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COLLECTED POLLEN BY THE HONEY BEE (*APIS MELLIFERA* L.)

Zheko Radev

Cosmocert S.A. - Certification Services, Athens, Greece

Abstract: The knowledge of the flora in the area of beekeeping is a main and important point about the productivity of the bee colonies. One of the proposed solutions for good beekeeping practices is knowledge of the floral specialization of *Apis mellifera* L. The bees have visited 51 species of honey plants from 43 genera and 24 families. The honey bees prefer to collect pollen from 5 to 6 plants species during every single month. Bees mainly collect pollen from two or three plant species every month. The agricultural species *Helianthus annuus* and especially *Brassica napus* are the most visited honey plants during their flowering. In July the most visited plant is *Plantago* sp. Bees prefer to collect pollen from 23 honey plants out of 51 visited taxons. Not all plants in the area serve as a source of pollen for the bees. The greatest amount of collected pollen comes from *Brassica napus*- 2539.87 gr. Around 80% of the visited honey plants are common natural as well as about 56.5% of the total amount collected pollen. The visited cultivated honey taxons are around 20% as well as about 43.5% of the total amount collected pollen. The highest number of visited honey species is represented by the family Asteraceae followed by Fabaceae, Rosaceae, Cucurbitaceae. The ecological factors can favor or hamper the development of different plant species. The cultivation of different agricultural crops which occupy large areas, also plays a major role in the pollen preferences of bees.

Keywords: *Apis mellifera* L., flora, honey bee, melissopalynologia, pollen traps, specialization.

INTRODUCTION

The knowledge of the vegetation is of great importance for planning and organize the beekeeping activities in accordance with the seasonal dynamics of the honey resources in a given region (Aires and Freitas, 2001). Research clearly shows the variability in the behavior of honey bees in the selection of flora, which in turn is determined by the disturbed natural balance in nature as a result of human influence (afforestation, felling, monoculture, mechanization, early mowing of a number of crops, pesticide use, etc.); seasons, and even the ratio of plant species flowering in a certain period and the genetic potential of honey bee colonies and their needs (Battaglini and Ricciardelli D'Albore, 1967, 1970). In a research of Raycheva and Radev (2012) on urban condition, over 40% of the collected pollen comes/ originates from native flora. The cultivated agricultural lands could be improved as a source of nectar and pollen for bees, by maintaining the biodiversity of plants in field margins and uncultivated areas (Radev, 2015 I, 2015 II). The grass mixes of blossoming plants for attracting pollinators may be composed of the following plant species: white mustard, phacelia, coriander, alfalfa, wild oats, crimson, Egyptian and white clover (Dimitrov et al., 2018).

According to Taranov (1972) every honey bee colony in the apiary has its favourite plants, from which it mainly collects pollen. The purple colour in the grass mix is provided by Phacelia and mostly attracts honey bees (Dimitrov et al., 2018). Studies carried out by Zherebkin and Mironova (1976), Radev (2018) shows that bees collect pollen primarily from of 5-6 species of plants when there are more than 41 flowering species. The results of the research statements of Maurizio (1953), Percival (1955), Louveaux (1958, 1959), Murrell and Szabo (1981) have established that the bulk of a colony's pollen usually comes from a relatively small number of plant species.

The objective of this study was to investigate the collected pollen by the honey bee (*Apis mellifera* L.) and to determine the most visited plants by honey bees in the area of Belozem.

MATERIALS AND METHODS

Pollen traps were placed in five bee hives and the pollen was harvested every 2 days from April until September 2013 in the area of Belozem (42.201860,25.049330), Bulgaria. The pollen loads from each hive were analysed carefully. Four hundred and sixty samples of the bee-collected pollen were separated with pincette over white sheets, according to colour, shape and texture.

The plant species of each pollen sample was identified through microscopic examination of the grains and weighed on an analytical scale. Melissopalynological analysis was carried out using similar methodology as Louveaux et al. (1978). Each identified pollen sample was placed on a slide with a drop of isoglucose and added fuchsin. The slides were then dried at a temperature not exceeding 40°C and fixed with Entelan™ (Entelan Microscopy, Karlsruhe, Germany). To identify the pollen, the database of the laboratory of Apiculture-Sericulture of the Agricultural school of Aristotle University in Thessaloniki, Greece, and a personally created database of the plants from the study area have been used for reference.

The data for the climatic characteristics of Belozem area for 2013 was taken from the National Institute of Meteorology and Hydrology.

RESULTS AND DISCUSSION

The analyses give that the bees have visited 51 species of honey plants from 43 genera and 24 families (Tables 1-6). Botanical analyses of the collected pollen indicate in the experimental year honey bees preferred to collect pollen from 5 to 6 plant species during each month, while the rest of the flora is less preferable (Tables 1-6). Importantly, bees mainly collect pollen from two or three plant species every month. The use of pollen traps gives precise results

about visited and pollen-giving plants (Dimou, 2006; Radev, 2018). It is made a list of the most visited plant species during the apicultural year (Figure 1). As a result of the conducted research, it can be concluded that bees prefer to collect pollen from 23 honey plants out of 51 visited taxons. According to Stanley and Linskens (1974) not all plants in the same area serve as a source of pollen for bees. Around 80% of the visited honey plants are common natural, while the visited cultivated honey taxons are around 20%.

Table 1. Amount collected and identified pollen (gr) in April 2013

Bee colony (№) →	Amount collected and identified pollen of each bee colony (gr)					Total amount of the collected and identified pollen from the bees (gr)
	№1	№2	№3	№4	№5	
Plant species						
<i>Brassica napus</i>	259.65	179.10	192.89	106.38	365.15	1103.17
<i>Salix</i> sp.	82.56	52.88	75.66	103.8	176.17	491.07
<i>Prunus cerasifera</i>	67.34	75.01	77.45	44.44	72.72	336.96
<i>Purus malus</i>	20.03	20.80	146.24	1.06	19.70	207.83
<i>Persica vulgaris</i>	35.69	15.83	5.52	6.31	61.97	125.53
<i>Lamium purpureum</i>	6.12	18.92	26.37	5.54	53.30	110.25
<i>Cornus mas</i>	39.57	50.55	0.40	12.64	1.79	104.59
<i>Cornus sanguinea</i>	0.84	96.58		0.14	0.34	97.90
<i>Morus nigra</i>	10.05	15.40	11.71	11.74	3.97	53.32
<i>Taraxacum officinale</i>	7.25	1.15	5.53	2.52	28.21	44.66
<i>Juglans regia</i>	14.61	16.92	1.33	4.88	1.20	38.94
<i>Asphodelus</i> sp.	0.51	0.30	3.62	0.30	4.77	9.50
<i>Veronica longifolia</i>	1.38	3.02	1.10	2.46	0.90	8.86
<i>Brassica nigra</i>	0.22	0.26	6.13	0.54	0.38	7.53

Table 2. Amount collected and identified pollen (gr) in May 2013

Bee colony (№) →	Amount collected and identified pollen of each bee colony (gr)					Total amount of the collected and identified pollen from the bees (gr)
	№1	№2	№3	№4	№5	
Plant species						
<i>Brassica napus</i>	147.38	111.76	227.33	215.62	276.76	978.85
<i>Papaver rhoeas</i>	144.36	45.17	201.4	148.94	158.00	697.87
<i>Amorfa fruticosa</i>	49.41	67.84	178.66	37.20	141.43	474.54
<i>Rosa canina</i>	36.12	5.39	23.58	6.50	4.33	75.92
<i>Trifolium dalmaticum</i>	18.41	1.81	32.30	13.74	3.39	69.65
<i>Robinia pseudoacacia</i>	8.29	4.77	23.79	3.23	2.95	43.03

Bee colony (№) →	Amount collected and identified pollen of each bee colony (gr)					Total amount of the collected and identified pollen from the bees (gr)
	№1	№2	№3	№4	№5	
Plant species						
<i>Pyrus malus</i>	4.41	2.87	24.06	1.56	2.03	35.47
<i>Plantago</i> sp.	0.89	3.04	0.48	7.43	12.46	24.30
<i>Coriandrum sativum</i>	2.69	1.48	9.39	2.22	4.18	19.96
<i>Brassica nigra</i>	0.99	0.26	8.73	1.55	0.49	12.02
<i>Ranunculus</i> sp.	0.40	0.56	0.28	1.92	6.30	9.46
<i>Vicia</i> sp.	0.10	2.05	2.22	3.45	0.77	8.59
<i>Juglans regia</i>	3.68	1.26	0.42	0.99		5.21
<i>Convolvulus arvensis</i>	0.80		1.53	0.70	0.98	4.01
<i>Morus nigra</i>	0.37	0.37	0.39	0.38	0.32	1.83
<i>Trifolium repens</i>			1.42	0.10		1.52
<i>Salix</i> sp.		0.08		0.12	0.10	1.02
<i>Centaurea cyanus</i>	0.09		0.50	0.05		0.64
<i>Crepis</i> sp.		0.05			0.44	0.49

Table 3. Amount collected and identified pollen (gr) in June 2013

Bee colony (№) →	Amount collected and identified pollen of each bee colony (gr)					Total amount of the collected and identified pollen from the bees (gr)
	№1	№2	№3	№4	№5	
Plant species						
<i>Helianthus annuus</i>	152.75	91.73	137.15	29.58	175.23	586.44
<i>Papaver rhoeas</i>	74.46	5.85	117.87	17.65	49.79	265.62
<i>Plantago</i> sp.	35.47	17.99	35.42	79.97	57.98	226.83
<i>Tilia</i> sp.	33.38	11.35	1.40	1.28	19.16	66.57
<i>Coriandrum sativum</i>	5.44	5.85	13.94	4.48	11.28	40.99
<i>Cirsium</i> sp.	30.41	0.10	0.62	0.57	0.98	32.68
<i>Convolvulus arvensis</i>	2.69	0.22	23.03	2.97	1.47	30.38
<i>Trifolium dalmaticum</i>	5.87	2.51	15.27	1.04	4.40	29.09
<i>Crepis</i> sp.	2.06	0.11	8.62	0.08	9.38	20.25
<i>Cucumis melo</i>	1.32	0.46	7.60		0.43	9.81
<i>Amorfa fruticosa</i>	0.38		1.21	0.03	2.89	4.51
<i>Carduus</i> sp.	3.80	0.39		0.07	0.07	4.33
<i>Verbascum</i> sp.			2.85		0.61	3.46
<i>Melilotus officinalis</i>	0.09	0.10	0.39	2.14	0.22	2.94
<i>Brassica napus</i>	0.11		0.58		2.20	2.89
<i>Zea mays</i>	0.03	1.37		0.38	0.71	2.49

Bee colony (№) →	Amount collected and identified pollen of each bee colony (gr)					Total amount of the collected and identified pollen from the bees (gr)
	№1	№2	№3	№4	№5	
Plant species						
<i>Citrullus lanatus</i>			1.21		0.06	1.27
<i>Centaurea cyanus</i>	0.51	0.05	0.15	0.09	0.16	0.96
<i>Ranunculus</i> sp.	0.34			0.16	0.30	0.80
<i>Vicia</i> sp.		0.29	0.46			0.75
<i>Cichorium intybus</i>	0.16		0.20	0.21	0.11	0.68
<i>Cucumis sativus</i>		0.61				0.61
<i>Brassica nigra</i>			0.35			0.35
<i>Amaranthus retroflexus</i>	0.11				0.17	0.28

Table 4. Amount collected and identified pollen (gr) in July 2013

Bee colony (№) →	Amount collected and identified pollen of each bee colony (gr)					Total amount of the collected and identified pollen from the bees (gr)
	№1	№2	№3	№4	№5	
Plant species						
<i>Plantago</i> sp.	187.35	101.56	48.16	159.64	158.18	654.89
<i>Helianthus annuus</i>	97.79	109.73	120.08	34.68	126.82	489.10
<i>Citrullus lanatus</i>	164.10			5.81	73.32	243.23
<i>Centaurea solstitialis</i>	72.85	28.49	37.26	2.89	30.25	171.74
<i>Centaurea</i> sp.	1.29		89.83	16.34	63.6	171.06
<i>Zea mays</i>	47.63	32.02	2.57	13.9	19.20	115.32
<i>Verbascum</i> sp.		1.37	86.01	10.04	13.36	110.78
<i>Convolvulus arvensis</i>	11.57	4.45	6.15	7.46	48.73	78.06
<i>Carduus</i> sp.	54.48	4.45	0.64	8.33	0.34	68.24
<i>Crepis</i> sp.	10.21	2.49	2.29	2.3	41.44	58.73
<i>Cirsium</i> sp.	22.82	12.15	0.88	9.75	7.14	52.74
<i>Centaurea calcitrapa</i>	19.43	14.54	1.50	4.85	6.29	46.61
<i>Portulaca grandiflora</i>	23.61	6.85	0.33	3.76	2.93	37.48
<i>Trifolium dalmaticum</i>	21.93	4.22	0.24	7.89	0.32	34.60
<i>Amaranthus retroflexus</i>	18.43	0.13	9.93	0.78	0.07	32.28
<i>Lythrum salicaria</i>	3.14	16.05		0.15		19.34
<i>Melilotus officinalis</i>	5.39	2.04	0.25	0.74	1.73	10.15
<i>Cichorium intybus</i>	0.09	2.71	6.20	0.12	0.21	9.33
<i>Eryngium campestre</i>	3.65	0.62	0.98	2.53	0.71	8.49
<i>Brassica napus</i>	4.42	1.37	0.30	0.76	0.12	6.97
<i>Melilotus sativus</i>	1.61	0.39	4.39		0.11	6.50
<i>Papaver rhoeas</i>	0.92		0.59		0.19	1.70

Bee colony (№) →	Amount collected and identified pollen of each bee colony (gr)					Total amount of the collected and identified pollen from the bees (gr)
	№1	№2	№3	№4	№5	
<i>Cucumis sativus</i>	0.28		0.13	0.41	0.04	0.86

Table 5. Amount collected and identified pollen (gr) in August 2013

Bee colony (№) →	Amount collected and identified pollen of each bee colony (gr)					Total amount of the collected and identified pollen from the bees (gr)
	№1	№2	№3	№4	№5	
<i>Brassica napus</i>	80.11	68.88	39.33	31.21	73.64	293.17
<i>Centaurea solstitialis</i>	118.67	19.85	51.02	13.02	73.04	275.6
<i>Convolvulus arvensis</i>	5.60	39.99	41.25	15.07	99.43	201.34
<i>Cirsium</i> sp.	30.68	32.12	6.76	2.82	13.82	86.20
<i>Centaurea</i> sp.		0.77	19.92	0.18	19.14	40.01
<i>Portulaca grandiflora</i>	9.60	7.78	3.73	16.02	2.39	39.52
<i>Dipsacus</i> sp.	14.63	3.91	4.21	1.82	12.74	37.31
<i>Carduus</i> sp.	3.30	2.50	19.06	0.93	1.10	26.89
<i>Centaurea calcitrapa</i>	4.05	3.28	1.86	10.35	6.47	26.01
<i>Helianthus annuus</i>	4.58	10.39	3.30	3.73	3.94	25.94
<i>Chondrilla juncea</i>	2.78	0.69	12.43	0.76	2.34	19.00
<i>Atriplex patula</i>	1.02	6.51	0.10	1.12	3.99	12.74
<i>Chenopodium</i> sp.	7.03	0.29	1.17	0.22		8.71
<i>Cichorium intybus</i>	1.58	0.45	5.82	0.13	0.35	8.33
<i>Plantago</i> sp.	0.68	4.37	1.50	1.01	0.36	7.92
<i>Zea mays</i>		0.78		7.14		7.92
<i>Trifolium dalmaticum</i>	4.98	0.85	0.04	0.36	0.07	6.30
<i>Verbascum</i> sp.		0.15	4.41	0.08	0.22	4.86
<i>Vicia</i> sp.	1.94					1.94
<i>Cucumis sativus</i>	0.27	0.52	0.16	0.4	0.18	1.53
<i>Citrullus lanatus</i>	0.98				0.38	1.36
<i>Crepis</i> sp.	0.07	0.27	0.62		0.11	1.07
<i>Melilotus officinalis</i>			0.23	0.26		0.49
<i>Ehinops ritro</i>	0.24			0.09		0.33

Table 6. Amount collected and identified pollen (gr) in September 2013

Bee colony (№) →	Amount collected and identified pollen of each bee colony (gr)					Total amount of the collected and identified pollen from the bees (gr)
	№1	№2	№3	№4	№5	
Plant species						
<i>Brassica napus</i>	5.28	34.94	32.8	25.49	56.31	154.82
<i>Centaurea solstitialis</i>	32.8	7.56	11.15	6.63	21.86	80.00
<i>Cirsium</i> sp.	6.13	15.94	1.35	4.23	6.17	33.82
<i>Convolvulus arvensis</i>	0.53	0.10	2.01	0.45	16.93	20.02
<i>Chondrilla juncea</i>	2.44	0.69	10.58	0.96	1.28	15.95
<i>Portulaca grandiflora</i>	1.19	1.62	0.80	2.80	0.35	6.76
<i>Carduus</i> sp.	0.25	0.61	4.75	0.13	0.75	6.49
<i>Dipsacus</i> sp.	3.10	0.99	0.19	0.73	1.19	6.20
<i>Centaurea calcitrapa</i>	1.43	0.55	0.87	1.16	1.39	5.40
<i>Chenopodium</i> sp.	1.81	0.57	1.49	0.03	0.07	3.97
<i>Atriplex patula</i>	0.57	1.92	0.07	0.81		3.37
<i>Ehinops ritro</i>	2.67	0.04		0.04	0.61	3.36
<i>Cichorium intybus</i>	0.10	0.16	1.77	0.07	0.94	3.04
<i>Cucumis sativus</i>	0.05	0.20	0.10	0.24	0.13	0.72
<i>Centaurea</i> sp.		0.04		0.35		0.39
<i>Lithrum salicaria</i>	0.04	0.11	0.09	0.12		0.36

The result coincides with previous research on urban environment by Radev and Gospodinova (2015) in the village of Saedinie (Bulgaria) which found the same distribution, and Radev (2015 II) in the village of Topchii (Bulgaria) who established that 85% of the visited taxons were natural and 15% were cultivated. Research by Raycheva and Radev (2012), Radev and Gospodinova (2015), Radev (2015 I, 2015 II), also establish the family Asteraceae as the one with the highest number of visited taxons. The weed and meadow flora 80% of the visited taxons provide a great diversity of pollen with different nutritive value, needed for the normal development of the bee colonies. This shows the need for the existence and preservation of uncultivated plants as a source of food for bees (Raycheva and Radev, 2012).

In the summer period, bees visit most taxons. The agricultural species *Helianthus annuus* (Figure 1/ Table 3) and especially *Brassica napus* (Figure 1/ Tables 1, 2, 5, 6) are the most visited honey plants during their flowering, according to the data collected in this study. In July, the most visited plant is *Plantago* sp. (Figure 1/ Table 4). The meadow and the weed flora are represented by many honey plant species whose pollen diversifies the diet of honey bees. The highest number of honey species is represented by the family Asteraceae (12 species) followed by Fabaceae (7 species). Rosaceae (4 types), Cucurbitaceae (3 types), Apiaceae (2 taxons), Brasicaceae (2 types), Chenopodiaceae (2 taxons), Cornaceae (2 species), Scrophulariaceae (2 types) and fifteen other families are represented by one kind (Tables 1-6). According to Radev and Raycheva (2012) the taxonomic structure of vascular honey plants in the survey area includes 133 species, which means that not all plants in the area are visited and used as a source of pollen by bees.

The total amount of collected pollen by the colonies is 10446.83 gr. The greatest amount of collected pollen comes from *Brassica napus*- 2539.87 gr, followed by: *Helianthus annuus*- 1101.48 gr, *Papaver rhoeas*- 965.19 gr, *Plantago sp.*- 913.94 gr, *Centaurea solstitialis*- 527.34 gr, *Salix sp.*- 492.09 gr, *Amorfa fruticosa*- 479.05 gr, *Prunus cerasifera*- 336.96 gr, *Convolvulus arvensis*- 333.81 gr, *Citrullus lanatus*- 245.86 gr, *Pyrus malus*- 243.3 gr, *Centaurea sp.*- 211.46 gr, *Cirsium sp.*- 205.44 gr, *Trifolium dalmaticum*- 139.64 gr, *Zea mays*- 125.73 gr, *Persica vulgaris*- 125.53 gr, *Lamium purpureum*- 110.25 gr, *Cornus mas*- 104.59 gr, *Carduus sp.*- 101.62 gr, *Portulaca grandiflora*- 83.76 gr, *Centaurea calcitrapa*- 78.02 gr, *Rosa canina*- 75.92 gr, *Tilia sp.*- 66.57 gr, *Coriandrum sativum*- 60.95 gr, *Robinia pseudoacacia*- 43.03 gr, *Chondrilla juncea*- 34.95 gr, etc. (Tables 1-6).

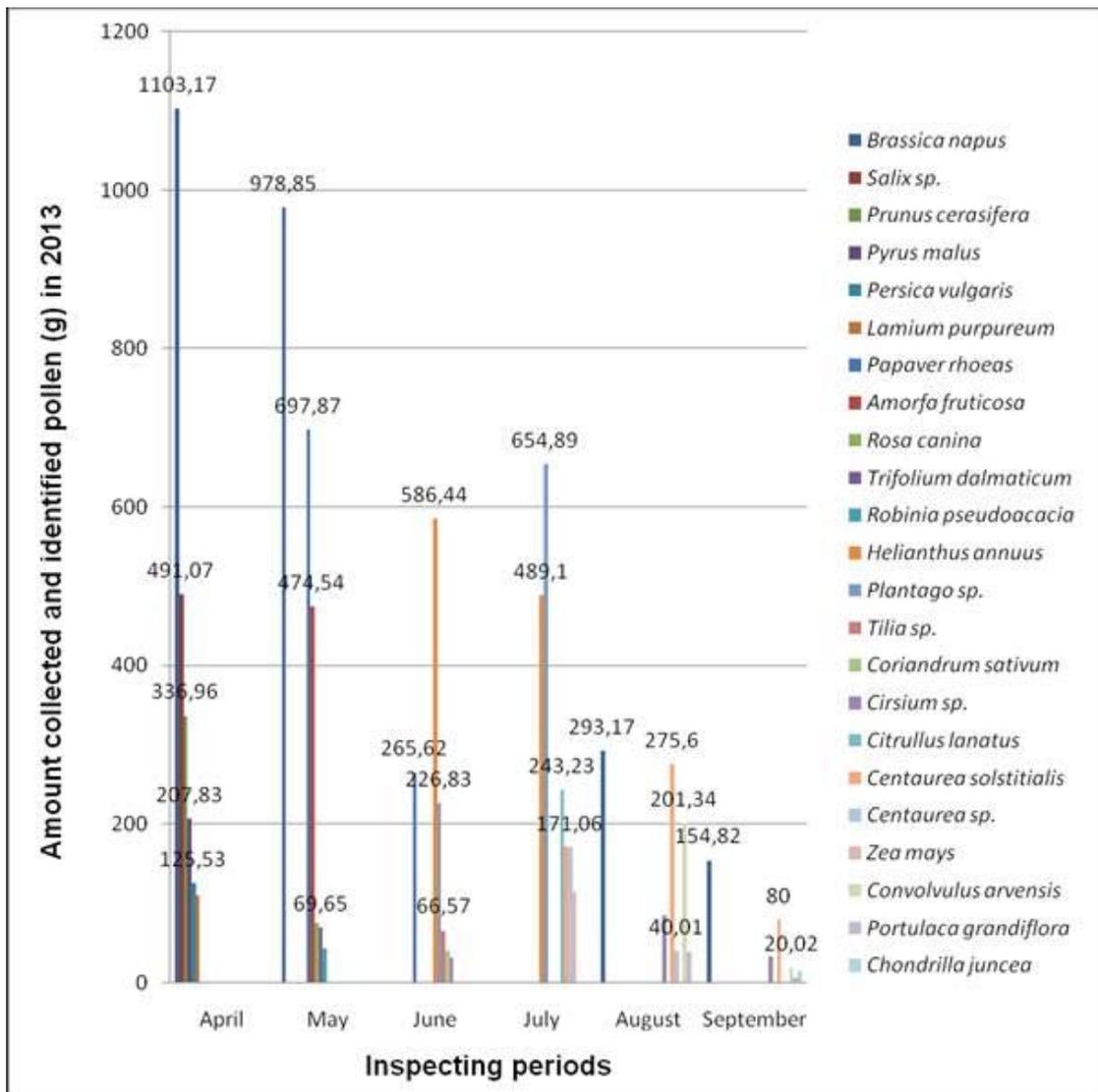


Figure 1. Amount collected and identified pollen (gr) in 2013

The collected pollen from natural taxons is 5906.82 gr, about 56.5% of the total amount, while the pollen from cultivated honey plants is 4540.01 gr, about 43.5%. The amount of pollen that the bees collect depends on the population of the certain plants that bees visit. We have to take into account the differences in the discoveries of bees-scouts, when searching for new crops, flower type, the number of flowers, bees' direct access pass, the distance to the hives,

ecological factors and etc. When flowering introduced agricultural plants, bees collect most of them pollen, depend on the climate condition (Radev, 2018).

By using the data shown in Figure 1 we can observe the underlying dynamics of the visited flora. This may be due to the climate dynamics which varies every year, the ecological factors- rain, temperature and humidity (Figure 2). The annual dynamics of the above-mentioned factors can be observed in Figure 2. The dynamic rainfall leads to increasing the moisture content of the soil and as a result it influences the flowering intensity of a great number of plants. There were no days with rainfall during mid April till first decade of June, while the summer months June, July and August (Figure 2) there were days with rainfall. The ecological factors can favor or hamper the development of different plant species. The phenology of honey flora flowering is directly dependent on the climatic characteristics of the geographical area (Fukushima-Hein et al., 1986; Moreti, 1992). The urban environment in the area of the experimental study, the anthropogenic factor, the cultivation of different agricultural crops which occupy a large area in the urban environment, also play a major role in pollen preferences of bees.

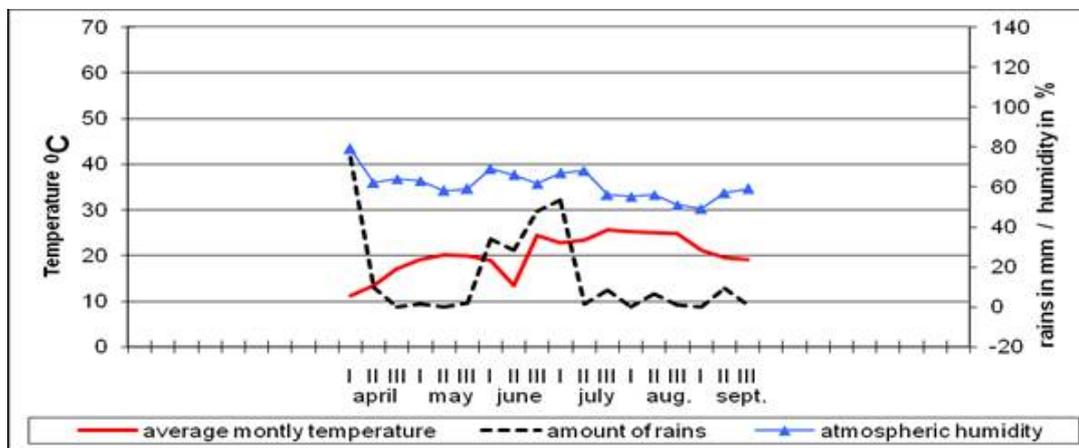


Figure 2. Climatic characteristics of Belozem area for 2013

CONCLUSION

The bees have visited 51 species of honey plants from 43 genera and 24 families. The honey bees preferred to collect pollen from 5 to 6 plants species during each month. The bees mainly collect pollen from two or three plant species every month. The agricultural species *Helianthus annuus* and especially *Brassica napus* are the most visited honey plants during their flowering. In July the most visited plant is *Plantago* sp. The bees prefer to collect pollen from 23 honey plants out of 51 visited taxons. Not all plants in the area serve as a source of pollen for the bees. The greatest amount of collected pollen comes from *Brassica napus*- 2539.87 gr. Around 80% of the visited honey plants are common natural and about 56.5% of the total amount collected pollen, while the visited cultivated honey taxons are around 20% and about 43.5% of the total amount collected pollen. The highest number of visited honey species is represented by the family Asteraceae followed by Fabaceae, Rosaceae, Cucurbitaceae.

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