BROOD AND BEE PRODUCTION IN HONEY BEE COLONIES IN THE WARMIA AND MAZURY REGION OF POLAND

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Summary

The experiment was conducted from 2005 to 2007 at the apiary of Apiculture Department, WM University in Olsztyn. Colonies of *Apis melliffera carnica* were divided into 3 groups. Group I - traditional management, without any additional feeding. Group II - colonies were fed regularly and only brood combs were removed. Group III - colonies were fed regularly. The combs of brood covered with bees were removed every 14 days.

The highest area of brood was produced every year by Group III, (258.1 dm^2, 161.6 dm^2 and 145.0 dm^2) with an average of 188.2 dm^2. In the two experimental groups II and III, the amount of brood was significantly lower in the 2nd and 3rd year of the investigations. The highest bee production (2.0 kg) was observed in Group III.

We found that the production of brood and bees significantly reduced honey production. However, additional production of brood and bees enlarge the total production of honey bee colonies.

Keywords: brood comb, worker bee, honey, total production.

INTRODUCTION

The main source of income for Polish beekeepers is the production and selling of honey. This kind of production does not insure a high profit nor does it provide competiveness among Polish apiaries (Cichoń and Wilde, 1996; Pidek, 1996). A drop in the price of multiflora honey (Pidek, 2000) as well as more import from outside the country (Semkiw and Skubida, 2006) and the low productivity of bee colonies (Bratkowski at al., 1998) are the main reasons for the lack of interest in beekeeping. However it is possible to improve this situation through higher brood and bee production (Bratkowski and Wilde, 2002). The impact of production of brood and bees on the total production of calculated honey from one colony can be estimated 25% (Bratkowski and Wilde, 2003). Although, bees and brood production are dependent upon weather and flow conditions, however these can be produce by feeding bees artificially (Wilde at al., 1996a), which is very important for making a new nuclei, because of high colony losses in the last few years (Topolska et al., 2008).

The recent findings of study done in Poland showed the production of bees 3.6 kg per year. When bees from brood were included, the figure jumped upto 8.1 kg of bees (Wilde et al., 1996a). However Wilde et al. (1996b) have stated that it is possible to get even 14 kg of bees from one colony when the Polish climate and flow conditions are taken into account. In countries with more favorable conditions, the production of bees can be on an average

of 6 kg without any negative effect on honey production (Mc Coutcheon, 1987).

The production of bees has an influence on the fitness and the development of bee colonies and their honey production. Marcinkowski (1991) noticed that negative repercussions from interference in colony structure were visible in the course of 50 days. According to Pidek (1989) rapid weakness of colonies and their partial death occurs after removal of all combs with brood, and forcing bees to build a new nest. According to Konopacka (1974) colony development and its production depends on its size, and the quality of worker bees in spring. Lee and Winston (1985) showed a positive relationship between the size of a colony and brood production, and the body weight of emerging bees.

Wilde (1995) has mentioned the posibility of producing about 3.0 kg of bees under Polish climate and flow conditions without any negative influence on honey production where as McCoutcheon (1987) reported thought that it could be even 6 kg. Bratkowski and Wilde (2003) demonstrated that taking out brood and bees from colonies during the season significantly lowered honey production. Low honey production is the result of a big drop in the worker population. A healthy worker population is essential for full utilization of the flow (Gromisz et al., 1978).

So far, the methods of brood and bee production and their influence on the productivity of honey bee colonies in the Warmia and Mazury region of Poland, have not been widely studied it is important to have up-to date information on this topic these days because of the high demand on new colonies as well as queens. The aim of the investigation was to make comparisons and evaluations of various methods used to increase brood and bee production.

MATERIAL AND METHODS

The investigations were carried out in Olsztyn, a town in the Warmia and Mazury region of Poland from 2005 to 2007 over 30 *Apis mellifera carnica* colonies. There were 10 colonies in each group: Group I was as the control traditional management and no feeding. Sometimes bees and brood combs were collected from colonies that were in a very strong and permanent swarming condition. Group II consisted the colonies that were fed with candy. Candy was prepared from powder sugar mixed with yeasts in a 10:1 proportion. In this group only combs with capped brood were taken out in every 2 weeks. Group III - consisted the colonies that were fed with the same candy as in the previous (II) group of colonies. Combs with capped brood covered with bees were removed in 14 days intervals in order to develop new colonies. The first brood combs and bees collected in Groups II and III were used to make new colonies that were strengthened by adding later brood combs and bees.

The experimental colonies were kept in polystyrene hives of the Ostrowska type. The hives were with frame measuring 360 mm x 230 mm squares in size. Each hive had 3 supers and a naturally mated sister queens.

Brood combs and bees were collected from May 15 till July 15 in 2005, from May 18 till July 20 in 2006 and from May 24 till July 17 in 2007.

In spring, the quantity of brood present in the hives was determined twice in all groups. The quantity of brood was determined by measuring the brood area (dm^2) on both sides of each comb (Woyke, 1981). During all three years, the first measurement was taken in May 5 and the next in May 26. Thus, the first measurement was done before the brood and bees were collected, whereas the

second after the brood combs and bees had been collected once.

Each year, the main sources of nectar was winter rape (*Brassica napus var. oleifera*) and linden (*Tillia spp.*). In 2005, the winter rape bloomed from May 10 to 28 and Linden from June 20 till July 5. In 2006 the winter rape bloomed from May 12 till June 1, and linden from June 18 till July 13. In 2007, the winter rape bloomed from April 24 till May 25 and Linden from June 10 till July 11.

Feeding to bees was started in the middle of winter rape blooming period (about 15th May each year). At the beginning, each colony was given 4 kg of candy in the frame feeder. Candy was given at every 7 days. Colony productivity was determined on the basis of extracted honey, additional production of calculated honey from gained brood and bees, as well as the additional wax on the comb (Bornus, 1973; Skowronek, 1976). The brood and bees taken from colonies, as well as the wax were converted into honey units as follows: 10 dm^2 of brood = 1 kg of honey, 1 kg of bees = 2.5 kg of honey, wax added to one foundation comb = 0.17 kg of honey. However, the value of candy was not calculated.

The temperatures during the year 2005 and 2006 were suitable for bees. The days during the experimention were usually bright with little rain. In 2007, the weather conditions were good around the winter rape blooming period with the raising temperatures to 25ºC and many bright days. Then, the weather rapidly changed during the linden blooming period (between 15 June and 10 July) with the wind and rain, and dropping temperature on an average to 15ºC.

The data thus obtained were analyzed stistically by using STATISTICA software. Analysis of variance (ANOVA) was done and the differences between means were compared by using the least significant differences (LSD) test. The values differing statistically at the level of $p < 0.05$ are marked with small letters and those differing significantly at the level of $p < 0.01$ with capital letters.

RESULTS

1. Development of bee colonies in spring.

Both brood area measurements showed a similar strength of colonies in spring (Tab. 1). During the first measurement, when brood and bees were not collected, the smallest area of brood was found in colonies managed traditionally (Gr I 46.2 dm^2) as compared to those from which later brood and bees were taken away (Gr III 51.7 dm^2). In spite of the differences in the means of all groups, they were not statistically significant. Similarly, during the second measurement after the brood and bees had already been collected once, there were no statistically significant differences between mean brood area in all groups. The amount of brood was the highest in Group I (64.3%), from where

Table 1

Average brood area of two measurements in spring during the three years (dm^2)

Group	n	1st measurement $\bar{x}$ ± s.d	2nd measurement $\bar{x}$ ± s.d	Change (in %)
I - control, traditional management	30	46.2 ± 15.8	75.9 ± 27.6	+64.3
II - production of capped brood	30	48.0 ± 12.3	74.8 ± 26.2	+55.8
III - production of capped brood and bees	30	51.7 ± 16.6	72.4 ± 24.4	+40.0

Table 2

Mean increase in brood area between measurements 1 and 2 during spring (dm^2)

Year	Group			Overall mean $\bar{x}$ ± s.d
	I - control, traditional management $\bar{x}$ ± s.d	II - production of capped brood $\bar{x}$ ± s.d	III - production of capped brood and bees $\bar{x}$ ± s.d	
2005	34.6^{ABCb} ± 12.3	20.5^{Bc} ± 7.4	3.3^{Dd} ± 19.1	**19.5^{B} ± 18.6**
2006	14.3^{Ccd} ± 9.1	12.5^{Ccd} ± 10.2	17.9^{BCc} ± 8.5	**14.9^{B} ± 9.2**
2007	40.3^{A} ± 17.4	47.4Aa ± 8.0	40.9C ± 14.6	**42.9A ± 13.8**
Overall mean	**29.7^{a} ± 17.2**	**26.8^{a} ± 17.3**	**20.7^{a} ± 21.2**	**25.7^{AB} ± 18.8**

Capital letters indicate significant differences at $p<0.01$,
small letters indicate significant differences at $p<0.05$.

brood and bees were not removed. The amount of brood was the least in colonies of Group III (40.0%), from where, both brood and bees had been collected.

The highest increase in brood area was found in the control group (29.7 dm^2- Tab. 2). The collection of capped brood from Group II resulted in the lower increase (26.8 dm^2) in brood area. The lowest increase of brood area was recorded in colonies from which brood and bees were collected (Group III - 20.7 dm^2). Despite the decrease in brood area as well as a more colony weakness, this method did not affect their brood rearing ability. The statistical analysis showed the similar conditions of effect on brood rearing in each year . The average brood increase in 2006 (14.9 dm^2) and in 2005 (19.5 dm^2) was significantly lower than the last year - 2007 (42.9 dm^2).

2. Productivity of bee colonies.

Honey production

The honey production in colonies of Group II (brood production) or Group III (brood and bees production) was significantly lower in the first two years compared to the control colonies (Tab. 3). The difference between the means exceeded by 50%. The production of honey was similar in all groups only in the last year. The results confirmed the negative influence of brood and bee production on the quantity of centrifuged honey. The effect of brood and bees production on honey production amounted upto 50%. The means of Groups II and III were significantly lower than the mean of the control group. Similarly, the overall mean honey production was significantly higher (15.4 kg) in the second year than that of third year (9.9 kg).

Brood and bees production

Worker bees were occasionally taken from colonies of the control group and from Group II also from where the brood was collected. Each year significantly less amount of bees were collected from the colonies of Groups I and II than that of colonies of Group III (Tab. 4). The overall mean of bees collected was significantly higher for colonies of Group III (2.0 kg), than that of colonies of Group II (0.1 kg) and Group I (0.5 kg).

A drop in the overall amount of bee production occurred in successive years. Production of bees decreased significantly by 1.3 kg in the first year and by 0.7 kg in both successive years.

A significantly lower the overall mean brood production was significantly lower in Group I (25.2 dm^2) as compared to

Table 3

Average amount of extracted honey in different years (in kg)

Year	Group			Overall mean $\bar{x} \pm$ s.d
	I - control, traditional management $\bar{x} \pm$ s.d	II - production of capped brood $\bar{x} \pm$ s.d	III - production of capped brood and bees $\bar{x} \pm$ s.d	
2005	$23.4^{A} \pm 5.9$	$6.6^{B} \pm 5.4$	$8.7^{B} \pm 3.3$	**$12.9^{ab} \pm 9.0$**
2006	$28.1^{A} \pm 5.8$	$9.1^{B} \pm 5.4$	$9.1^{B} \pm 2.4$	**$15.4^{a} \pm 10.2$**
2007	$8.3^{B} \pm 5.8$	$11.3^{B} \pm 6.9$	$10.3^{B} \pm 5.4$	**$9.9^{b} \pm 6.2$**
Overall mean	**$19.9^{A} \pm 10.3$**	**$9.0^{B} \pm 6.1$**	**$9.4^{B} \pm 3.8$**	**12.8 ± 8.8**

Capital letters indicate significant differences at $p<0.01$,
small letters indicate significant differences at $p<0.05$.

Table 4

Average weight of collected bees (kg) and area of brood (dm^2) in different years

Year	Group			Overall mean $\bar{x} \pm$ s.d
	I - control, traditional management $\bar{x} \pm$ s.d	II - production of cappes brood $\bar{x} \pm$ s.d	III - production of capped brood and bees $\bar{x} \pm$ s.d	
Bees				
2005	$0.9^{C} \pm 0.7$	$0.1^{D} \pm 0.2$	$2.7^{A} \pm 0.8$	**$1.3^{a} \pm 1.3$**
2006	$0.2^{D} \pm 0.2$	$0.1^{D} \pm 0.1$	$1.7^{B} \pm 0.5$	**$0.7^{b} \pm 0.8$**
2007	$0.2^{D} \pm 0.2$	$0.2^{D} \pm 0.2$	$1.5^{B} \pm 0.5$	**$0.7^{b} \pm 0.7$**
Overal mean	**$0.5^{Ba} \pm 0.5$**	**$0.1^{Bb} \pm 0.2$**	**$2.0^{A} \pm 0.8$**	**0.9 ± 1.0**
Brood				
2005	$32.6^{C} \pm 26.9$	$225.1^{A} \pm 74.9$	$258.1^{A} \pm 79.8$	**$171.9^{A} \pm 93.8$**
2006	$14.3^{C} \pm 19.1$	$102.7^{Bb} \pm 24.5$	$161.6^{Ba} \pm 48.2$	**$92.9^{B} \pm 69.3$**
2007	$28.6^{C} \pm 25.2$	$111.3^{Bb} \pm 32.5$	$145.0^{Bab} \pm 51.6$	**$95.0^{B} \pm 61.9$**
Overall mean	**$25.2^{B} \pm 24.5$**	**$146.4^{Ab} \pm 74.0$**	**$188.2^{Aa} \pm 78.1$**	**119.9 ± 93.8**

Capital letters indicate significant differences at $p<0.01$,
small letters indicate significant differences at $p<0.05$.

colonies of Group II (146.4 dm^2) and Group III (188.2 dm^2). Similarly, the overall mean brood production in successive years decreased significantly from 171.9 dm^2 to 92.9 dm^2 in the first year and by 95.0 dm^2 in the second and the third year. So, the production of brood had a negative influence again to produce brood in successive years.

In the first and as well as in the last year the highest total production was obtained from colonies from which bee and brood were collected (Group III, Tab. 5). In the second year, however, the production was similar to that of the control colonies. The production in the colonies from which only

Table 5

Total production by bee colonies expressed in kg of calculated honey

Year	Group			Overall mean $\bar{x}$ ± s.d
	I - control, traditional management $\bar{x}$ ± s.d	II - production of capped brood $\bar{x}$ ± s.d	III - production of capped brood and bees $\bar{x}$ ± s.d	
2005	31.0^{Ba} ± 6.5	30.1^{B} ± 6.3	42.0^{A} ± 10.4	**34.3^{A} ± 9.5**
2006	31.0^{Ba} ± 6.8	19.7^{CDb} ± 7.0	29.7^{B} ± 6.8	**26.8^{Ba} ± 8.4**
2007	12.0^{Dc} ± 6.6	23.0^{BCb} ± 6.4	28.9^{B} ± 9.2	**21.3^{Bb} ± 10.2**
Overall mean	**24.7^{B} ± 11.2**	**24.3^{B} ± 7.7**	**33.5^{A} ± 10.5**	**27.5± 10.7**

Capital letters indicate significant differences at $p<0.01$,
small letters indicate significant differences at $p<0.05$.

brood was collected (Group II), appeared to be significantly lower in the second year as compared to the control colonies. That is why the results did not show a clear positive influence of additional bee or bee and brood production on the total productivity of the bee colonies.

The overall means show that the total production of calculated honey was similar in Groups I and II and was significantly higher only in Group III.

The yearly overall total production of calculated honey was significantly higher in the first year (34.3 kg) which dropped to 26.8 kg and 21.3 kg in the following next two years.

DISCUSSION

Production of brood and bees is based on a very strong interference into the structure of a bee colony. In order for the achievement of better economical results (Cichoń and Wilde, 1996) the methods used on colony function must be taken into account (Nelson et al., 1987; Pidek, 1989; Marcinkowski, 1991; Bratkowski and Wilde, 2003). In our experiment, inappropriate conditions for brood rearing were the result of manipulations that made colonies weak. New conditions could have a negative effect on the quality of bees that wintered (Konopacka, 1974; Muszyńska, 1987). It was proved that the weak colonies rear weak generations of bees, whereas strong colonies rear bees with better fitness because of better conditions. Pidek (1984) also confirmed this phenomenon in his experiment. In our experiment despite our various apprehensions, the colonies of all groups had a comparable area of brood in spring during both measurements. The rate of brood-area-increase in the study years, confirmed good colony conditions in spring. It is worth mentioning that the weakest colonies of Group II (brood production) showed significant ($p=0.01$) brood area increase every year (Tab. 2). In 2007, colonies of the other groups showed a dynamic increase after displaying a weak increase in 2006. The findings indicated the right time to stop removing brood and bees, is during the first half of July. Colonies are able to rebuild their strength before wintering and insure proper nursing conditions for wintering generations of bees (Muszyńska, 1987; Pidek, 1989; Skubida and Skowronek, 1995). Problems with the survival rate of wintering colonies when colonies had been transferred to a new nest before winter

were not observed. He also stated that more brood had been reared thanks to the changed structure of the colonies. Investigations made by Wilde et al. (1994) confirmed the great ability of colonies to rebuild their strength. They observed that fact in colonies in which brood and bees were taken in order to create new colonies. Thus, in our experiment, colonies were divided in a way that guaranteed the preservation of enough workers and quantity of brood. This in turn then decide about the population of winter bees and their quality (Konopacka at al., 1975).

A negative effect of long lasting brood and bee removal may be expressed in the measured productivity of brood reared the following season. A high brood production was only noticed in the first experimental year. In the following years a significant drop ($p = 0.01$) appeared in the amount of gained brood and bees (Tab. 4). It may happen that colonies are able to once again reach their biological balance (Marcinkowski, 1991). But workers reared the next season are not ready to bear the expense of higher brood rearing during the resumption of intensive production of brood and bees. From the very beginning of brood and bees production the quality of worker bees begins to decline.

Taking brood and bees away (Group III) or only brood (Group II) reduced honey production to same degree. The negative effects of the removing of brood and bees was observed by Bratkowski and Wilde (2003).

In our experiment the biggest drop in the amount of extracted honey compared to the control group was in 2006 for Groups III and II - about 67.5%. In 2007 less honey was extracted from the control colonies, but that may be explained by the poor climatic and flow conditions for honey production. Mc Coutheon (1987) claims that removing bees does not make worse for honey production if less than 6 kg of bees were removed. However, Wilde (1995) has mentioned that removing about 3 kg of bees do not affect honey production in Poland, because of the Polish climatic conditions. Collection of brood started at the beginning of the winter rape blooming period. At this time there were not so many bees in the hives which is normal for our region (Gromisz at al., 1978). However reducing the next generations population of bees (by taken brood) prevented the swarming impulse of bees. This was also confirmed earlier by Wilde and Bratkowski (1997).

Wilde et al. (1996a) produced a lower number of bees than we did in our experiment. The range of production was from 1.3 kg to 2.4 kg of bees depending on the year as well as the method of production. In our experiment, the production lasted from the middle of May till the first half of July, despite this it did not exceeded by 3 kg (Wilde, 1995). After the conversion of brood into bees the total production of bees was from 7.5 kg to 13.3 kg of bees in the best colonies. Wilde et al. (1996a), on the other hand, produced from 4.8 to 8.1 kg of bees from incubated brood and collected bees. In theoretical calculations for our climatic conditions, Wilde (1995) pointed out on the possibility of producing maximum of 13 kg of bees which amount can be exceeded in particular colonies which have an exceptionally dynamic development. Wilde et al. (1996a) obtained 16.1 kg of bees from the best colony.

The fact worth mentioning here is that more brood was produced by weaker colonies, than by colonies with bees left in hive (Group II). The findings suggests that weaker colonies had higher inclination and ability to nurse brood. Our results have shown that there is even better nursing of brood in weak colonies, which appeared after taking brood as well as bees at the

same time (Group III). However, Bratkowski et al. (2000) insist, that rearing new brood and building a new appropriate nest area are a priority for a colony. Mattila and Seeley (2007) also observed a systematic increase in area of reared brood in colonies forced to rebuild their nest. It may explain the stimulating effect of methods of brood and bee production on more intensive rearing of a new generation of bees in order to prepare to winter. The production of brood and bees caused the colonies of only Group III, to have a visible tendency towards lower total production of calculated honey in the following years. Probably the worst results were felt by the next generations of bees, even those reared the next year. It may confirm observations made by Marcinkowski (1991). Good spring development along with a statistically confirmed decrease in brood and bee production in the second and third experimental years confirms such an opinion.

Production of brood and bees made the total production of colonies significantly higher only in chosen years (Tab. 5). In 2006, the control colonies still gave the highest total production; significantly higher ($p = 0.01$) than in colonies of Group II (brood production). The highest total production was observed in colonies from which brood and bees were taken (42.0 kg), which dropped year after year. Thanks to the production of bees and brood only in 2005, the value of the total production was higher than 34 kg, which is what produced by Polish beekeepers (Bratkowski et al., 1998). Bratkowski and Wilde (2003) obtained a productivity of 20 kg of honey consisting of brood and bees produced from a colony as well as extracted honey. The obtained results do not reflect positively on bee and brood production methods. A positive effect of the evaluated methods on colony productivity was observed only in 2005 and in the last year (2007). It was characterised by difficult climatic and flow conditions, especially in the second half of the season. Wilde and Bratkowski (1997) pointed out advantages of the additional production during cool and rainy days. During such years, additional production from brood and bees as well as wax, made up for the losses in honey production. In our experiment, the additional production from brood and bees did not insure an increase in total production. Instead it happened an opposite as it led to a significant decrease in total production compared to the control colonies (2006, Group II - brood production). The restriction of brood production allowed the control colonies to be exceeded by only 0.1 kg of honey.

CONCLUSIONS

1. An intensive brood and bee production reduces honey yield.
2. In years when the climate and flow conditions are unfavorable for honey production, brood and bee production have a positive effect on colony productivity.

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INTENSYFIKACJA PRODUKCJI CZERWIU I PSZCZÓŁ W RODZINACH PSZCZELICH W REGIONIE WARMIŃSKO-MAZURSKIM

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

Poprawa sytuacji ekonomicznej polskich pasiek jest możliwa przez intensywne pozyskiwanie z rodzin pszczelich czerwiu oraz pszczół. W doświadczeniu oceniono efektywność pozyskiwania czerwiu lub czerwiu i pszczół. Doświadczenie wykonano w Katedrze Pszczelnictwa Uniwersytetu Warmińsko-Mazurskiego w Olsztynie w latach 2005-2007 w rodzinach z pszczołami kraińskimi. W grupie I (kontrolnej) prowadzono tradycyjną gospodarkę pasieczną, bez podkarmiania. Rodziny z grupy II podkarmiano, lecz zabierano im tylko plastry z czerwiem krytym. Rodziny z grupy III systematycznie podkarmiano i co 14 dni zabierano im czerw kryty wraz z obsiadającymi go pszczołami. W każdym roku doświadczenia w poszczególnych grupach było po 10 rodzin pszczelich.

Odbieranie czerwiu i pszczół prowadzono od 15.05 do 15.07. w 2005 roku, od 18.05. do 20.07.2006 i od 24.05. do 17.07. 2007. Podkarmianie rozpoczynano w I połowie kwitnienia rzepaku ozimego poddając w podkarmiaczkach gniazdowych 4 kg ciasta wykonanego z cukru pudru i drożdży (10:1). Pokarm uzupełniano co 7 dni. Produkcyjność rodzin określono na podstawie odwirowanego miodu i produkcji dodatkowej, czyli z odebranego czerwiu i pszczół oraz wosku.

Średnio wysoko istotnie najwięcej miodu odwirowano z rodzin w grupie kontrolnej (19,9 kg). Jedynie w ostatnim roku doświadczenia produkcja miodu wynosiła w tej grupie tylko 8,3 kg i nie różniła się istotnie od grupy II (11,3 kg) i III (10,3 kg).

Średnio istotnie najwięcej czerwiu pozyskano od rodzin grupy III, z której pobierano zarówno czerw jak i pszczoły - 188,2 dm^2. W obu grupach z których pobierano czerw lub dodatkowo pszczoły ilość odebranego czerwiu zmniejszyła się wysoko istotnie w 2. i 3. roku badań. Produkcja pszczół w grupie III wynosiła średnio 2,0 kg i była wysoko istotnie najwyższa.

Średnią najwyższą produkcję całkowitą zanotowano w rodzinach, którym odbierano czerw i pszczoły (grupa III - 33,5 kg). Wartość ta była wysoko istotnie wyższe niż w grupie I i II. Stwierdzono, że pozyskiwanie czerwiu i pszczół spowodowało istotne zmniejszenie produkcji miodu towarowego.

Chociaż produkcja czerwiu i pszczół zwiększa produkcję całkowitą, to jest ona zależna od warunków klimatycznych i pożytkowych, i tylko w lata niekorzystne pod względem produkcji miodu, może przynieść pszczelarzowi dodatkowy dochód.

Słowa kluczowe: czerw pszczeli, pszczoły robotnice, miód, produkcja całkowita.