Osmia rufa* L.) as a pollinator of commercial plantations of winter rape (*Brassica napus* L. var. *napus f. biennis*) was studied from 2004 to 2006 at the Research Institute of Pomology and Floriculture, Apiculture Division in Puławy, Poland. The study included observations of rape flowers visited by bees, pollen analyses of nest cells and a calculation of the *Osmia rufa* population increase in the consecutive years of the experiment. The *Brassica napus* pollen content in nest cells for each year was equal to: 2004 - 36.1%; 2005 - 8.3%; 2006 - 45%. Besides rape pollen, pollen of the following entomophilous plants was determined: *Acer, Aesculus,* Caryophyllaceae*, Lamium* type, *Lilium, Lonicera, Malus* type, *Taraxacum* type*, Prunus* type*, Ranunculus, Rubus* type*, Salix* as well as that of such anemophilous taxons as: *Carpinus, Fagus, Juglans, Pinus, Populus, Quercus, Ulmus.* The population was found to grow three-fold every year, with a growth factor equal to: 2004 - 3.04; 2005 - 3.4; 2006 - 3.2.

Keywords: red mason bee, *Osmia rufa*, pollination, *Brassica napus*.

INTRODUCTION

With the biocomponent share in the fuel market in Poland growing in recent years, the area of rape cultivation has increased from about 437 thousand hectares in 2000 to over 800 thousand hectares in 2009 (Rocznik statystyczny rolnictwa i obszarów wiejskich, 2009). A positive ratio of rapeseed price to that of wheat grain is another factor which has positively influenced farmer interest in rapeseed crop cultivation. Forecasts are promising as well, since under the current regulations the share of biofuels sold in the European Union countries should be at least 5.75% by 2010, and it should reach 10% by 2020. Growth in the cultivation area of this entomophilous plant entails an increased demand for pollinating insects. Assuming 3 bee colonies per 1 ha of a plantation (Jabłoński, 1997), means that 2.25 million bee colonies were needed for effective pollination of the rape sown in Poland in 2008. There are, however, only 1.1 million bee colonies, according to recent reports (Gerula et al., 2007). It is therefore necessary to seek alternative and supplementary pollinators. *Osmia rufa* is known to be an effective pollinator of many cultivated plants (Wilkaniec, 1990; Wilkaniec, 1991; Biliński and Teper, 2004; Wilkaniec and Giejdasz, 2003; Wilkaniec et al., 2004; Wilkaniec and Maciejewska, 1998; Wilkaniec and Radajewska, 1997). Because of *Osmia rufa's* pollinating abilities, a decision was made at the Research Institute of Pomology and Floriculture, Apiculture Division in Puławy, Poland to test its utility for pollinating commercial plantations of rape.

The significance of pollinating insects in

increasing rape yield (Jabłoński et al., 1985; Kołtowski, 2005) and that of other Brassicaceae species (Ladurner et al., 2002) has been corroborated in scientific studies. The presence of pollinators on a plantation results in increased rapeseed quality and yield. The increase ranges from 10 to 33%, depending on the rape cultivar (Jabłoński et al., 1985; Kołtowski, 2005). Moreover, Ladurner et al. (2002) showed *Osmia cornuta* to be a highly efficient pollinator of *Brassica rapa* L. when cultivated under isolated conditions.

The studies conducted by Wilkaniec and Warakomska (1992) as well as by Wilkaniec et al. (1997), dealing with the feeding plants of *Osmia rufa,* confirmed the flights of those bees to plants of the Brassicaceae family. The authors also reported on the considerable content of anemophilous plant pollen in nest cells of *O. rufa*. Moreover, a palynological analysis of faeces, conducted by Teper (2007) in his study of the feeding plants of *O. rufa,* revealed the presence of numerous grains of pollen of Brassicaceae species and anemophilous species of *Quercus* and *Juglans*.

MATERIAL AND METHODS

The experiment was conducted in the years 2004-2006 on a plantation consisting of several hectares of winter rape at the Experimental Department in Kępa of the Institute of Soil Science and Plant Cultivation in Puławy, Poland.

Every year, 7-10 days before the expected beginning of plant blossoming, 3 to 6 thousand cocoons of the red mason bee, and cut reed stems as nest materials, were put out close to the plantation. Here the red mason bees were able to hatch freely.

During the first year of the experiment, when the plantation was in full bloom, three day-long observations of bees on flowers were conducted on May 5, 10 and 13. All the insects observed on flowers over an area of 40 m² (1 x 40 m) of the plantation, at 1 hour intervals, were counted and recorded, and divided into species. The observations started every day at 8.00 a.m. and ended at 7.00 p.m. On the basis of the results a diagram of the average daily dynamics of rape flowers visited by bees was performed (Fig. 1).

The second part of the study which tested the utility of the red mason bee in rape pollination, was a palynological analysis of the pollen gathered by females in the nests. For the study, 10 inhabited nest tubes were collected every year after the end of the rape full bloom period. They were subsequently slit and microscopic preparations were made from the pollen in accordance with the principles commonly followed in melissopalynology (Wilkaniec and Warakomska, 1992).

The inhabited nest tubes were taken to the laboratory after season, and their content was analysed. The population growth index was calculated from the ratio of the number of post-season and spring cocoons.

RESULTS

Relatively few insects were recorded working on rape flowers in the morning (Fig. 1). The number increased steadily later on, with the peak of flights observed between 11.00 and 4.00 p.m. The most numerous *Apis mellifera* were observed between 10.00 a.m. and 3.00 p.m whereas *Osmia rufa* between 1.00 p.m and 4.00 p.m. The number of flying insects decreased steadily in the afternoon, with only individual bees seen to fly to rape flowers in the evening, during the last observation at 7.00 p.m. In general, the density of bees on the plantation was not

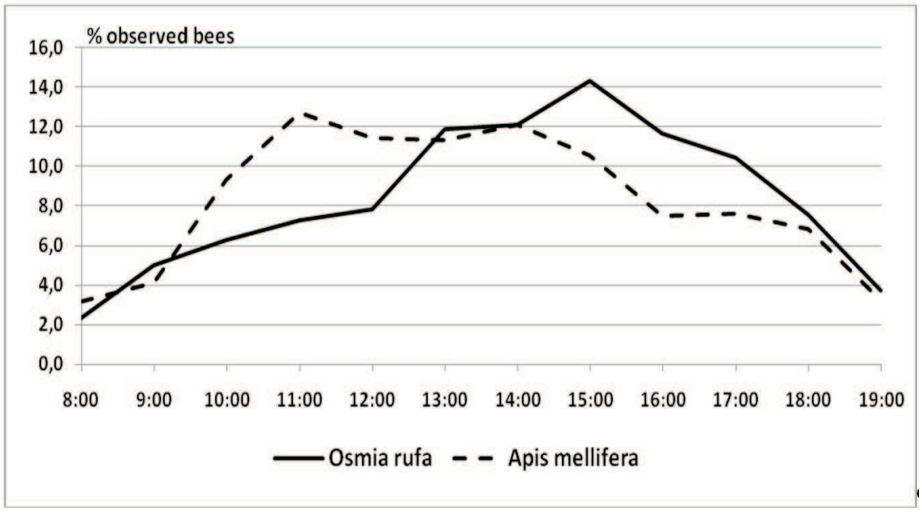

Fig. 1. Average daily dynamics of the insects visiting winter rape flowers on the basis of observations done on May 5, 10, 13, 2004.

high, with an average of only 1.4 working honeybees and only 0.5 red mason bees/m^2 recorded during the most intense flights period.

The palynological analysis of the pollen accumulated in individual nest cells showed the share of rape pollen ranging from 0% to 100% (Tab. 1). The average share of *Brassica* pollen in all the analysed cells was the highest in 2006 - 45% and the lowest in 2005 - 8.3%. Besides rape pollen, that of the following nectar-giving species were determined: *Acer, Aesculus,* Caryophyllaceae, *Lamium* type, *Lilium, Lonicera, Malus* type, *Taraxacum* type, *Prunus* type, *Ranunculus, Rubus* type, *Salix* as well as that of anemophilous taxons: *Carpinus, Fagus, Juglans, Pinus, Populus, Quercus, Ulmus* (Tab. 1).

Every year after the season, the cocoons taken out of the nest tubes were counted and the population multiplication index was calculated. In the years of the

Table 1

The results of analysis of pollen provisions from the nests of *Osmia rufa* in 2004-2006

Year of the experiment	Ranges of *Brassica* pollen portion in *Osmia rufa* nest cells (%)	Average % of *Brassica* pollen	Pollen of other species	
			entomophilous	anemophilous
2004	0 - 100	36.1	*Acer, Aesculus, Malus* type, *Prunus* type, *Taraxacum* type,	*Carpinus, Juglans, Quercus*
2005	0 - 72	8.3*	Caryophyllaceae, *Lamium* type, *Lilium, Malus* type	*Quercus, Fagus, Juglans, Ulmus,*
2006	0 - 100	45.0	*Aesculus, Lamium* type, *Lonicera, Prunus* type, *Ranunculus, Rubus* type, *Salix*	*Quercus, Fagus, Juglans, Populus, Pinus*

*a colony located near a clump of anemophilous trees

experiment this index was equal to: 3.04 in 2004; 3.4 in 2005 and 3.2 in 2006.

DISCUSSION

The study indicates that the solitary bee, the red mason bee (*Osmia rufa*), can be used to pollinate commercial plantations of rape. High contents of rape pollen - even as much as 100% - were found in the bee nest cells. The data on the high attractiveness of Brassicaceae plants has been confirmed by literature reports (Teper, 2007; Wilkaniec and Warakomska, 1992; Wilkaniec et al., 1997). The relatively low average percentage of *Brassica* pollen in nest cells in 2005 (8.3%) was probably caused by the location of the red mason bee colony in the vicinity of anemophilous trees. The anemophilous trees blossomed at the same time as the rape and anemophilous tree pollen dominated in the nests. The high preference of red mason bees for anemophilous plants (which produce much more pollen) has also been confirmed by literature reports (Wilkaniec and Warakomska, 1992; Wilkaniec et. al., 1997; Teper, 2007). Considering that the red mason bees have a high interest in anemophilous species, their colonies should be located close to plantations but away from competitive plants. Studies into the effect of the vicinity of competitive plants on *Osmia rufa's* flights to cherry flowers have shown a considerable increase in *Prunus* pollen content in the nests situated 300 m away from anemophilous plants (Teper and Biliński, 2009a). Due to the relatively short flight range of the red mason bee (several hundred metres) it is necessary to put their colonies at more than one site on large (several dozen or several hundred hectares) plantations.

The density of bees on the plantation in 2004 was not high probably due to chilly weather during the whole rape blooming period.

A high population increase of more than 3-fold of *Osmia rufa* was recorded in subsequent years. This may have been caused by the park in the distant neighbourhood which has many utility species, including anemophilous ones, blossoming throughout the period of the red mason bee flights. The population increase is much lower in a monoculture cultivation due to the relatively short blossoming period of the cultivated plants (Teper and Biliński, 2009a; Teper and Biliński, 2009b).

CONCLUSIONS

1. A high share of *Brassica* pollen in nest cells of *Osmia rufa* proves that it can be a valuable pollinator of commercial rape plantations.

2. A high population growth, more than 3-fold, was recorded in the consecutive years of the study.

3. *Osmia rufa* can be an efficient supplementary pollinator of rape plantations if its colonies are situated at least 300 m away from competitive entomophilous plants.

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MURARKA OGRODOWA (*Osmia rufa* L.) JAKO ZAPYLACZ PLANTACJI RZEPAKU

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Streszczenie

W latach 2004-2006 w Oddziale Pszczelnictwa Instytutu Sadownictwa i Kwiaciarstwa w Puławach prowadzono badania przydatności murarki ogrodowej (*Osmia rufa* L.) jako zapylacza towarowych plantacji rzepaku ozimego (*Brassica napus* L. var. *napus f. biennis)*. Każdego roku około 7-10 dni przed przewidywanym początkiem kwitnienia roślin, wystawiano tuż przy plantacji od około 3 do 6 tys. kokonów murarki ogrodowej do swobodnego wylęgu. Wraz z kokonami wystawiano trzcinowe rurki jako materiał gniazdowy. W pierwszym roku badań przeprowadzono 3-dniowe obserwacje oblotu kwiatów rzepaku i na tej podstawie sporządzono wykres dziennej dynamiki oblotu rzepaku (Ryc. 1). Każdego roku po zakończeniu okresu pełni kwitnienia rzepaku, pobierano po 10 zasiedlonych trzcinowych rurek w celu przeprowadzenia analizy pyłkowej ich zawartości. Jesienią rozcinano zasiedlone gniazda i przeprowadzano ich analizę. Na podstawie stosunku liczby kokonów uzyskanych po sezonie do wystawionych wiosną obliczono współczynnik przyrostu populacji.

Zawartość pyłku *Brassica napus* w poszczególnych latach wynosiła: 2004 - 36,1%; 2005 - 8,3%; 2006 - 45%. Poza pyłkiem rzepaku w komórkach gniazdowych oznaczono pyłek owadopylnych gatunków: *Acer, Aesculus,* Caryophyllaceae*, Lamium* type, *Lilium, Lonicera, Malus* type, *Taraxacum* type*, Prunus* type*, Ranunculus, Rubus* type*, Salix* oraz wiatropylnych taksonów: *Carpinus, Fagus, Juglans, Pinus, Populus, Quercus, Ulmus.* Przyrost populacji był co roku ponad 3-krotny i wynosił: 2004 - 3,04; 2005 - 3,4; 2006 - 3,2.

Słowa kluczowe: murarka ogrodowa, *Osmia rufa*, zapylanie, rzepak.