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POLLINATORS DIVERSITY IN RAPESEED CROPS OF SOUTH ROMANIA

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Abstract

The study on pollinators diversity in rapeseed crops was carried out in the spring season of 2024, in four sites located in South Romania. Rapeseed (Brassica napus L. ssp. oleifera (DC.) Metzg.) is an important oil crop in Romania reaching approximately one third of the total area of oilseed crops. The obtained data show that the observed pollinators belonged to four orders (i.e., Hymenoptera, Diptera, Lepidoptera, and Coleoptera), but Hymenoptera insects were the most numerous pollinators. The obtained results revealed that the major floral visitors of the Hymenoptera order belonged to Apidae family. Undoubtedly, the honey bee (Apis mellifera) was the most important visitors (about. 60%) followed by some species of solitary bees and bumblebees. The wild bees ranked a secondary place, they being known to have a significant contribution to increasing agricultural production. A high number of non-syrphid flies were also observed on flowers in rapeseed crops.

Key words*: rapeseed, pollination, insect pollinators.*

INTRODUCTION

Insects play a considerable role in providing services for human well-being (Jactel et al., 2021) since the world's agricultural crops depend, at least in part, on pollinators, mainly honey bees. Food crops such as apples, almonds, strawberries, onions, pumpkins, coffee, cocoa, watermelons and mangoes could be most at risk due to declining insect populations. With 70% of agricultural crops being pollinator dependent, and with the ongoing global decline in wild and managed pollinators, there is a growing concern that the negative impact of crop pollinators' dependence on global food production and stability will become even more pronounced (Adamidis et al., 2019).

Rapeseed (*Brassica napus* L. ssp. *oleifera* (DC.) Metzg.) is a globally important crop, benefitting by a mixed pollination system (self-pollination and cross-pollination). Although rapeseed is mainly considered a self-pollinating plant (Williams et al., 1986), cross-pollination is mediated by wind, insects and plants movement. The sugar content and flower morphology play an important role in attracting different pollinators (Shakeel et al., 2018). The floral physiology of rapeseed (i.e., bilaterally symmetrical yellow flowers with sticky pollen) and the high volume of nectar found in rapeseed flowers that is food resource to bees and other insects (Ion et al., 2012) implies rather the insects for the dispersion of pollen, and more less the wind (Adamidis et al., 2019).

Many authors have hypothesized that a good nectar secretion of the rapeseed flowers is associated with a better pollination due to the increased number of bees that visit the flowers. From this point of view, rapeseed is one of the main melliferous plants due to its nectar secretion and important number of flowers per plant (Ion et al., 2012). Even if the self-fertility of the rapeseed flowers is an important characteristic, the seed yields obtained without entomophilic pollination are significantly lower (Bommarco et al., 2012). Many studies conducted globally show the benefits of insect visitation in rapeseed crops production and quality (Bommarco et al., 2012; Stanley et al., 2013; Jauker & Wolters, 2008). Differences among rape seed varieties regarding the volume of nectar could explain the results regarding the effect of insect pollination on oilseed rape production (Ion et al., 2012). Rapeseed plants

show variation in their ability to compensate for a pollination deficit, which may depend on the cultivar, climatic conditions and the pollination efficiency of flower visiting insects (Holzschuh et al., 2012; Hoyle et al., 2007, Stanley et al., 2013; Ion, 2021). Many researches have shown a positive relationship between crop yield, the diversity and abundance of insect pollinators and the amount of native vegetation in the area around the crop. Maybe it worth a more thorough examination of pollinator dependence (i.e. the extent that a rapeseed plant/variety depends on pollinator visitation for the fruit set) and its associated traits among rape seed varieties (Adamidis et al., 2019). On-going agricultural intensification threatens wild pollinator communities with negative consequences for crop productivity (Klein et al., 2007). Wild pollinator abundance and diversity contribute to oilseed rape yield by mediating increased allocation to seeds rather than above-ground biomass. The maintenance of large and varied pollinator habitats near crops is guaranteeing such beneficial effects from wild bees.

Although rapeseed has become an important crop in Romania in recent years, reaching approximately one third of the total area of oilseed crops, studies on the abundance and diversity of pollinating insects in rapeseed crops in Romania are missing or insufficient. Furthermore, the contribution of pollinating insects to crop yield has rarely been estimated. It is important to note that the yield of rapeseed crops is generally influenced by three components: the number of plants per unit area, the number of seeds per plant, and the seed weight. Considering that one of the main components of yield, namely the number of seeds per plant, depends on the quality of the pollination process, the correct management of the pollination process can influence the seed yield. Insects are widely used as indicators to evaluate ecosystem biodiversity and for environmental assessment, mainly because they are relatively small in size, widely distributed, inhabit complex and diverse environments, and are very sensitive to environmental changes (Zhao et al., 2023).

The present study started from the idea that there is a strong need to identify pollinators in rapeseed crops and to determine whether these insects visit the rapeseed flowers which could help the cross pollination. Therefore, understanding the current state in insect community composition is helpful to reveal the current status of insects' biodiversity in rapeseed fields and its maintenance mechanisms (Zhao et al., 2023). Our study is all the more necessary as there is an increasingly accentuated trend of the pollinator decline. The honey bee population losses in Romania (Căuia & Ion, 2023) could contribute to understand some difficulties in providing the necessary number of insects/area unit to assure quality pollination. Following these aspects, this study is focused on a preliminary evaluation the diversity and abundance of bees and other insect species present in comercial rapeseed crops from South Romania.

MATERIALS AND METHODS

The study was conducted in South of Romania, in Ilfov County (43°37'07" N, 25°23'32" E). The region lies in a favourable area for rapeseed (*Brassica napus* L. ssp. *oleifera* (DC.) Metzg.) cultivation in Romania. The region includes the main commercial rapeseed crops in intensive system.

The surveys of insects were undertaken in four commercial rapeesed crops, respectively located in Balotești - Dumbraveni (44.632284, 26.092778) (site 1), Balotești - Dimieni (44.604816, 26.133809) (site 2), Grădiștea (44.632492, 26.303770) (site 3) and Moara Domnească (44.496743, 26.232794) (site 4).

The rapeseed crops were chosen based on the presence of similar microtopography conditions, namely the presence in their immediate vicinity of some dispersed large patches of woody vegetation or proximal groups of smaller patches of woody vegetation such as forest edges, forest curtains, hedges, uncultivated lands and also household gardens. In these conditions, the insect species richness, diversity, and abundance can be expected to show a great level because of the relatively high richness and coverage of vegetation species from study areas.

Data gathering was performed in April 2024 during the flowering of the rapeseed crops. The year specific weather conditions led to an early blooming (1th April) as a result of high temperature values before the start of flowering, but also to an extension of the flowering period (15th May) as a result of temperatures falling

below the specific average of the month and of the precipitations that occurred during flowering.

The transect method was used to evaluate the insects. Transects were laid in each rapeseed crop at least 50 m from the road to reduce border effects. Along each transect, 4 surveillance areas were established in each study site. At the start of each transect all insects seen on or near flowers were counted in an imaginary quadrat extending 1.5 m either side and 1.5 m out in front of the observer. The recording of insect species from each transect were for 10 minutes, between 11:00 and 13:00, and this was performed by two operators. Surveillance areas were established every 10 m along each transect. Local temperature and wind speed were recorded at the start of each transect as these can affect insects behaviour, although counting was conducted only at temperatures above 15°C to eliminate the impact of low temperatures on counts. These factors were included in initial analyses of data.

To assess the diversity and abundance of pollinating insects a **protocol** was used (Vaissière et al., 2011). In each rapeseed crop, the all observed insects both on flowers and leaves, in the surveillance areas, as well those in flight, were recorded and registered into six main categories (honey bees, wild bees, bumblebees, syrphids, butterflies, and other insects). Additionally, where possible, images of observed insects under rapeseed crops conditions were taken and then processed. Based on these, insects were classified as accurately as possible into genera and species according to some relevant reference materials (Packer, 2023). Insect specimens' identifications were confirmed with the aid of open-access galleries and databases of insect taxa (along with the references provided therein). Websites were also excellent sources for insect identification.

In order to simplify the identification and classification of bee insects (honey bees, wild bees and bumblebees) under field conditions, some observations were made on their behaviour of collecting pollen. Taking into account especially their various forms of adaptation for pollen collection, one grouped bee species into three categories, respectively bees that have the whole body covered with dense hairs and retain a large amount of pollen in the baskets, bees which have their hind legs covered with such a dense brush of bristles that the pollen is easily retained, and bees that collect and transport pollen on their abdomens.

In order to highlight the differences between the assessed groups of pollinators in the surveillance areas, the obtained results were analysed using the statistical software (NCSS, 2021) for descriptive statistic and ANOVA one-way tests. For a better view of differences, the data were presented by boxplot quartiles.

RESULTS AND DISCUSSIONS

A total of 678 individual insects were recorded in the surveillance areas of rapeseed crops, in the studied locations and throughout the evaluation period. They were distributed over six main insect categories, respectively honey bees, wild bees, bumblebees, syrphids, butterflies, and other insects. The abundance variability of the obtained data on different categories of insects is presented in the Figure 1 and Table 1. The average percentage of all recorded insects was the following: 61.1% honey bees, 9.4% wild bees, 4.1% bumblebees, 4.6% syrphids, 8.4% butterflies, and 12.4% other insects. Of these, dominant insect categories were honey bees and wild bees. Other insect categories accounted a little over 12% of the total individual insects.

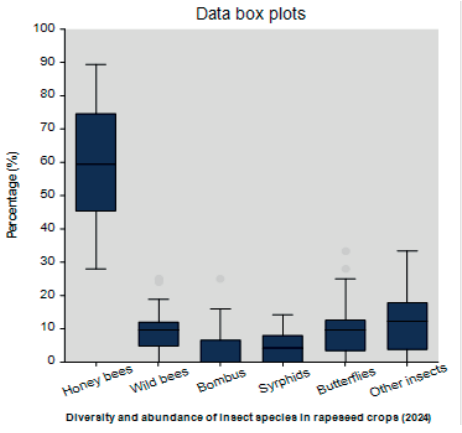


Figure 1. The abundance variability of insects in the categories evaluated in rapeseed crops

The results of our study showed that pollination of rapeseed crops have clearly been dominated by honey bees.

Table 1. A summary descriptive statistic for data gathered on all sampled sites during the study

Short descriptive statistics	Honey bees (n)	Wild bees (n)	Bombus (n)	Syrphids (n)	Butterflies (n)	Other insects (n)	Total insects (n)
Counts	28	28	28	28	28	28	28
Sum	414	64	28	31	57	84	678
Mean	14.79	2.28	1.00	1.11	2.04	3.00	24.21
St. Error	1.48	0.32	0.25	0.23	0.31	0.47	1.62
Lower 95% CL mean	11.75	1.63	0.49	0.64	1.39	2.04	20.88
Upper 95% CL mean	17.82	2.94	1.51	1.57	2.68	3.96	27.54
Min.	4	0	0	0	0	0	9
Max.	36	7	4	4	7	10	44

Although wild bees and bumblebees were less visible compared to honey bees, they are important and efficient as pollinators. It is known that worldwide, social bees such as the honey bee make up about 90% of the effective pollinating insects, several species of solitary bees (Andrenidae, Halictidae, Megachilidae and lower Apidae) and bumblebees (*Bombus* spp.) are as efficient (Mesquida et al., 1988) but they are less known and appreciated by farmers. Species of Diptera, Lepidoptera, Hemiptera and Coleoptera are less abundant, and less efficient in the rapeseed crop pollination.

Bee pollination of oilseed rape has been studied by numerous researchers who have demonstrated more or less appreciable effects, and sometimes drawn contradictory conclusions (Mesquida et al., 1988).

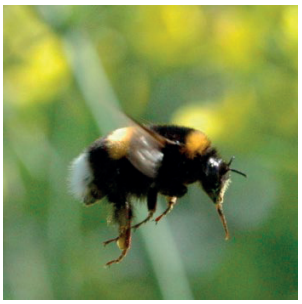
A possible explanation why bumblebees, as a semi-social species, had a relatively low number in rapeseed crops would be that this crop blooms early in season and the biologic cycles of insects does not allow an abundance in crops. In addition, in 2024 conditions, rapeseed crops had a much earlier flowering (early April). However, early rapeseed crops appear to be important for these species as they can contribute to increased populations for subsequent crops such as sunflower or other species of interest in neighbouring areas, thus leading to higher productivity and a better yield quality.

Variability of insects collecting pollen

Within the studied rapeseed crops it was found that solitary bees can often be confused with honey bees, wasps or even flies, as they show an extraordinary diversity in terms of morphology and foraging behaviour. The differences mainly concern the disposition and coloring of the hair that cover their bodies, the conformation of the legs etc. To determine the mechanism underlying the differentiation of them, and taking into account the various forms of adaptation for pollen collection (Figure 2), the following results were found:

- Bees that have the whole body covered with dense hairs and retain a large amount of pollen in the baskets: two insects species were identified in this category, namely honey bee (*Apis mellifera* - fam. Apidae) and the bumble bee (*Bombus terestris* - fam. Apidae).
- Bees which have their hind legs covered with a dense brush of bristles as the pollen to be very easy retained. In this category we have identified three insect species from wild bees' category, namely *Andrena flavipes* (fam. Andrenidae), *Andrena cineraria* (fam. Andrenidae) and *Lasioglossium* sp. (fam. Halictidae).
- Bees that collect and transport pollen on their abdomens covered with hairs. Members of this group were difficult or impossible to identify from field images. According with literature Osmia bees could be included in this category. Further researches would be necessary to make easier their identification and to inform farmers about the presence of Osmia into rapeseed crops. The solitary blue orchard bee (*Osmia lignaria*), compared with honeybees, flies early in the spring when it might still be too cold for honey bees, which means that they could appear in rapeseed crops even before flowering to improve the crops pollination.

Apis mellifera (Apidae)



Bombus terestris (Apidae)

Andrena flavipes (Andrenidae)

Andrena cineraria (Andrenidae)

Lasioglossium sp. (Halictidae)

Figure 2. Representatives of bees collecting pollen in rapeseed crops (Ilfov County, Romania, 2024)

A relatively high number of non-syrphid flies were observed on rapeseed flowers in all study sites (Figure 3). Non-syrphid flies have also been recorded in other studies on rapeseed crop (Garrat et al., 2014). The obtained data are similarly with other studies that registered non-syrphid Diptera as made up the majority of the flower-visiting Diptera in the agricultural studies. Although there are many records of non-syrphid Diptera visiting flowers, they are generally not regarded as important pollinators (Orford et al., 2015). Further research is necessary to understand their contribution on the rapeseed pollination.

Anthomyiidae

Chrysopidae

Lepidoptera

Figure 3. Some representatives of non-syrphid flies and butterflies category in the studied rapeseed crops (Ilfov County, Romania, 2024)

In the category "other insects" there were included various species of insects which are not specialised in pollination (known without specialized organs for the transport of nectar and pollen) as Coleoptera, Hemipterae, Orthoptera or Nemopterae. In the same category were recorded also the insects considered harmful to rapeseed crops, such as aphids (Aphididae), thrips (Thysanoptera), or the hairy beetle (Coleoptera) (Figure 4). Some of them lay their

eggs in the flower, from which the larvae develop and spread the accumulated nectar, but also the pollen, thus causing damage to the pollination process (Figure 4). It has to be also mentioned the presence in this group of some useful insect species for rapeseed crops, which perform sanitary functions, such as the lacewing insect (from the Chrysopidae family) or the ladybug (from Coccinellidae family). The diversity of insect visitors to rapeseed crops has also been noticed in other studies, some showing an impact of seasonality and local landscape (Garrat et al., 2014).

Scarabaeidae Scarabaeidae *Brassicogethes aeneus* larvae

Figure 4. Some representatives of other insects' category in the studied rapeseed crops (Ilfov County, Romania, 2024)

Spatial variability of insect species

Regarding spatial variability of insect species, the obtained results of this study showed that the insect community had some different characteristics along the sites at the individual levels and insect categories, despite the fact that all study sites were selected to have similary microtopography conditions. The number of individual insects from one site was higher compared to the other 3 locations, even double (i.e. 247 individual insects in site 1 - Balotești-Dumbraveni, compared with 120 in site 3 - Grădistea) (Figure 5).

Honey bees and wild bees were dominant insect categories in all sites. In addition, these two insect categories seemed to be the most balanced. Bumblebees recorded the lowest value or even were missing in site 2 Balotesti-Dimieni. The obtained data confirm also that the morphology of the rapeseed flower allows insects belonging to many orders (Hymenoptera, Diptera and Lepidoptera) to collect pollen and nectar. There are studies showing that along with honey bees, many non-*Apis* bee species across multiple genera, including *Andrena*, *Agapostemon*, *Bombus*, *Lasioglossum*, *Halictus, Melissodes* have been observed visiting flowers in both conventional and organic canola fields (Esquivel et al., 2021). Authors as Pearson (1932) cited by McGregory (1976) considered that bees from various families as Andrenidae, Megachilidae and Nomadidae [= *Nomada* spp. of Anthophoridae] are more important than honey bees in the pollination of Brassica species, but they did not offered any information regarding the relative populations, either on the plants or in the area. Sneep (1952) cited by McGregory (1976) mentioned the presence of *Bombus* and *Psithyrus* in the area of rapeseed crops but only incidentally.

A commonality of rapeseed crops is that they produce large number of flowers that producing copious amounts of nectar, making them highly attractive to pollinators. Rapeseed is a mass-flowering crop which represents for approximately 4 weeks an important source of nectar for bees as well as for other insects. Rapeseed crops often exceed and surpass semi-natural habitats in the sheer quantity of floral resources they offer at a given time (Esquivel et al., 2021). A characteristic of rapeseed crops is that they bloom in the spring, sometimes in conditions of temperatures below the minimum 12ºC, the threshold temperature for honey bee flight, in windy or rainy conditions. Under these conditions, some wild bee populations, which search for food even at lower temperatures, could be effective pollinators of rapeseed crops.

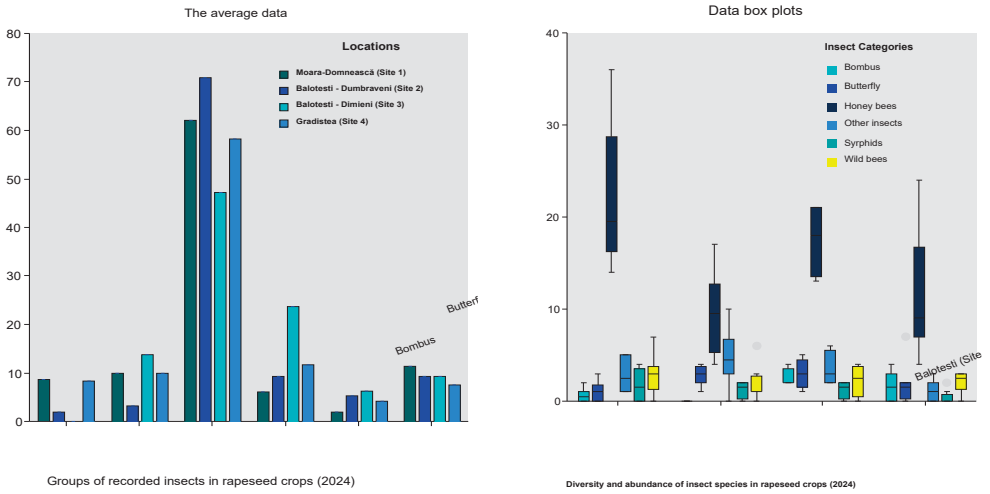


Figure 5. The variability of data regarding the insects' groups registered in the four studied locations

Westphal et al. (2003) cited by (Esquivel et al., 2021) demonstrated that densities of bumblebees were not related to the proportion of semi-natural habitat within an agricultural landscape, but were driven by the availability of mass-flowering crops in the landscape that were highly rewarding to foragers.

The abundance of insect species found on our study is particularly interesting not only in terms of biodiversity and biological resources, but also from a purely ecological point of view. The abundance of species reflects a diversity of both micro-habitats and resources, and may indicate a relative 'good health' of these micro-habitats cultivated with rapeseed (Aissat et al., 2023).

CONCLUSIONS

The obtained preliminary data highlighted that the structure of insect species as visitors in rapeseed crops was unequally distributed to the six main insect categories, respectively honey bees, wild bees, bumblebees, syrphids, butterflies and other insects.

Rapeseed in south of Romania (Ilfov county) was visited by almost 10 species of insect pollinators, but the dominant insect category was honey bee. The wild bee species, as specialised pollinators, were represented by *Andrena flavipes*, *Andrena cineraria* and *Lasioglossium* sp.

Among bees' category that have the whole body covered with dense hairs and retain a large amount of pollen in the baskets, two insects' species were identified, namely honey bee (*Apis mellifera* - fam. Apidae*)* and the bumble bee (*Bombus terestris* - fam. Apidae).

Among bees which have their hind legs covered with a dense brush of bristles for the pollen to be easily retained, three insect species were identified, namely *Andrena flavipes* (fam. Andrenidae), *Andrena cineraria* (fam. Andrenidae) *and Lasioglossium* sp. (fam. Halictidae).

The preliminary results showed also that the insect community registered some differences in the four studied loctions, at the insect category and species levels, despite the fact that all sites were selected to have similarly microtopography conditions.

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