

IMPORTANCE OF BEES IN POLLINATION OF CROPS IN THE EUROPEAN UNION COUNTRIES

Beata Madras-Majewska¹, dr hab., professor; Janusz Majewski², PhD, assistant professor

¹ Apiculture Division, Warsaw University of Life Sciences – SGGW

² Department of Agricultural Economics and International Economic Relation,
Warsaw University of Life Sciences – SGGW

Abstract. The main task of bees is pollination. The results achieved with pollination are many times higher than the value of the products of these insects. Due to changes in production technologies, reduction of the surface of non-productive areas, environmental pollution and improper use of pesticides, the importance of bees in pollination is constantly growing. This applies especially to countries with highly developed agriculture.

According to FAOSTAT, in the years 1961-2013, the number of bee colonies in the EU countries increased by 30%. At the same time, the acreage of open-pollinated crops increased more than 3 times. The biggest growth of the acreage was observed in the case of rape and sunflower. The area of these crops in the EU is too large to be entirely pollinated by bee colonies, especially because the flowering time of rape is similar to that of some fruit plants. In addition, sunflower crops are concentrated in several EU countries which do not have a sufficient number of bee colonies needed for pollination of the entire acreage of the plant. This results in losses, on the one hand – caused by reduction of the crop yield, and on the other hand – by the unused potential of plants for honey production.

Key words: bees, pollination, pollination needs, the European Union.

JEL code: Q51, Q57

Introduction

Beekeeping provides two types of benefits for humans. On the one hand, bees produce various products, among which the most important is honey as well as pollen, propolis, royal jelly, beeswax and bee venom. On the other hand, bees perform the function of a 'service provider' in terms of plant pollination, including pollination of crop plants. Plant pollination is the most important benefit provided by bees. It is estimated that these insects, by pollinating crop plants, provide the economy with ten times, or according to some calculations – even one hundred times, greater effects than the value of their products (Prabucki J. (ed.), 1998). In addition, insect pollinators are an important contributor in terms of maintaining biodiversity.

Most plant species are pollinated by insects, the most important of which are apidae, with the predominant role played by the honeybee. The significance of the honeybee in plant pollination is constantly growing. This is due to changes in production technologies (e.g. vast area of agricultural land where access of wild pollinators is largely prevented), reduction of the surface of non-productive areas as well as environmental pollution and improper use of pesticides, which limits the number of wild insect pollinators (Majewski J., 2011).

The aim of the article was to point to the growing importance of bees in pollination of entomophilous crop

plants in the European Union countries. Comparisons were made between the acreage of entomophilous crops and the estimated number of bee colonies needed for their pollination. The study took into account 27 major crop plants, whose total acreage in the EU countries in 2013 amounted to more than 14.5 million hectares.

The study is based on the data provided by FAOSTAT and the subject literature. Statistical data were used to determine the quantities of crops of major entomophilous plants and the number of bee colonies in the EU countries. Based on the subject literature, the author was able to define the impact of bees on the plant yield and the number of bee colonies needed to pollinate a single unit of acreage of the surveyed crop plants.

Research results and discussion The importance of crop pollination

Pollination by insects is an essential process which enables us to obtain satisfactory yields of many crop plants. It is estimated that approximately 35% of the food produced worldwide depends on pollination, and this figure has shown an upward trend in recent years (Klein et al., 2007; Lautenbach et al., 2012). In the European Union, the crops grown on approximately 12% of arable land are dependent on pollination (Schulp et al., 2014).

Figures related to plant pollination by insects are difficult to estimate. This is due, inter alia, to

²Corresponding author. Tel.: +48 22 59 34 112; fax: +48 22 59 34 101. E-mail address: Janusz_Majewski@sggw.pl.

unavailability of uniform results of research into the influence of pollinators on the yield of crop plants, and the varied approach to the definition of pollination values (Morse R.A., Calderone N.W., 2000; Mburu et al., 2006; Allsopp et al., 2008; Gallai et al., 2009; Winfree et al., 2011). This gives rise to significant differences in the results obtained. Gallai et al. (2009) estimated the value of pollination of crop plants worldwide at EUR 153 billion, of which more than a half was attributable to Asia, approx. 15% to Europe (with EUR 14.2 billion attributable to the EU-25), less than 10% to North America and South & Central America respectively, and 8% to Africa. In terms of figures by plant, the largest share in the value of pollination was as follows: fruit and vegetables (approx. $\frac{1}{3}$ of the value of pollination each) and oil plants with 25% of the global value of crop pollination (Gallai et al., 2009). Leonhardt et al. (2013), based on the figures from the years 1991-2009, estimated the average value of insect pollination of crop plants in the European Union countries at EUR 14.6 billion per annum. The research involving estimates of the value of pollination was also carried out for individual countries. In the USA, the value of pollination of crop plants, taking into account the value of fruits, vegetables and seeds produced using pollination, increased from USD 9.3 billion in 1989 to USD 14.6 billion in 2000 (Morse R.A., Calderone N.W., 2000). In England, in 2007, this value was estimated at more than GBP 918 million (Breeze et al., 2011), while in Poland, in 2012, it was estimated at more than EUR 825 million (Majewski J., 2014).

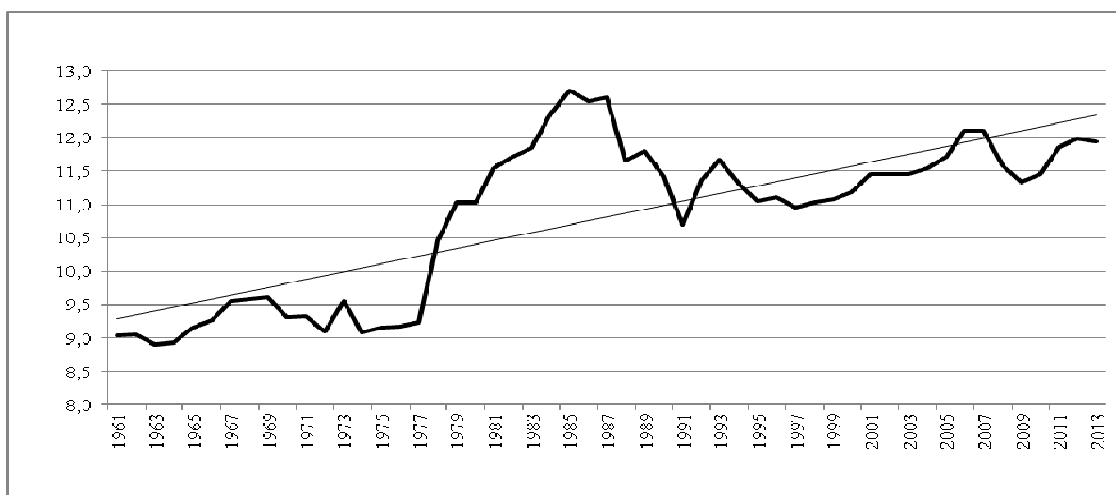
The estimated figures point to the significant role of bees as pollinators in agriculture. However, it should be noted that bees are also the main species involved in

the pollination of wild growing plants. Therefore, it may state that the value of pollination performed by these insects is higher than the value resulting from the figures given above.

The number of bee colonies in the EU

According to the figures provided by FAOSTAT, in 2013, approximately 12 million bee colonies were utilised in the EU countries. In comparison to the early 1960s, this number increased by more than 30%. Over the last fifty years, there have been significant changes in the number of bee colonies bred by humans, including a rapid growth of their population in the years 1977-1985, and a decrease in the population of bees by approx. 17% in the second half of the 1980s. In subsequent years, the number of bee colonies grew by approx. 0.4% per annum. Throughout the study period, the number of bee colonies in the EU countries showed a slight upward trend (Figure 1). In 2013, the countries with the largest number of bees included: Spain (2.4 million), Poland (1.5 million), Greece (1.3 million) and Romania (1.2 million). In total, the population of bees in these countries accounted for more than 50% of the overall number of bees utilised in the EU countries.

In the years 2000-2013, the number of beehives utilised in the European Union countries increased by less than 7%. The changes in the population of bees in individual countries were varied. During that period, the largest growth in the number of bees was recorded in Croatia (3-fold), Romania (2-fold), Estonia and Bulgaria (over 60%). Therefore, the most significant drop in their population was observed in Slovenia and Luxembourg (over 60%), Italy (almost 50%) and France (over 30%) (Table 1).



Source: FAOSTAT data

Fig. 1. The number of bee colonies in the EU in the years 1961-2013
(by bee colony, in millions)

Table 1

Changes in the number of bee colonies in the years 1961-2013 and 2000-2013

| Country | Changes in the number of bee colonies in 2013, in comparison to: | |
|-----------------------|--|------|
| | 2000 | 1961 |
| Austria | 123% | 82% |
| Bulgaria | 162% | 87% |
| Cyprus | 88% | 398% |
| Estonia | 167% | na |
| Finland | 102% | 215% |
| France | 69% | 89% |
| Germany | 78% | 35% |
| Greece | 104% | 197% |
| Hungary | 115% | 168% |
| Croatia | 347% | na |
| Italy | 56% | 81% |
| Latvia | 111% | na |
| Lithuania | 121% | na |
| Netherlands | na | na |
| Czech Republic | 100% | na |
| Poland | 115% | 125% |
| Portugal | 111% | 166% |
| Romania | 204% | 192% |
| Slovenia | 33% | na |
| Slovakia | 91% | na |
| Spain | 114% | 334% |
| Sweden | 91% | 24% |
| United Kingdom | na | na |
| Belgium | 109% | 81% |
| Luxemburg | 39% | 29% |
| Total | 107% | 131% |

na - no data available.

Source: author's calculations based on FAOSTAT data

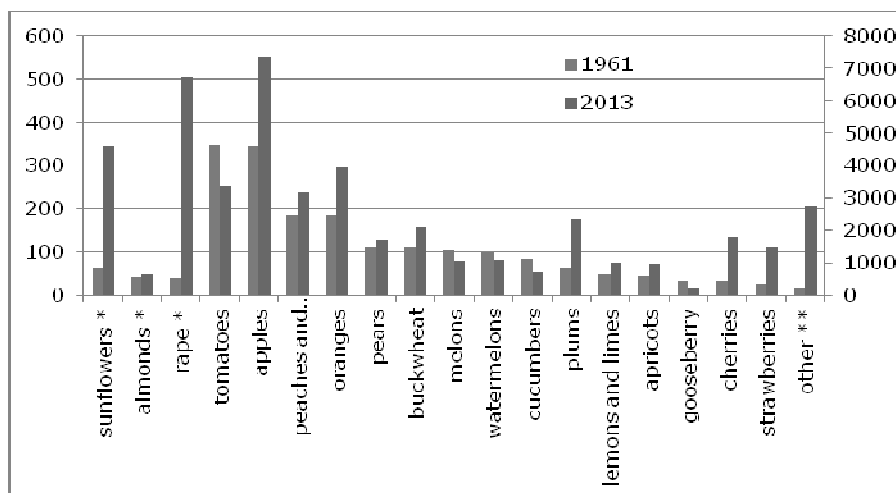
The number of bee colonies in the EU countries in 2013, in comparison to the figures from 1961, increased by more than 30%. The number of bee colonies grew in countries with a lower level of agricultural development, and gradually decreased in countries with a higher level of agricultural development. This may be attributable to the production technologies and the quantity of chemicals used in these countries as well as the degree of industrialisation of their agriculture.

Need for pollination of crop plants in the EU countries

Pollination determines the possibility of obtaining yield of adequate quality. In most cases, pollination is performed by bees. Their significant role in the pollination of plants is associated with several factors. These insects live in swarms and form bee colonies,

each of them consisting of several thousand to tens of thousands of individuals. Unlike the bumblebees, where the only overwintering individual is the fertilised mother, in the case of bees, the entire bee colony hibernates during the wintertime. This means that bees are able to pollinate large areas of entomophilous plants already in early spring. A hive with a bee colony can be transported to honey pastures, which enables the use of these insects in pollination of different species of plants. Bees are also characterised by the so-called flower fidelity, i.e. during their flight they tend to visit flowers of one species only, which increases the quality of pollination. In addition, with appropriate measures, people are able, in a way, to force the bees to pollinate the flowers of a particular plant species. That is why, in the case of many crops, bees are the best pollinators.

²Corresponding author. Tel.: +48 22 59 34 112; fax: +48 22 59 34 101. E-mail address: Janusz_Majewski@sggw.pl.



* - right axis.

** - other – applies to the total acreage of the following plants: raspberries, currants, sweet cherries, grapefruit, avocado, cranberries, blueberries and bilberries.

Source: FAOSTAT.

Fig. 2. Changes in the acreage of entomophilous plants in the EU in the years 1961 - 2013 (in thousand hectares)

It has been pointed out that among the 115 most important crop species, 87 require pollination by animals. For 52 of these plant species, bees are the most important pollinators, and in the case of 21 species, absence of pollination may result in the yield reduction by at least 40% (Klein et al., 2007).

The influence of plant pollination by insects on the quantity and quality of the yield has not been subject to any thorough research yet. Both Polish (Majewski J., 2010), and foreign (Morse R.A., Calderone N.W., 2000; Losey J.E., 2006) literature provides varied figures with regard to the influence of pollination on the crop yield. This is probably due to a large number of factors, including those beyond human control, determining the levels of crop yields. Table 2 presents figures, most frequently quoted in the literature, regarding the influence of insect pollinators on the yield of some of the major open-pollinated crops in the EU.

In terms of crops, pollination needs are mainly determined by their acreage. In the years 1960-2013, the acreage of entomophilous plants in the EU increased by more than 10 million hectares. The main contributors to this growth were rape, with the 13-fold increase in the area of cultivation (by more than 6.2 million hectares), and sunflower, with the 5.5-fold increase in the area of cultivation (by more than 3.7 million hectares). In 2013, these crops accounted for approximately 2/3 of the area of the entomophilous plants covered by the studies.

Similarly in the case of other crops, in the period in question, there was a growth in their acreage. In the same period, years 1960-2013, the acreage of these plants increased by more than 1.2 million hectares. However, there were several exceptions – in the case of tomatoes, cucumbers, watermelons, melons and gooseberries, the acreage decreased by a total of approx. 20 % (Figure 2).

In 2013, the area of the main entomophilous crops in the EU exceeded 14 million hectares. In order to pollinate the main crops humans needed more than 40 million bee colonies (Table 2). This does not mean that the same number of hives would be required in order to pollinate the crops. Some of the plants bloom at different times, thus, the bees may be used to pollinate various crops. Nevertheless, the number of bees in the EU is insufficient to pollinate all the plants. According to the data provided by FAOSTAT, in 2013, less than 12 million bee colonies were utilised in the European Union. However, in order to pollinate rape crops humans needed more than 20 million bee colonies. This indicates that the number of pollinators is insufficient, given the actual needs. In the case of pollination of sunflower crops, more than 9 million bee colonies were required – a number which also exceeded the actual number of bee colonies available in the countries with concentrated cultivation of this plant. In the case of other plants, the number of hives required for pollination is much lower. However, it should be noted that some of them bloom at approximately the

²Corresponding author. Tel.: +48 22 59 34 112; fax: +48 22 59 34 101. E-mail address: Janusz_Majewski@sggw.pl.

same time. Furthermore, some crops, for example fruit plants, are characterised by a relatively low yield of

honey, which does not encourage the use of these plants as honey pastures.

Table 2

Acreage of the main entomophilous plants, the effect of pollination on their yield, and the number of bee colonies needed to pollinate the crop plants in the EU in 2013

| Plant | Acreage in thousand hectares | Effect of pollination by insects on the yield | Number of bee hives needed to pollinate 1 hectare | Number of bee colonies needed to pollinate the crop plant in thousand hectares |
|-----------------------------|------------------------------|---|---|--|
| Rape | 6724 | 0.3 | 3 | 20172 |
| Sunflower | 4559 | 1.0 | 2 | 9118 |
| Almonds | 636 | 1.0 | 4 | 2544 |
| Apples | 553 | 1.0 | 4 | 2210 |
| Oranges | 294 | 0.3 | 4 | 1177 |
| Peaches and nectarines | 237 | 0.6 | 4 | 949 |
| Plums | 177 | 0.7 | 5 | 885 |
| Cherries | 136 | 0.9 | 5 | 678 |
| Pears | 129 | 0.7 | 4 | 518 |
| Buckwheat | 159 | 0.4 | 3 | 476 |
| Sweet cherries | 60 | 0.9 | 5 | 302 |
| Lemons and limes | 75 | 0.3 | 4 | 299 |
| Apricots | 73 | 0.7 | 4 | 294 |
| Currants | 64 | 0.7 | 4 | 256 |
| Watermelons | 80 | 0.7 | 3 | 241 |
| Melons | 79 | 0.7 | 3 | 236 |
| Strawberries | 110 | 0.2 | 2 | 220 |
| Cucumbers | 52 | 0.9 | 3 | 157 |
| Raspberries | 39 | 0.8 | 3 | 117 |
| Avocado | 23 | 1.0 | 4 | 91 |
| Gooseberry | 18 | 0.6 | 4 | 74 |
| Blueberries and cranberries | 15 | 1.0 | 2 | 30 |
| Grapefruit | 4 | 0.8 | 4 | 14 |
| Cranberry | 0.6 | 1.0 | 3 | 2 |
| TOTAL | 14297 | - | - | 41061 |

Source: author's calculation based on FAOSTAT, Morse and Calderone 2000.

Conclusions

Pollination is the most important task of insect pollinators, among which the dominant role is played by the honeybee. Its importance in the pollination of crops and wild growing plants is constantly increasing, among others, due to the growing surface of agricultural fields, increasing use of chemicals, reduction of non-productive areas and environmental pollution.

The importance of bees is also growing due to the increase in the acreage of entomophilous crops in the EU, in particular rapeseed and sunflower. Since 1961, the area of open-pollinated crops in the EU has risen more than 3 times (i.e. by more than 10 million hectares), with the increase in the number of bee

colonies, at the same time, by 30%. The significantly lower rate of bee population growth, in relation to the arable land of entomophilous crops, confirms the growing importance of bees in plant pollination. Their significance is even more pronounced due to the fact that the population of wild pollinators is growing smaller as a result of human activity.

Conclusions and recommendations arising from the studies:

- 1) The increasing importance of pollinating insects, especially bees as pollinators of crops, should be taken into account in the agricultural policy of the European Union. Providing support to beekeeping seems necessary, especially given the fact that the

'outcomes' of pollination performed by bees are consumed by the owners of plantation crops and by the society in general (ensuring biodiversity).

2) The effects of pollination on the yield of crops are varied. Apart from the plants in the case of which pollination by insects determines the yield to a large extent, such as sunflower, almonds, apples, sweet cherries, avocado, blueberries and cranberries, there are also plants for which the impact of pollination on the yield is relatively low. These include, inter alia: strawberries, oranges, lemons and rape. However, it should be noted here that apart from the growing yields, the use of pollinators also affects their quality. Therefore, a quantitative analysis of yields itself is insufficient, and as a result, the limited knowledge about the importance of pollinators in yielding crops gives rise to the lack of motivation to use the 'services' of insect pollinators.

3) The varied changes in the size of population of bee colonies in different countries of the European Union indicate different development opportunities for beekeeping in the individual EU countries. The absence of data on the number of bee colonies in such countries as the Netherlands and the United Kingdom may be perceived as marginalisation of this area of agriculture in these countries.

Another important issue is the economic value of pollination. As indicated in the study, the results of calculations in this respect are varied and depend, among others, on the approach applied. It seems advisable that the existing methods of estimating the economic value of pollination should be refined, especially in the case of determining the economic value of pollination of wild growing plants.

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