

DEGREE OF UTILIZATION OF POTENTIAL SUGAR YIELD OF A RAPESEED PLANTATION BY INSECTS IN RESPECT OF RAPESEED HONEY YIELD IN AN APIARY

Z b i g n i e w K o ł t o w s k i

Research Institute of Pomology and Floriculture, Apiculture Division, ul. Kazimierska 2, 24-100 Puławy, Poland; E-mail: zbigniew.koltowski@man.pulawy.pl

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S u m m a r y

In the years 2002-2004, plantations of rapeseed were investigated for their sugar potential, intensity of visitation by pollinating insects and a degree of utilization of their nectar flow by insects. In addition, an assessment was carried out for rapeseed honey yield in apiaries adjacent to rapeseed plantations.

The research demonstrated that on production plantations examined, winter rapeseed burst into blossom in the last week of April or in the first week of May and its blooming season spanned 3 to 4 weeks on average. On those plantations, plants were observed to grow 149 cm in height on average, whereas at particular plantations their height ranged from 129 to 187 cm. On average, there were 72 plants per 1 m² (range from 32 to 121), that had an average number of 7 branches (from 5 to 7). Abundance of blooming reached 10,300 flowers on average, at fluctuations ranging from 6,500 to over 14,000 flowers. On all plantations, nectar secretion of the plants was very good and reached 10.47 mg of sugar per 10 flowers on average (range: from 6.44 to 13.76 mg). The mean sugar potential of a plantation accounted for ca. 105 kg of sugars per 1 ha, with a minimum of 42.4 kg and a maximum of 156.1 kg. The intensity of flower visitation by honeybees ranged from 7 to 28 working bees per 10 m² of plantation and was not affected by the size of plantation, the sugar potential of a cultivar or by the number of bee colonies per 1 ha. In turn, the intensity of foraging was found to influence the degree of nectar utilization by bees and accounted on average for nearly 82%, fluctuating between 76 and 93%. In the surveyed apiaries, even in those standing in the proximity of the same plantation, the mean yield of rapeseed honey from one colony varied significantly from 0 to 27 kg. This clearly indicates that the sugar potential of rapeseed does not determine the yield of honey in an apiary.

Keywords: rapeseed, nectar secretion, sugar potential, foraging intensity, honey yield

INTRODUCTION

Winter rapeseed *Brassica napus* L. subsp. *napus* is counted amongst industrial crops and cultivated throughout Poland mainly for seed harvest. Its seeds are also used in the production of oil for consumption purposes and for the production of biofuels. For consumption purposes, use is only made of oil with low contents of erucic acids and glucosinolates, and

cultivars suitable for oil pressing are referred to as low erucic or double-improved. For a number of years, honeybees have been utilizing nectar and pollen flow from rapeseed plantations and, due to its abundance, beekeepers were collecting unifloral honey from that crop. With the introduction of double-improved cultivars, beekeepers have reported an inability to collect rapeseed honey because the new cultivars did not secrete nectar. Ample investigations

have shown, however, that the recently introduced cultivars of rapeseed demonstrate nectar secretion at a level similar to that reported for the old high-erucic cultivars (Jabłoński et al. 1985, Kołtowski 2001, 2002). However, these studies were carried out on small experimental plots, the results of which cannot be always referred to large commercial plantations. Although cultivar-specific traits of plants are re-occurring, the specificity of large areas has a great impact on the degree of nectar flow utilization by bees in particular. In the previous plot investigations on nectar secretion by rapeseed flowers, attempts were made to collect nectar from non-isolated flowers. Nevertheless, on small areas, bees were capable of collecting nectar systematically and even if some samples were collected, they represented minimal amounts that were insufficient even for the determination of sugar concentrations in the sample.

The process of nectar secretion by flowers of rapeseed has been extensively explored to date. All studies emphasized the medium nectar potential and high pollen potential of this species and, consequently, its high beekeeping value (Maksymiuk 1958, Demianowicz 1968, Bobrzecka and Bobrzecki 1973, Kamler 1980, 1984, Kubishova et al. 1980, Jabłoński et al. 1985, Mesquida et al. 1988, Mohr and Jay 1990, Pierre et al. 1999, Hedtke 2000). In addition, research has always confirmed the high attractiveness of rapeseed flowers to insects (among others, Westcott and Nelson 2001). Bees have been observed to visit its flower very eagerly even knowing that they may expect nectar only on the middle nectaries, at the inner side of the base of two opposite short stamens. The lateral nectaries, outside the long stamens, are visited by them sporadically as if they knew there would be no nectar there (Free 1993).

Benedek (1974) reports that winter rapeseed that begins its blooming season at the turn of April and May constitutes a good source of nectar flow, to 4 bee colonies per 1 ha on average, for the period of ca. 4-5 weeks. Hence, the reason for poor rapeseed honey harvest should be sought in an excessively high density of bee colonies in plantations, referred to as the phenomenon of overdensity of bees. It should also not be overlooked that the process of nectar secretion by flowers, as well as efficiency of its foraging by bees, are determined by weather conditions likely to be highly variable in the blooming season.

Therefore, a decision was taken to establish an experiment on production plantations that were foraging sites to bees that collect nectar and store it as honey. In addition, where possible, sugar potential calculated based on the number of flowers and abundance of their nectar secretion was confronted with real yields of rapeseed honey in an apiary.

MATERIAL AND METHODS

Typical commercial plantations of winter rapeseed in the closest proximity to the Apiculture Division, Institute of Pomology and Floriculture in Puławy, were selected for the study. They all were located within 45 km of Puławy. In 2002, an evaluation was carried out for 12 plantations of winter rapeseed in sizes ranging from 5 to 80 ha, in 2003 experiments were carried out only on two 5-ha plantations of spring rapeseed because all winter rapeseed had been destroyed by winter frost, whereas in 2004 analyses were conducted on 8 plantations of winter rapeseed in sizes from 2 to 55 ha. A detailed list of plantations is provided in Table 1.

On the surveyed plantations, measurements of nectar secretion by plants were carried out with the pipette method (Jabłoński 2002, 2003). To this end, whole inflorescences were isolated for 2-3

days by tulle air-permeable bags. Flowers were then collected on the second day of life, since the total portion of nectar is secreted by that time (Demianowicz 1968, Jabłoński et al. 1985). Nectar was collected with micropipettes, weighed and determined for the content of sugars with the refractometric method using an Abbe refractometer. For each cultivar examined in a given day, 3 samples of nectar were collected, each of 10 flowers. Evaluation of nectar secretion by flowers of particular cultivars was conducted over at least 6 days in the blooming season of rapeseed. This allowed the collection of the results of mean contents of sugars secreted by flowers of particular cultivars.

In the first year of study, according to the above-described methodology, nectar was also collected from the non-isolated plants. Nectar was collected on the same days as for the isolated plants, three times for each plantation in the blooming season. The material was to be used for determination of the degree of utilization of nectar from rapeseed flowers of commercial plantations by bees.

In the blooming season, observations were also carried out for the intensity of visitation of flowers of the examined rapeseed cultivars by pollinating insects. To this end, an observation plot 1 m in width and 32 m in length was delimited on each plantation, at which inspections were carried out alongside in the noon hours (between 11 a.m. and 2 p.m.) in good weather to count all bees working on flowers. Amongst the observed insects there were basic groups of pollinating insects discriminated under climatic conditions of Poland, i.e. honeybees, solitary bees, bumble bees and flies. The counting of insects was performed three times a day in 30-min intervals. There were at least five days of experimental observations for each cultivar in the blooming season of rapeseed. This enabled determining the mean density of for-

aging honeybees per 10 m² of plantation, under conditions favorable to visitations in the full blooming season.

Once rapeseed gained technological maturity, 3 samples of plants were collected from the area of 1 m² of each plantation. Each sample was determined for the number of plants and each plant – for the number of branches, number of developed siliques and the number of peduncles. This enabled calculating the number of flowers per 1 m² for each plantation, which was then used to calculate the number of flowers per 1 ha. The height of plants of each sample was measured as well.

Where possible, contacts were established with beekeepers who had their apiaries in the direct proximity of the rapeseed crops. A questionnaire was elaborated in which beekeepers, apart from detailed apicultural data on their colonies utilizing rapeseed nectar flow, were to provide a reliable answer on the mean amount of rapeseed honey extracted from 1 colony. This was an attempt to elucidate the causes and circumstances of a lack of rapeseed honey yield in some apiaries. Nowadays the beekeepers often complained that the new, currently-grown cultivars of rapeseed are characterized by poor nectar secretion.

RESULTS

Due to a completely different collation of experimental units in particular years, i.e. plantations of rapeseed at various locations, with different sizes and covering a different set of cultivars, the experimental results should be considered for each year separately. In 2002, on the 12 surveyed plantations, there were 8 different cultivars of winter rapeseed grown, as listed in Table 1. All, except for the 5-ha plantation No. 8 on a field in Osiny, had sizes greater than 10 ha, which made them a potential source of commercial nectar flow of rapeseed. The size of the greatest plantation reached 80 ha (No. 12), whereas that of the others ranged

Table 1

Blooming season and area size of the surveyed rapeseed plantation in the proximity of Puławy in the years 2002-2004.

Plantation No.	City	Cultivar	Size in ha	Onset of blooming	End of blooming
Year 2002 – winter cultivars					
1	Niezabitów	Lirajet	28	23 of April	19 of May
2	Osiny – station	Contact	26	26 of April	15 of May
3	Wysokie Koło	Kana	20	29 of April	13 of May
4	Kępa	Capio	11	29 of April	16 of May
5	Klikawa	Votan	22	29 of April	19 of May
6	Palikuje	Kaszub *	30	30 of April	20 of May
7	Bełżyce	Lirajet	25	30 of April	20 of May
8	Osiny – field	Lisek	5	1 of May	17 of May
9	Klikawa	Liropa	22	1 of May	19 of May
10	Sadłowice	Lisek+Lirajet	14	1 of May	20 of May
11	Borowina	Lisek	13	2 of May	23 of May
12	Końskowola	Lisek	80	2 of May	23 of May
Year 2003 – spring cultivars (all winter cultivars were destroyed by winter frost)					
13	Osiny – field	Jura *	5	11 of June	6 of July
14	Osiny – field	Licosmos	5	11 of June	6 of July
Year 2004 – winter cultivars					
15	Osiny – field	Californium	5	30 of April	21 of May
16	Żyrzyn	Carina	2	2 of May	21 of May
17	Osiny – station	Carina	14	3 of May	25 of May
18	Kępa	Californium	15	4 of May	26 of May
19	Sobieszyn	Batory	7	4 of May	28 of May
20	Matygi	Lisek	13	4 of May	29 of May
21	Klikawa	Lirajet	44	4 of May	31 of May
22	Skowieszyn	Lisek	52	4 of May	1 of June

* - hybrid composite cultivars

from 11 to 30 ha (Table 1). In 2003, all plantations of winter rapeseed in the region of Lubelszczyzna were destroyed by winter frost, hence we were able to evaluate only

two small plantations of spring rapeseed established after liquidation of the winter plantations. In turn, in 2004, the assessments covered 8 plantations of winter rape-

seed with sizes ranging from 2 to 52 ha and 5 different cultivars grown therein.

The evaluated rapeseed plantations were highly diversified in terms of blooming. In 2002 they were observed to begin blooming from the 23rd of April till the 2nd of May. Their blooming season spanned a very short period, ca. 20 days on average, yet definitely the shortest stage of blooming was reported for plantation No. 3 in Wysokie Koło – 14 days, whereas the longest one was for the plantation No. 1 in Niezabitów – 26 days (Table 1). In 2004, the investigated plantations of winter rapeseed burst into blossom slightly later, from the 30th of April till the 4th of May, and ended their blooming between the 20th of May and the 1st of June. For all plantations, the blooming season lasted for 24 days on average, and for individual plantations it ranged from 19 to 28 days. In 2003, spring rapeseed burst into blossom on the 11th of June and ended blooming on the 6th of July, hence its blooming season spanned 26 days.

Evaluation of the conditions of rapeseed plantations

Depending on habitat conditions, the course of weather and the cultivation treatments used by planters, the examined plantations were in highly diversified condition. In the first year of the study, the plants reached, on average, from 125 to 154 cm in height. It should be emphasized that the smallest plants were observed on plantations No. 11, 10 and 1, and the highest ones on plantation No. 7 (Table 2). Plant density per area size unit accounted for almost 83 plants per 1 m² on average and ranged from 56.3 (plantation No. 7) to 121.3 (plantation No. 3). The number of branches on a plant ranged from 5.3 and 5.4 on plantations No. 12 and 13 with the highest plant density to 7.2 on plantation No. 2, which, surprisingly, also had one of the highest plant densities. Taking into account all

plantations, the plants had over 6 branches on average. From the viewpoint of beekeeping value, the most significant, however, is the blooming abundance of a plantation, which in 2002 reached ca. 11,000 flowers per 1 m² on average. In terms of that trait, the poorest appeared to be plantation No. 10, which produced as few as 6,500 flowers per 1 m² on average, which was only half the number noted on six of the 12 examined plantations. The highest number of flowers per 1 m² (14,300) was recorded on plantation No. 12.

In 2003, plants of spring rapeseed (plantations No. 13 and 14) grew at the height of ca. 131 and 154 cm on average. Due to the relatively low plant density, which accounted for nearly 51 and 32 plants per 1 m², they were high ramose, i.e. 9.8 and 10.8 branches. Both plantations examined had a similar number of flowers per 1 m², i.e. ca. 8,500.

In the year 2004, plants of rapeseed were higher as compared to the year 2002. The mean height of plants for all plantations reached 158.8 cm and ranged from 136.1 (plantation No. 19) to 187 cm (plantation No. 18). The number of plants growing on 1 m² fluctuated between 38 and 115.3, yet a high plant density was only observed on plantations No. 19 and 17. The number of branches per plant oscillated around 7-8, however, on plantation No. 19 it was substantially lower and reached 5. In contrast, the highest number of branches per plant (almost 11) was reported on plantation No. 22. In that year of study, the abundance of blooming of the analyzed plantations was lower as compared to 2002 and accounted for slightly over 9,500 flowers per 1 m² on average. The lowest number of flowers per area size unit, namely ca. 8,000, was observed on plantations No. 15 and 16, whereas the highest one, i.e. 11,800 of flowers per 1 m², on plantation No. 21.

Table 2

Shape of plants and abundance of blooming on the surveyed plantations of rapeseed in the proximity of Puławy in the years 2002-2004.

Plantation No.	Cultivar	Number of plants per 1 m ²	Number of branches per plant	Plant height in cm	Number of flowers per 1 m ²
Year 2002 – winter cultivars					
1	Lirajet	80.7	5.6	136.3	8,161
2	Contact	106.0	7.2	146.2	13,051
3	Kana	121.3	5.4	145.5	9,397
4	Capio	65.7	7.0	148.7	13,650
5	Votan	90.7	6.7	142.4	12,593
6	Kaszub *	70.3	7.1	149.8	13,790
7	Lirajet	56.3	6.2	154.0	8,991
8	Lisek	77.3	5.3	145.5	9,560
9	Liropa	79.0	6.8	150.8	12,520
10	Lisek+Lirajet	59.0	6.3	129.2	6,576
11	Lisek	74.0	6.1	125.6	10,002
12	Lisek	115.0	5.3	140.5	14,300
Mean		82.9	6.3	142.9	11,049
Year 2003 – spring cultivars					
13	Jura *	50.7	8.8	131.2	8,649
14	Licosmos	32.0	10.8	154.3	8,734
Mean		41.3	9.8	142.7	8,691
Year 2004 – winter cultivars					
15	Californium	70.7	6.8	143.9	8,048
16	Carina	46.3	7.6	166.7	7,889
17	Carina	94.0	7.0	143.4	9,978
18	Californium	38.0	8.0	187.0	10,896
19	Batory	115.3	5.0	136.1	8,735
20	Lisek	46.0	7.7	158.4	9,380
21	Lirajet	48.3	7.7	165.0	11,821
22	Lisek	45.0	10.9	170.2	10,085
Mean		63.0	7.6	158.8	9,604

* - hybrid composite cultivars

Table 3

Sugar potential of rapeseed plantations, their bee colony density and intensity of flower visitations by honeybee workers.

Plantation No.	Cultivar	Mass of sugars per 10 flowers in mg	Sugar potential of plantations in kg/ha	Number of bee colonies per plantation	Number of bee colonies per 1 ha	Foraging bee density per 10 m ²
Year 2002 – winter cultivars						
1	Lirajet	9.33	76.1	-	-	9.9
2	Contact	11.43	149.2	91	3.5	7.3
3	Kana	8.74	82.2	80	4.0	14.4
4	Capio	7.56	103.2	29	2.6	19.1
5	Votan	12.40	156.1	53	2.4	15.1
6	Kaszub *	11.24	95.0	-	-	8.4
7	Lirajet	11.13	100.1	17	0.7	11.3
8	Lisek	8.25	78.8	18	3.5	8.1
9	Liropa	12.06	151.0	52	2.4	8.4
10	Lisek+Lirajet	6.44	42.4	23	1.6	15.0
11	Lisek	9.21	92.1	-	-	8.8
12	Lisek	10.88	155.7	180	2.2	18.6
Year 2003 – spring cultivars						
13	Jura *	8.68	43.6	-	-	15.4
14	Licosmos	12.11	105.7	-	-	22.1
Year 2004 – winter cultivars						
15	Californium	8.92	88.9	-	-	15.4
16	Carina	10.79	84.8	-	-	28.2
17	Carina	11.14	89.6	-	-	8.7
18	Californium	10.65	116.7	-	-	21.7
19	Batory	13.76	120.3	28	4.0	16.3
20	Lisek	10.77	101.2	-	-	25.1
21	Lirajet	12.14	143.3	-	-	13.6
22	Lisek	12.62	127.2	-	-	11.0
Mean		10.47	104.7	-	-	14.6

* - hybrid composite cultivars

Evaluation of the intensity of nectar secretion by flowers and their foraging by bees

On most of the inspected plantations nectar secretion was very good. The mass of sugars per 10 flowers reached 10.47 mg for all plantations on average (Table 3). The lowest content of sugars in nectar was secreted by flowers from plantation No. 10 – as little as 6.44 mg, whereas the highest one by those from plantation No. 19 – as many as 13.76 mg. In respect to that characteristic, the other plantations were within a range from 7.56 mg to 12.62 mg. It should be emphasized, however, that in the case of hybrid cultivars („Kaszub” on plantation No. 6 and „Jura” on plantation No. 13), the results referred to nectar secretion of normal, bisexual flowers, the percentage of which in such cultivars fluctuates at a level of 30%. The other 70% include male-sterile flowers that do not produce pollen and, simultaneously are characterized by twofold weaker nectar secretion than the normal flowers (Kołtowski 2003). Hence, the sugar potential of those cultivars is lower than would result from the abundance of their blooming and nectar secretion by normal flowers. Having considered the nectar secretion of male-sterile flowers and their number, the potential yield of plantation No. 13 turned out to be one of the lowest and reached merely 43.6 kg per 1 ha. A similar quantity of nectar flow (42.4 kg of sugars per 1 ha) was yielded by the poorest plantation No. 10 characterized by small plants, the lowest number of flowers per area size unit and, additionally, the poorest nectar secretion. The mean sugar potential of all plantations analyzed accounted for almost 105 kg per 1 ha. Individual plantations appeared to be highly diversified in terms of that trait. Their sugar yield per 1 ha, apart from the above-mentioned cultivars, ranged from 76.1 kg to 156.1 kg.

Observations demonstrated that workers of honeybee were predominant insects on rapeseed. They constituted 96.6, 94.1 and 94.8% respectively of all insects observed on flowers in the subsequent years of the research. In the years 2002 and 2004, the second group of insects in terms of number (3.4% and 4.6%, respectively) was constituted by solitary bees, and in the year 2003 in spring rapeseed, 3.3% of the observed insects were *Diptera*, mainly those of the family *Syrphidae*. To compare the plantations, results were restricted to the mean number of currently working honeybee workers per area size unit. On average, 14-15 honeybees collecting nectar and pollen were observed in an area of 10 m² of each plantation (Table 3). The lowest bee density on flowers (8-9 workers) was recorded on plantations No. 2, 6, 8, 9, 11, and 17, whereas the highest density (over 20 workers) was on plantations No. 14, 16, 18, and 20. Unfortunately, no correlation was demonstrated between insect density on flower and sugar potential of a plantation nor their area size and the number of bee colonies living near the plantations.

Evaluation of nectar utilization by honeybees

In analyzing the intensity of nectar secretion by flowers of rapeseed, the decision was made to evaluate the degree of nectar utilization by pollinating insects. A comparison was made, therefore, between the mass of sugars secreted by flowers isolated from the access of insects with the mass of sugars collected from flowers freely available to insects. On none of the analyzed plantations was there a complete lack of nectar in non-isolated flowers, whereas relatively the highest amounts were left on plantation No. 7 (Table 4). That plantation was additionally characterized by the poorest utilization of the offered nectar flow by insects – merely 68%, whereas on all plantations it was utilized at an average level of

82%. The highest utilization of nectar was reported on plantation No. 12, followed by plantation No. 4. It was confirmed in the intensity of flowers visiting by insects expressed by the number of honeybees working simultaneously on area size unit. Definitely, the highest density of insects on the same days when nectar was collected was observed on plantations No. 4 and 12 (rounding: 26 and 22 of bees per 10 m², respectively), whereas the lowest was on plantation No. 7 where on 10 m² there were observed as few as 6-7 bees.

Number of bee colonies on a plantation and honey yield

Data referring to the number of colonies are, unfortunately, incomplete, since not all beekeepers have returned their questionnaires. They would enable determining the

number of bee colonies per area size unit for some plantations. It ranged from 0.7 to 4 colonies per 1 ha, which, as mentioned earlier, is not reflected in the stock density of bees on flowers (Table 3).

However, some conclusions may be drawn even from those fragmentary data. Collation of the number of colonies and mean yield of rapeseed honey is presented in Table 5. In the table, plantations No. 2 and 8 in Osiny and plantations No. 5 and 9 in Klikawa were joined since they were located in direct proximity, within range of bees which were likely to utilize nectar flow from both plantations. It may be noted that in each apiary, even in those standing on the same plantation, the mean yield of rapeseed honey from one colony oscillated at a highly diversified level from 0 to 27

Table 4

Degree of nectar utilization by bees on 12 plantations of winter rapeseed in the proximity of Puławy in the year 2002

Plantation No.	Cultivar	Mass of sugars per 10 flowers (mg)		Degree of nectar utilization in %	Density of foraging bees per 10 m ²
		isolated	non-isolated		
1	Lirajet	11.46	1.80	84	13.2
2	Contact	12.70	2.68	79	8.1
3	Kana	6.59	1.65	75	14.4
4	Capio	9.92	1.24	88	25.8
5	Votan	14.12	2.40	83	10.8
6	Kaszub *	14.06	3.32	76	10.1
7	Lirajet	14.20	4.60	68	6.5
8	Lisek	11.29	1.97	83	7.5
9	Liropa	12.81	2.27	82	8.6
10	Lisek+Lirajet	6.91	1.03	85	11.9
11	Lisek	9.80	1.59	84	8.1
12	Lisek	16.58	1.21	93	22.2
Mean		11.70	2.15	81.7	12.3

* - hybrid composite cultivars

kg. This indicates clearly that by no means does the sugar yield of a plantation determine the honey yield in an apiary. Under no circumstances, can this be referred to the size of apiary, since in both large and small apiaries there were results exceeding 20 kg per colony or even equal to zero.

Documented yield of rapeseed honey enabled calculating the yield obtained from 1 ha of rapeseed plantation. Honey yield of 0 kg was adopted in the case of no feedback from the beekeepers on their apiaries, thus, a theoretical minimal yield of honey per 1 ha was determined (in table, results preceded with "min."), which actually could have been and, presumably, was substantially higher. It may be concluded that the reported yield of honey per 1 ha of a plantation ranged from 13.6 to 42.2 kg, whereas the minimal fluctuated between 3.5 and 35.4 kg. In respect to the sugar potential of

a plantation provided in Table 3, which indicates the potential amount of nectar flow provided to insects from 1 ha of plantation, it may only be stated that in no case did the sugar potential reduce honey yield in an apiary, and that the final success depended only on the quality of bee preparation for the utilization of rapeseed nectar flow. This was confirmed by the case of a very poor plantation No. 10 where at a very low sugar potential (ca. 42 kg), the beekeeper was able to collect on average over 10 kg of honey from 1 colony.

DISCUSSION

The presented results referring to the period and abundance of blooming fully confirm findings of other authors who investigated rapeseed in the area of Poland (Jabłoński et al. 1985, Kołtowski 2002). Again it was confirmed, yet under condi-

Table 5
Honey yield in apiaries utilizing nectar flow of winter rapeseed

Plantation No.	Cultivar	Number of colonies in an apiary vs. mean honey yield per 1 colony			Honey yield in kg per 1 ha
		apiary 1	apiary 2	apiary 3	
2	Contact	60 vs. 10 kg	30 vs. 20 kg	19 vs. 5.7 kg	42.2
8	Lisek				
3	Kana	41 vs. 10 kg	30 vs. X* kg	10 vs. X* kg	min. 20.5
4	Capio	11 vs. 3.5 kg	10 vs. X* kg	8 vs. 0 kg	min. 3.5
5	Votan	80 vs. 10 kg	25 vs. X* kg	-	min. 18.2
9	Liropa				
7	Lirajet	17 vs. 20 kg	-	-	13.6
10	Lisek+Lirajet	23 vs. 10.6 kg	-	-	17.4
12	Lisek	105 vs. 27 kg	60 vs. X* kg	15 vs. X* kg	min. 35.4
19	Batory	7 vs. 15 kg	5 vs. 4.2 kg	16 vs. 0 kg	18.0

* - missing data

tions of field production, that winter rapeseed is an excellent nectar flow to bees in the first two decades of May. Also, an assessment of production plantations in terms of their blooming abundance proved that the number of flowers per area size unit was completely concurrent with that obtained for cultivars surveyed on small experimental areas (Jabłoński et al. 1985, Kołtowski 2002). This points to the application of an appropriate methodology of establishing plot experiments, which fully reflected conditions of growth and development of plants on a field.

The described results of analyses into the abundance of nectar secretion by flowers indicate even a tendency for a slight increase in the content of sugars secreted in nectar as compared to the experiments from previous years. For various plantations examined in the reported study, the mean mass of sugars per 10 flowers (over 10 mg) seems to be slightly higher than mean values recorded for cultivars in the earlier studies (in general, reaching below 10 mg), yet it still fits within extreme results reported in literature (Free 1993, Westcott and Nelson 2001).

The wide range of sugar potential of plantations observed in the study (from 42 to 156 kg per 1 ha) may be explained by a diversified set of cultivars grown on plantations characterized by specific habitat conditions. In addition, agricultural treatments applied therein yield a variety of effects, as a result of which the plantations were either in very good or very poor condition.

Some differences in respect of the previously reported results were observed in the evaluations of the intensity of flowers foraging by insects. As expected, in the reported study, the density of honeybee workers on a blooming field was substantially lower as compared to results obtained for the same species on experimental plots (Jabłoński et al. 1985, Kołtowski 2002) where the mean number of bees per 1 m²

ranged from 3.3 to 6.7 as compared to an average of 1-2 honeybee workers counted per 1 m² of plantation. Undoubtedly, this may point to the effect of vast areas, which reflects the real intensity of rapeseed plantation foraging in practice.

Of practical significance is also the evaluation of honey yield in an apiary from which bees utilize rapeseed nectar flow. Unfortunately, no literature data was found on that matter, yet they are likely to be highly diversified as indicated by the presented results. It turned out that even from the same plantation, one beekeeper was able to harvest on average 15 kg of rapeseed honey from 1 hive, whereas the other may have failed to collect any honey. It indicates explicitly that the sugar potential of a rapeseed plantation is not a factor determining the size of rapeseed honey yield in an apiary.

CONCLUSIONS

Under conditions of commercial plantations, nectar secretion by flowers of all new rapeseed cultivars was demonstrated to be good (ca. 10.47 mg of sugars per 10 flowers on average), which places rapeseed in a group of good nectar flow plants providing over 100 kg of sugar per 1 ha to insects with high chances for commercial nectar flow.

Honeybee workers are the predominant group of pollinating insects on the plantations of rapeseed, and their contribution in the total number of insects on flowers accounted for nearly 95%.

The intensity of flowers visitation by honeybees on the examined rapeseed plantations, ranging from 7 to 28 simultaneously working bees per 10 m², is not affected by the size of plantation, the sugar yield of a cultivar or by the number of bee colonies per 1 ha and is substantially lower than under conditions of experimental plots.

Under conditions of large rapeseed plan-

tations, the utilization of nectar by insects accounts for 82% and is determined by the current density of nectar foragers on flowers.

The mean harvest of rapeseed honey from one colony, varying considerably even between apiaries located near the same plantation, indicates undoubtedly that the sugar potential of rapeseed plantations by no means reduces the yield of honey in an apiary.

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STOPIEŃ WYKORZYSTANIA PRZEZ OWADY POTENCJALNEJ WYDAJNOŚCI CUKROWEJ PLANTACJI RZEPAKU W ODNIESIENIU DO ZBIORÓW MIODU RZEPAKOWEGO W PASIECE

Kołtowski Z.

S t r e s z c z e n i e

W latach 2002-2004 badano plantacje rzepaku pod kątem ich wydajności cukrowej, intensywności ich oblotu przez owady zapylające oraz stopnia wykorzystania tego pożytku przez owady. Dokonano również oceny zbiorów miodu rzepakowego w pasiekach sąsiadujących z plantacjami rzepaku.

W wyniku badań stwierdzono, że rzepak ozimy na plantacjach produkcyjnych rozkwitał w ostatnim tygodniu kwietnia lub pierwszym maja i kwitł przeciętnie od 3 do 4 tygodni. Rośliny na plantacjach wyrastały na wysokość średnio 149 cm, a na poszczególnych plantacjach od 129 do 187 cm. Średnio na 1 m² było 72 rośliny, przy rozpiętości od 32 do 121, które miały średnio po 7 (od 5 do 11) rozgałęzień. Obfitość kwitnienia wynosiła średnio 10,3 tysiąca kwiatów, przy wahaniami od 6,5 do ponad 14 tysięcy. Rośliny na wszystkich plantacjach nektarowały bardzo dobrze wydzielając średnio po 10,47 mg cukrów z 10 kwiatów, przy rozpiętości od 6,44 do 13,76 mg. Średnia wydajność cukrowa plantacji wynosiła około 105 kg cukrów z 1 ha, przy minimum 42,4 kg i maksimum 156,1 kg. Intensywność oblotu kwiatów przez pszczoły miodne zawierała się w granicach od 7 do 28 jednocześnie pracujących pszczoł na 10 m² plantacji i nie zależała ona ani od wielkości plantacji, ani wydajności cukrowej odmiany, ani od liczby rodzin pszczelich na 1 ha. Od intensywności oblotu zależał natomiast stopień wykorzystania nektaru przez pszczoły, który średnio wynosił prawie 82% przy wahaniami od 76 do 93%. W ankietowanych pasiekach, nawet w tych stojących przy tej samej plantacji, średni zbiór miodu rzepakowego z jednej rodziny kształtował się na bardzo różnym poziomie od 0 do 27 kg. Świadczy to dobitnie o tym, że wydajność cukrowa plantacji rzepaku w żaden sposób nie warunkuje zbiorów miodu w pasiece.

Słowa kluczowe: rzepak, nektarowanie, wydajność cukrowa, intensywność oblotu, zbiór miodu