

**INFLUENCE OF THE AGE OF HONEY BEE QUEENS AND
DOSE OF SEMEN ON CONDITION OF
INSTRUMENTALLY INSEMINATED QUEENS KEPT IN
CAGES WITH 25 WORKER BEES IN BEE COLONIES**

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S u m m a r y

The study was done in the Department of Bee Breeding in the Institute of Pomology and Floriculture, Apiculture Division in Puławy, Poland. It was done in July and August of 2006 and 2007. The aim of the research was to determine the age of queens when inseminated and the dose of semen used in insemination. The condition of the oviducts and the filling of the spermatheca were determined. Queens 5, 7 or 10 days old were inseminated with 6, 8, or 10 μ l of semen collected from free flying Caucasian drones. In both years, 1027 queens were inseminated and dissected. Altogether 80.3% of inseminated queens had cleared oviducts, 16.6% had some residue of semen, and 3.1% died. Significantly more queens which were inseminated at the age of 7 and 10 days had cleared the oviducts (82.3 and 86.2% respectively) compared to 5-day-old ones (72.4%). Among the 5 days old, 23.8% queens had some residue of semen. The losses of queens 5, 7 and 10 day-old were 48 hours after insemination similar (3.8, 3.2 and 2.3% respectively).

Queens that cleared their oviducts had on an average 3.199 mln spermatozoa in the spermatheca. A significantly higher number of spermatozoa in the spermatheca (average 3.4 mln) was found in a group of queens that were inseminated at the age of 5 days. A lower number of spermatozoa was found in queens that were inseminated at the age of 7 and 10 days, regardless of the dose of semen. It was stated that most of the queens had from 3 mln to 4.5 mln of spermatozoa in their spermatheca. The highest percent of queens that had more than 4.5 mln of spermatozoa in their spermatheca was found in all the groups of queens that were inseminated as at the age of 5 days. Unfortunately as much as 25% of queens inseminated at the age of 5 days did not clear their oviducts and it is expected that they may die within a few days after the treatment. For that reason these queens should not be distributed among the beekeepers.

Keywords: age of honeybee queen, dose of semen, insemination, filling of the spermatheca, clearing of the oviducts.

INTRODUCTION

Instrumental insemination of honeybee queens is the only way of individual

selection of parents. During many years of research, factors affecting the results of the treatment were determined.

Woyke and Jasiński (1976) found that the highest survival rate (75-100%) and the highest number of spermatozoa entering the spermatheca (average 3.975 mln) was found in queens inseminated at the age of 5 to 10 days. They stated that there was a higher mortality rate among the younger inseminated queens whereas older ones had a significantly lower number of spermatozoa in the spermatheca. Similar findings reported Konopacka (1989). Concerning the spermatheca filling, and the mortality rate of the queens, Woyke and Jasiński (1976) recommended inseminating the queens at the age of 7 to 8 days, while Mackensen (1964, 1969) 7 to 10 days old.

The volume of semen used in insemination that influences the spermatheca filling, was determined. Most authors use a single dose of 8 μ l of semen in insemination (Mackensen 1969, Woyke 1979, Woyke and Jasiński 1980, Prabucki et al. 1987), though Woyke (1960) recommended a dosage of from 8 to 10 μ l of semen for a single insemination. Dividing the single dose of semen into two doses resulted in better spermatheca filling as well as facilitated to clearing of the oviducts (Woyke 1960; Konopacka 1989).

Laidlaw (1954, 1981) and Mackensen (1969) stated that the ambient temperature influences the transit of semen from the oviducts into the spermatheca after insemination. The temperature of the bee colony is said to be optimal for keeping inseminated queens. Another important factor influencing the filling of the queen's spermatheca is the contact of the bee workers (Vesely 1971, Woyke and Jasiński 1973, Woyke 1979, 1983, Wilde 1995). Woyke and Jasiński (1979, 1980, 1982a,b) stated that queens should be attended by 250 to 350 workers when kept after insemination in small boxes in incubators at temperature of

34°C. If kept outdoors in mating hives no less than 350 workers should attend them. That enables an optimal temperature to be kept directly in the queens' environment. Keeping the queens after insemination in different conditions can modify the optimal temperature. Keeping the queens in a cage without attendant bees or with too low number of bees, in a bee colony or in the incubator can influence a lower spermatheca filling (Woyke 1979, Woyke and Jasiński 1979, Konopacka 1989). Woyke (1979) and Woyke and Jasiński (1979) found out that queens inseminated with 8 μ l of semen and kept after the treatment in optimal conditions in a bee colony had on average 4.6 mln of spermatozoa in their spermatheca. Queens kept in optimal conditions in boxes with 250 attendant bees had on an average 4.5 mln of spermatozoa and those with 350 attendant bees 4.1 mln. However Woyke and Jasiński (1980) stated that the number of bees attending the queens before insemination did not influence the number of spermatozoa filling the spermatheca.

It was found that not all instrumentally inseminated queens clear their oviducts within 48 hours after insemination. This usually causes the death of the queens. Semen residue in queens' oviducts is the result of inappropriate conditions in which the queens are kept after insemination. These inappropriate conditions are: either too low or too high temperature, too low number or absence of attendant workers, as well as the single dose of semen used in insemination being too large (Vesely 1965, 1969, 1971, Woyke 1979, Jasiński 1984, Gontarz et al. 2005). Also the age of the drones which yield semen for insemination, influences the results of the treatment. Woyke and Jasiński (1978) found that the older the drones used for insemination, the higher the rate of queens with semen residue in their oviducts (up to

50-70%). Bieńkowska and Panasiuk (2006) reported that a significantly higher percent of queens (72.3%) emptied an excess of semen in their oviducts, when inseminated with a needle with a smaller inner diameter of tip (0.16 mm) compared to those inseminated with a bigger (0.19 mm) one (50%).

In a mass production of inseminated queens, some of factors analyzed above are omitted due to economical reasons. The queens are usually kept for 48 hours after insemination in small mailing cages with several dozen attendant bees. They are put in incubators or moved into queenless colonies. The cages are set together in a frame and then placed in colonies between brood frames, as so called queen banks. Queens should clear their oviducts of the excess of semen within 48 hours after insemination. They can then be either introduced into colonies, nuclei, or mating hives, or delivered to beekeepers. Bieńkowska and Panasiuk (2006) found that queens kept in these conditions had on an average 3.3 mln spermatozoa in their spermatheca. However these results are lower than in queens kept in optimal conditions, when spermatheca filling was on an average higher than 4 mln of spermatozoa (Woyke 1979, Woyke and Jasiński 1979, 1982 a,b).

The objective of the study was to determine the age of honeybee queens and the size of a single dose of semen on the results of insemination in a mass production of instrumentally inseminated queens. The effect was evaluated by the number of spermatozoa in the spermatheca and by the semen residue in the oviducts.

MATERIAL AND METHODS

The observations were carried out in the Department of Bee Breeding in the Institute of Pomology and Floriculture, Apiculture Division in Pulawy, Poland. They were carried out in June and August

of 2006 and 2007. In both years of the research, Carniolan sister queens from the "Marynka" line, were reared from one-day-old larvae. Capped queen cells (within five days after larvae grafting) were moved into incubators. The temperature of the incubators was 35°C. The emerging, virgin queens were kept at room temperature (about 18°C) in two-chamber "Folchron" mailing cages with an external dimension of 7 x 4 x 1.5 cm. The queens were attended by ca. 15 worker bees that originated from queenless colonies. They were all introduced into a chamber 4 x 4 x 1.5 cm in size. A smaller chamber of 3 x 4 x 1.5 cm in size was filled with candy to be used as food for the queens and the attending bees. The queens were inseminated in groups at the age of 5, 7 and 10 days. They were inseminated with 6, 8 or 10 µl of semen from free flying drones. These drones came from an apiary with Caucasian queens.

Immediately after insemination, queens attended by ca.25 bees originating from queenless colonies, were introduced into the bigger chamber of the cage. The bees were from the colonies where the queens had lived with before insemination. The frames with 30 cages containing the queens and workers were placed in colonies between a brood frame and a storage frame. On three walls there were cone-shaped round openings tapering towards the center of the cage that enabled contact with hive bees. The dead queens were counted 48 hrs after insemination. Surviving ones were killed and then dissected. Their oviducts were examined for a residue of semen. The number of spermatozoa that entered the spermatheca was counted.

The conditions of oviducts was considered to be:

- residue of semen (some residue of semen in one or both oviducts)
- cleared oviducts

The oviducts were checked for a residue of semen directly after the killing of the experimental queens. Each spermatheca was then placed in a drop of water and its diameter was measured in order to enable a later calculation of its volume. Each spermatheca was subsequently crushed in 0.5 ml of 0.9% saline solution. For further dispersion of spermatozoa, 4.5 ml distilled water was added. The spermatozoa were then counted in 25 Bürker counting chambers and the number of filling spermatozoa in the spermatheca was calculated (concentration).

There were two years of research. In each year three series were done. Altogether a total of 1027 honeybee queens were inseminated and dissected.

ANOVA was used for statistical calculations. Results of the experiment concerning the number of queens with a

RESULTS

During the two years of research a total of 1027 honeybee queens were inseminated and dissected, 80.3% had completely cleared oviducts, 16.6% had some residue of semen and as many as 3.1% died. A significantly higher number of queens that were inseminated at the age of 7 and 10 days cleared their oviducts (respectively 82.3% and 86.2%) as compared to 5-day-old queens (72.4%), regardless of the dose of semen. Significantly more queens among 5-day-olds did not empty their oviducts (23.8%). There were no statistical differences in the percentage of dead queens inseminated as far as their difference in age was concerned (Table 1).

It was stated that the older the queens were when inseminated the lower the percentage of queens with a semen residue in their oviducts, however significant

Table 1.

The conditions of oviducts and the survival of queens that were inseminated at different age and kept in cages with 25 worker bees.

Age of queens (days)	Number of queens (n)	Condition of oviducts				Dead queens after 48 hours	
		Cleared		The residue of semen		n	%
		n	%	n	%		
5	340	246	72.4a	81	23.8b	13	3.8a
7	345	284	82.3b	50	14.5a	11	3.2a
10	342	295	86.3b	39	11.4a	8	2.3a
Total	1027	825	80.3	170	16.6	32	3.1

a,b – differences significant at $p \leq 0.05$ (using the Bliss' transformation).

residue of semen or cleared oviducts were presented in percentages. Data were calculated according to the Bliss' transformation. Differences between means were measured using Duncan's multiple range test. The correlation coefficient between the volume of spermatheca and the number of spermatozoa was measured.

differences were found only in 2007. The tendency for a higher percentage of queens to have a semen residue when inseminated with a higher semen volume was also observed (Table 2).

In both years of research significant differences were found in the number of spermatozoa entering the spermatheca of inseminated queens. Also different fillings

Table 2.

Influence of the age of inseminated queens and dose of semen on the condition of the oviducts.

Year	Age of queens (days)	Dose of semen						Average	
		6 μ l		8 μ l		10 μ l		n	The residue of semen in oviducts %
		n	The residue of semen in oviducts %	n	The residue of semen in oviducts %	n	The residue of semen in oviducts %		
2006	5	18	23.7	19	17.1	12	23.5	49	20.6a
	7	7	9.3	22	15.2	16	29.1	45	16.4a
	10	10	15.6	17	13.3	9	14.1	36	14.1a
	average	36	16.3a	58	15.1a	37	21.8a	130	16.9
2007	5	10	30.3	12	36.4	10	27.8	32	34.4b
	7	2	8.7	2	8.3	1	4.3	5	7.1a
	10	0	0	0	0	3	10.3	3	3.5a
	average	12	14.3a	14	16.3a	14	15.9a	40	15.5
2006 and 2007	5	28	25.7	31	21.5	22	25.3	81	23.8b
	7	9	9.2	24	14.2	17	21.8	50	14.5a
	10	10	10.9	17	10.8	12	12.9	39	11.4a
	average	47	15.7a	72	15.7a	51	19.8a	170	16.6

a,b – differences significant at $p \leq 0.05$ (using the Bliss' transformation).

Table 3.

Influence of the age of queens with cleared oviducts on the number of spermatozoa in the spermatheca

Year	Age of queens (days)	Range min-max	Mean number of spermatozoa in the spermatheca (mln)	Average
2006	5	1.5 - 7.9	3.290 b	3.047 a
	7	0.5 - 7.0	2.990 a	
	10	0.5 - 6.5	2.900 a	
2007	5	0.6 - 6.5	3.626 a	3.645 b
	7	1.6 - 6.5	3.528 a	
	10	1.3 - 7.0	3.754 a	
2006 and 2007	5	0.9 - 7.9	3.379 b	3.199
	7	0.5 - 7.0	3.111 a	
	10	0.5 - 7.0	3.135 a	

a,b – differences significant in columns $p \leq 0.05$.

of the spermatheca were found in queens inseminated at different ages. Queens that were inseminated at the age of 5 days had a significantly higher number of spermatozoa in their spermatheca (average 3.4 mln). This was regardless of the dose of semen used for insemination. Queens

inseminated at the age of 7 and 10 days had an average of 3.1 and 3.2 mln respectively. A high rate of variability in the number of spermatozoa entering spermatheca was observed among inseminated queens. That was from 0.5 to 7.9 mln of spermatozoa in queens that cleared their oviducts and from

Table 4.
Number of spermatozoa in the spermatheca of queens with cleared oviducts.

Year	Age of queens (days)	Dose of semen					
		6 μ l		8 μ l		10 μ l	
		Mean number of spermatozoa in the spermatheca min-max (mln)	Sd	Mean number of spermatozoa in the spermatheca min-max (mln)	Sd	Mean number of spermatozoa in the spermatheca min-max (mln)	Sd
2006	5	3.058 0.5-5.8	1.17	3.250 2.5-7.9	1.33	3.744 1.8-6.1	1.28
	7	2.708 0.9-5.2	1.12	3.180 0.5-7.0	1.13	2.878 0.6-6.3	1.41
	10	2.624 0.5-6.5	1.03	2.942 0.6-6.2	0.98	3.090 0.6-6.5	1.03
Average		2.795 A	1.12	3.117 B	1.18	3.219 B	1.26
2007	5	3.634 0.6-5.9	1.38	3.084 0.8-5.6	0.99	4.069 1.9-6.5	1.33
	7	3.209 1.8-4.4	0.70	3.433 1.6-4.9	1.13	3.923 2.1-6.5	0.95
	10	3.851 2.1-6.0	0.89	3.764 1.3-5.2	1.01	3.638 2.6-7.0	1.45
Average		3.590 AB	1.04	3.471 A	1.05	3.872 B	1.130
2006 and 2007	5	3.215 b 0.6-5.9	1.25	3.218 a 2.5-7.9	1.30	3.872 b 1.8-6.1	1.30
	7	2.830 a 0.9-5.2	1.05	3.217 a 0.5-7.0	1.19	3.267 a 0.6-6.5	1.35
	10	3.038 b 0.5-6.5	1.14	3.116 a 0.6-6.9	1.04	3.266 a 0.5-7.0	1.20
Average		3.021 A	1.15	3.181 A	1.17	3.453 B	1.30

Table 5.
Frequency distribution of queens with cleared oviducts (%), inseminated at different ages with different doses of semen.

Number of spermatozoa in the spermatheca (mln)	Percentage of queens								
	5 days			7 days			10 days		
	6 μ l	8 μ l	10 μ l	6 μ l	8 μ l	10 μ l	6 μ l	8 μ l	10 μ l
<1.5	9.1	6.5	0	12.8	7.9	15.3	5.0	3.6	3.8
1.5 – 3.0	32.5	38.9	29.5	43.0	34.5	18.6	47.5	43.2	42.3
3.0 – 4.5	41.5	39.8	37.7	39.5	43.2	50.8	35.0	43.2	43.7
4.5 – 6.0	16.9	12.0	29.5	4.7	12.9	11.9	11.3	9.3	7.7
>6.0	0	2.8	3.3	0	1.5	3.4	1.2	0.7	2.6
total > 3.0	58.4	54.6	70.5	44.2	57.6	66.1	47.5	53.2	54.0

0.1 to 5.7 mln of spermatozoa in queens with some semen residue in their oviducts (Table 3).

It was observed that the higher the dose of semen used for insemination the higher the number of spermatozoa in the spermatheca. The highest spermatheca filling was observed when queens were inseminated with 10 μ l of semen regardless of their age. The exception were queens inseminated at the age of 7 days in 2006 and 10 days in 2007. They had a lower number of spermatozoa compared to queens inseminated at the same age with 6 and 8 μ l of semen (Table 4).

In both years of the experiment, the modal, which is the number of spermatozoa filling the spermatheca in the largest group of inseminated queens, was from 3.0 to 4.5 mln. Queens of standard value should have not less than 3 mln spermatozoa in the spermatheca. In this experiment, the percentage of queens that had more than 3 mln spermatozoa in their spermatheca was: in 5 days old queens from 54.6 to 70.5%, in 7 days old queens from 44 to 66.1% and in 10 days old queens from 47.5 to 54% (Table 5).

The correlation coefficient between the volume of spermatheca (from 0,89 to 0,93 mm³) and the number of spermatozoa filling the spermatheca (from 0.528 to 7.920 mln) was $r=0.218$ at $p=0.000$, $n=825$.

DISCUSSION

In recent years about 80 thousand honeybee queens have been inseminated in Poland. They were distributed among beekeepers before oviposition started (Troszkiewicz 2006). According to the beekeepers they are of a different quality. Some of the queens have not been accepted after introduction to the bee colonies, other were lost or did not start oviposition (Bieńkowska and Panasiuk 2006).

In the research of Woyke and Jasiński (1976) the survival rate of queens

inseminated at the age of 5 days or older was from 75 to 100%. In the present experiment the survival rate of queens inseminated at the age of 5, 7 or 10 days was 72, 82 and 86% respectively. This was the estimation 48 hours after the treatment.

In our research, the percentage of queens that did not clear their oviducts was 16.6%. This includes all individuals inseminated at the age from 5 to 10 days. This result is significantly lower than in queens kept in similar conditions obtained by other authors (Woyke and Jasiński 1976, Konopacka 1989, Gontarz et al. 2005, Bieńkowska and Panasiuk 2006). However as was stated, among the youngest queens, there was significantly more individuals that did not clear their oviducts (24%). This is compared to 7 and 10-day-olds (Table 1). This result is similar to the results obtained by others where 25% of 5 day-old inseminated queens did not clear their oviducts (Fresnaye 1966, Woyke and Jasiński 1976). Instrumentally inseminated queens with some residue of semen in their oviducts die within few days after the treatment. It is estimated that about 25% of the queens delivered to beekeepers will die.

One of the gauges of the quality of the insemination of honeybee queens is the number of spermatozoa filling the spermatheca. In the reported research, the average number of spermatozoa in the spermatheca of queens that were kept with 25 attending bees and which had oviducts cleared of semen-excess was 3.2 mln. However, taking into consideration that the filling of the spermatheca was done on queens, which were kept after insemination in cages with a low number of bees, in queenless colonies, the differences in the number of spermatozoa were not significant. When queens were kept in Zander cages without attendant bees, the average number of spermatozoa entering the spermatheca was 3.1 mln (Wilde

1995). Woyke and Jasiński (1976) found that from 3.6 to 3.9 mln of spermatozoa were in the spermatheca of 7 to 8 days old queens kept in Zander cages. However Woyke (1979) stated that queens kept in Zander cages with about 10 attendants had on an average slightly more than 3 mln spermatheca, while Woyke and Jasiński (1979) stated - 2.6 mln. Although Woyke (1959) and Woyke and Jasiński (1979) stated that queens inseminated with 8 μ l of semen and kept after treatment in optimal conditions in or outside the bee colony, had on an average more than 4 mln of spermatozoa in their spermatheca.

According to Mackensen (1955) the age of a queen influences the filling of her spermatheca. Other researchers (Woyke and Jasiński 1976) stated that number of spermatozoa entering spermatheca increases, when the age of the inseminated queens is higher. This is true up to the 8-10th day of a queen's life. When the queen is older, the spermatheca filling is lower. However, in this research, the highest spermatheca filling was among queens inseminated at the age of 5 days (the average 3.4 mln). A lower number of spermatozoa was in the group of queens inseminated at the age of 7 and 10 days, regardless of the dose of semen used. The highest percentage of individuals with a residue of semen (23.8%) was found from among the youngest queens.

In the reported research, according to Woyke (1960), the higher the dose of semen used for insemination the higher the average number of spermatozoa in the spermatheca. In both years of this experiment, however, it was observed only among the youngest queens (5 days old) when inseminated with 10 μ l of semen.

In this experiment inseminated queens had from 0.5 to 7.9 mln spermatozoa in their spermatheca. Woyke (1958, 1960) obtained similar result (from 0.7 to

7.9 mln.). Therefore the results can be seen to be characterized by a high variability. However Woyke and Jasiński (1976, 1979), regardless of the method of keeping queens after insemination, observed lower variability of the spermatheca filling.

In both years of this experiment, the modal, which is the number of spermatozoa filling the spermatheca in the largest group of inseminated queens, was from 3.0 to 4.5 mln. According to Woyke (1958, 1960) queens that did not mate naturally and started oviposition after being inseminated had more than 3 mln spermatozoa in their spermatheca. In our experiment the percentage of such queens was from 44.2 to 70.5%. Therefore the percentage of queens with proper aspermatheca filling was lower than queens that naturally mated (Woyke 1960). However this is acceptable in such a mass production where some of the factors are omitted.

SUMMARY AND CONCLUSIONS

Keeping the queens after insemination in cages with 25 attendant workers in queenless colonies is not the best method. However, with regard to economical conditions, it is the only method adapted in mass production of instrumentally inseminated queens. The lower quality queens (higher percentage of queens with semen-residue in their oviducts as well as a lower number of spermatozoa in their spermatheca) seems to be connected with the method of keeping them after insemination.

— Queens inseminated at the age of 5 days have a significantly higher number of spermatozoa in their spermatheca than 7 and 10 days old. However, a higher percentage of 5-day-old queens do not clear the oviducts from the excess of semen.

- The higher the dose of semen used for insemination of 5-day-old queens, the higher the number of spermatozoa filling the spermatheca.
- The dose of semen does not influence the filling of the spermatheca in 7 and 10 days old queens.
- Simplification of the production-technology of instrumentally inseminated queens, affects optimal conditions. It is associated with a higher number of queens with a residue of semen in their oviducts and a lower number of spermatozoa in their spermatheca.
- From among queens inseminated at the age of 5 days old, 25% die. They should not be distributed to commercial apiaries.

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WPŁYW WIEKU MATEK I DAWKI NASIENIA NA JAKOŚĆ MATEK SZTUCZNIE UNASINIANYCH PRZETRZYMYWANYCH W RODZINIE PSZCZELEJ W KLATECZKACH Z OKOŁO 25 PSZCZOŁAMI

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

Celem badań było określenie wpływu wieku matek i dawki nasienia na wypełnienie zbiorniczków nasiennych i stan jajowodów w warunkach prowadzenia masowego sztucznego unasieniania.

Badania prowadzono w 2006 i 2007 roku, w pasiece hodowlanej Oddziału Pszczelnictwa w Puławach. Łącznie unasieniono 1027 matek pszczelich linii „Marynka” w wieku 5, 7 i 10 dni, różnymi dawkami nasienia 6, 8 i 10 mm³, pobieranego od trutni rasy kaukaskiej. Matki do czasu unasienienia przetrzymywano w laboratorium w temperaturze pokojowej, w dwukomorowych klateczkach transportowych wraz z pszczołami. Po unasienieniu, matki w klateczkach z 25 pszczołami przetrzymywano przez 48 godzin w osieroconych rodzinach pszczelich. Następnie matki zabijano i preparowano w celu określenia stanu jajowodów i liczby plemników w zbiorniczkach nasiennych.

W przedstawionych badaniach, spośród matek unasienianych w wieku 5, 7 i 10 dni odpowiednio 72, 82 i 86% opróżniło jajowody. Istotnie najczęściej matek (24%) nie opróżniło jajowodów po unasienieniu w wieku 5 dni. (Tab. 1). Procent martwych matek po 48 godzinach od inseminacji wynosił od 2,3 do 3,8%.

W naszych badaniach średnia liczba plemników w zbiorniczkach nasiennych matek, które opróżniły jajowody, wynosiła 3.199 mln plemników. Istotnie najlepiej wypełnione zbiorniczki nasienne miały matki 5-dniowe (średnio 3.379 mln plemników), natomiast mniej plemników było w zbiorniczkach matek starszych - 7 i 10 dniowych bez względu na dawkę nasienia (Tab. 3).

Wraz ze wzrostem dawki nasienia zwiększała się średnia liczba plemników w zbiorniczkach nasiennych matek w każdym wieku, co jest zgodne z wynikami badań Woyke (1960). W obu latach istotnie najwięcej plemników znajdowało się w zbiorniczkach nasiennych matek najmłodszych (5-dniowych) unasienianych 10 μ l nasienia (Tab. 4).

W omawianych badaniach matki miały w zbiorniczkach nasiennych od około 0,500 do około 7.900 mln. plemników podobnie jak w badaniach Woyke (1958, 1960) od 0,693 do 7,915 mln., a więc rozpiętość była bardzo duża (Tab. 3 i 4).

W obu latach, modalna tj największa grupa matek miała w zbiorniczkach od 3.000 do 4.500 mln. plemników (Tab. 5). Według Woyke (1958, 1960) matki, które w warunkach naturalnych nie unasieniały się ponownie, a rozpoczęły czerwienie, miały w zbiorniczkach nasiennych więcej niż 3 mln. plemników. W naszych badaniach procent takich matek wynosił od 44,2 do 70,5%. Wynika z tego, że rozkład procentowy matek w zależności od wypełnienia zbiorniczków nasiennych jest mniej korzystny, niż u matek naturalnie unasienionych (Woyke 1960). Biorąc jednak pod uwagę odejście w technologii produkcji matek od zapewnienia im optymalnych warunków po sztucznym unasienieniu, wynik ten nie jest najgorszy.

Należy przypuszczać, iż spośród matek unasienionych w wieku 5 dni i dostarczonych pszczelarzom około 25% padnie. Nie należy, więc takich matek sprzedawać.

Słowa kluczowe: wiek matek pszczelich, dawka nasienia, inseminacja, wypełnienie zbiorniczków nasiennych, opróżnianie jajowodów.