ISSN 1644-0714
ISSN 2300-6145 (online)
DOI:10.21005/asp.2016.15.1.03
www.asp.zut.edu.pl

ACTA SCIENTIARUM POLONORUM

Acta Sci. Pol. Zootechnica 15(1) 2016, 31–40

COMPARISON OF THREE METHODS OF QUEEN BEE INTRODUCTION IN A STATIONARY COMMERCIAL APIARY

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Abstract. Three methods of queen introduction to honey producing colonies using a metal one-frame isolator, a round queen's cap, and a standard mailing cage were evaluated. In total, 60 *Apis mellifera carnica* queens, naturally inseminated, with verified oviposition, were introduced, 20 per each method. The queens were introduced in two series, 10 in each of them, in the commercial nectar-flow period and in the post-nectar-flow period, during the feeding of bees for winter. The efficiency of queen introduction in high season amounted to 95%, whereas 100% after the post-nectar-flow period. In the method with a metal one-frame isolator, 65% of queens started egg laying to 24 hours after the time of introduction. In the method using a metal round queen's cap, 90% of queens laid eggs to 48 hours after introduction. In the method using a mailing cage, 90% of queens started oviposition between 48–72 hours after introduction.

Key words: *Apis mellifera*, queen bee, replacement, oviposition

INTRODUCTION

Modern bee management is based on using various natural nectar flows and, increasingly, those being grown in the so called monocultures. Especially the latter occupy ever greater areas of our country forcing the beekeepers to run an apiary towards maximum development of bee colonies from as early as the beginning of April. This is because winter oilseed rape bloom in this period of time and honey from this crop constitutes approximately 30–60% of annual honey production in most apiaries, particularly in stationary ones. Bee colonies with young one-year-old queens produce 19–30% more honey than those with older queens [Woyke

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1984, Genc 1992, Inci 1999]. Although sometimes a large number of bees in a bee colony does not always determine its good productivity [Woyke 1984]. Under intensive bee management, interruption of oviposition due to queen replacement may however adversely affect utilisation of successive nectar flows [Gąbka 2009]. Apart from that, old queens lay significantly fewer eggs to raise enough worker bees, particularly before overwintering. Lack of the sufficient number of bees in a bee colony with old queen frequently leads to whole colony falling at the end of winter or in early spring [Kartanoğlu 1987, Genc 1992, Tarpy et al. 2000]. Young one-year-old queens can lay by 90% more eggs than three-year-old one and by 30% more than two-year-old ones [Akyol et al. 2007]. One of the reasons for reduced number of eggs being laid by a queen is the time of sperm storage in the spermatheca. The longer this time, the smaller the number of live spermatozoa, and hence the number of fertilised eggs being laid is reduced [Al-Lawati et al. 2009].

Another aspect that should be highlighted when substantiating the replacement of queens in bee colonies is the state of bee health. Especially in these times of occurrence of many disease, particularly of varroosis, which is caused by an external parasitic mite Varroa destructor and which, in view of recent research, is most likely responsible for CCD [Lipiński 2014], and nosemosis, being caused by Nosema cerane [Paxton 2010] and which affects the length of bee life – its intensity is greater in bee colonies with queens being older than one year and, in consequence, the productivity of bee colonies is being reduced [Simeunovic et al. 2014]. Moreover, excessive use of chemicals in agriculture and in the beekeeping itself causes that queen replacement is an alternative for running bee farms without interfering with the natural environment of hive beyond all bounds, which leads to the production of healthy food as a consequence.

The aim of this study was to compare the efficiency of three methods of queen introduction to honey-producing colonies in a stationary apiary.

MATERIAL AND METHODS

Bee colonies in a stationary apiary were selected to perform an experiment in the southern part of West Pomeranian region (N 52°53′, E 14°27′). The colonies were settled in the Wielkopolski (box-type, wooden) hives with ten standard frames (360×260 mm), arranged warm way. In total, 60 honey-producing colonies with two-year-old queens *Apis mellifera carnica* were prepared. The bee colonies had from 5 to 7.5 kg of carbohydrate food [Lipiński 2013], about 1.5 kg of beebread, and 8–9 combs with brood at different stages of ontogenesis each. Young bees, largely non-flying, prevailed.

For replacement, *Apis mellifera carnica* queens, naturally inseminated, from breeding apiaries, were used; they were delivered in 24 hours after collection from mating nuclei, their weight was at least 200 mg. The queens were introduced using a full, one-frame isolator with a plastic disc, a round queen's cap measuring 10 cm in diameter, and a mailing cage. Round queen's caps and full isolators were made of stainless acid-resistant steel with 2×3 mm mesh, whereas mailing cages were made of plastic with two chambers for honey-and-sugar candy. In a one-frame isolator, a queen was introduced on a comb, without bees, with 1–2 dm^2 of brood upon entry, stores of food and empty cells for laying eggs by queens. A queen's cap with a queen was placed on a fragment of comb with some bees emerging from cells and empty cells being prepared for egg laying. A mailing cage with a queen was mounted to the bottom bar of half-height super frame. In all these methods, a comb in isolator with a queen's cap and a frame with a cage were inserted into the centre of the brood nest, between combs with emerging brood.

Two series of queen replacement, 30 queens in one series each, were performed. The first series was introduced in high season during the commercial nectar-flow period. The second series was introduced at the end of season in the post-nectar-flow period. One series consisted of ten queens being introduced in a queen's cap, and as many queens in an isolator and a mailing cage. The queens were introduced without accompanying bees [Skubida 2004], whereas the bee colonies were made queenless for a period of 1 to 2 hours before introduction of young queen. In the bee colonies, prior to making them queenless, old queens were closed in wooden cages ($50\times50\times20$ mm in size) with an excluder for a period of 24 hours. The cages were placed on the top bars of brood box frames in the central part of hive. After this time, the cages with queens were taken away and, instead, a young queen was introduced, depending on the method, in an isolator, queen's cap or mailing cage after 1–2 hours. After 24 hours, a revision of bee colonies was conducted, and potential queen cell cups were broken down. Then, a plastic protection was removed from the opening in mailing cages, leaving a honey-and-sugar candy plug. In the "under a queen's cap" method, a small opening was made in the comb under the rim and it was plugged with honey-and-sugar candy. In one-frame isolator, the opening in its wall, on a plastic disc, was plugged. The amount of candy in all the methods was sought to be such that the time when bees ate through it to a queen was not longer than 8–10 hours (own observations). The inspections of queen acceptance or killing and the time after which queens initiated oviposition were carried out at intervals of 24, 48 and 72 hours.

RESULTS

In total, 60 queens were replaced, 20 ones per each method. The results displayed in Table 1 present the arrangement of introduced queen bees taking into account the efficiency obtained in respective technical solutions. The data collected show that a 95% acceptance was obtained, which means that 57 of the queens were accepted by bee colonies. In each method, one young queen was lost.

Table 1. Acceptance of replaced queen bees in bee colonies

Tabela 1. Przyjęcie wymienianych matek pszczelich w rodzinach

Method of introduction Metoda poddania	Number of queen bees Liczba matek		Percentage of accepted queen bees Procent przyjętych matek
	introduced poddanych	accepted przyjętych	
One-frame isolator – Izolator ramkowy	20	19	95.0
Round queen's cap – Kołpak okrągły	20	19	95.0
Mailing cage – Klateczka wysyłkowa	20	19	95.0
Total – Łącznie	60	57	95.0

In the first series of queen replacement being conducted in high season, during the commercial nectar-flow period, a 90% acceptance in queen introduction was obtained. In the second series, the queens were introduced at the end of season in the post-nectar-flow period, during replenishment of stores for winter. In this series, a 100% efficiency in the acceptance of introduced queens was obtained (Table 2).

Table 2. Efficiency of queen bee replacement according to time of season

Tabela 2. Skuteczność wymiany matek w zależności od pory/sezonu

Time of replacement Okres wymiany	Number of queen bees Liczba matek		Percentage of accepted queen bees Procent przyjętych matek
	introduced poddanych	accepted przyjętych	
High season in commercial honey-flow period Pełnia sezonu w okresie pożytku towarowego	30	27	90.0
End of season in post-honey-flow period Koniec sezonu w okresie popożytkowym	30	30	100.0

Table 3 shows the results obtained in two series of queen introduction taking into account the time after which the queens started egg laying in bee colonies. The queens started oviposition at the earliest in the method with a full one-frame isolator. To 24 hours after introduction, 65% of queens started oviposition. The queens being introduced "under a queen's cap" started oviposition later that in the

method with a full one-frame isolator but earlier than those being introduced in mailing cages. In this method, 90% of queens started oviposition to 48 hours. In contrast, the queens being introduced in mailing cages started oviposition at the latest. In this method, 90% of queens started egg laying between 48 and 72 hours after introduction.

DISCUSSION

This experiment shows that the efficiency being obtained is significantly higher that the values presented in literature. According to Skubida and Pohorecka [2000], it is possible to obtain a 75–89% efficiency in the method with mailing cages. Marcinkowski [1982] has found that the method with a queen's cap allows obtaining the efficiency at a level of 88%. Gerula et al. [2007] have obtained a 77% efficiency in one-frame isolators when introducing queens without interracial compatibility. High efficiency being obtained in the conducted experiment can be explained by meeting several conditions. The first such aspect was the location of young queen between combs with emerging brood, and, what is more important, young bees prevailed in bee colonies, which encourages the process of young queen acceptance [Chuda-Mickiewicz 2008]. Also the time after collection of queens from mating nuclei to their introduction to bee colonies was approached rigorously. In each case, 24 hours were not exceeded because, according to Bieńkowska [2006], transport-exhausted, chilled or overheated queens are reluctantly accepted by new bee colonies. Moreover, keeping young queens in confinement, particularly in June, makes bees to damage highly significantly more queens in this period of time than in July and August [Gąbka et al. 2015]. As a consequence, bees can replace a damaged queen by supersedure [Gerula et al.

Table 3. Initiation of oviposition by introduced queen bees

Tabela 3. Rozpoczynanie czerwienia przez poddane matki

Method of introduction Metoda poddania	Number of introduced queen bees Liczba poddanych matek	Percentage of queen bees laying eggs from introduction to initiation of oviposition after it Procent matek czerwiących od poddania do rozpoczęcia czerwienia po			
		24 h	48 h	72 h	total łącznie
One-frame isolator Izolator ramkowy	20	65.0 (13)	25.0 (5)	5.0 (1)	95.0
Round queen's cap Kołpak okrągły	20	40.0 (8)	50.0 (10)	5.0 (1)	95.0
Mailing cage Klateczka wysyłkowa	20	5.0 (1)	50.0 (10)	40.0 (8)	95.0

2000]. Also the weight of introduced queens was an important aspect (at least 200 mg); this is because such queens are accepted around 96%, while those weighing 180 mg only in 47% [Taranov 1973]. Subspecies affiliation is important, too. For the most part, the queens of different subspecies are reluctantly accepted by bee colonies [Chuda-Mickiewicz 2008]. In this study, however, queens and bees in the bee colonies, to which they had been introduced, were of the same subspecies. An important factor affecting the obtained efficiency was the fact that the queens being introduced were laying eggs. According to Chuda-Mickiewicz [2008], bees accept worse the non-inseminated and artificially inseminated queens without verified oviposition than the egg-laying ones, naturally or artificially inseminated. Moreover, the results obtained confirm that it is better to introduce queens in late July and early August or later because, according to Gerula [2007], the efficiency in that time reaches 92%, while in June is lower by more than 20%.

An important aspect that differs all these technical solutions is the time of initiation of oviposition by a queen. The method with a mailing cage is a technique in which queens initiated oviposition ate the latest. If we do not limit queen bees in egg laying and, due to abundant and interrupted nectar flows, we are concerned about strong bee colonies, this method is not an optimal one in such a bee management. The method with a full one-frame isolator is a technique which allows of the fastest initiation of oviposition by young queens in a bee colony. These findings are confirmed by the observations made by Gerula [2007] who has found that the queens being introduced in mailing cages started egg laying significantly later when compared with the method with a one-frame isolator. The disadvantage of this method, however, is the searching for an appropriate comb with emerging brood. This solution is even more problematic that it can take up much time to a bee-keeper in a honey-producing apiary numbering several dozen of bee colonies. In the method with a round queen's cap, the results obtained (time of initiation of oviposition) are comparable with the method with a full one-frame isolator. However, it is devoid of tedious searching for whole combs with emerging brood. In the "under a queen's cap" method, only ten emerging bees closed together with a young queen bee are already enough. The simplicity of this method is a factor which caused that it should be recommended and disseminated among bee-keepers.

CONCLUSIONS

The results obtained show that, regardless of the method being applied, a very high efficiency in introduction of queens to bee colonies was obtained. It was also found that this efficiency depends on the time of season. In high season, in the

commercial nectar-flow period, the efficiency reached 90%. At the end of season, in the post-nectar-flow period, it reached 100%.

The waiting time for starting egg laying by queens was the shortest in the method with a full one-frame isolator, whereas the longest one in the method with a mailing cage. The method with a round queen's cap is a technique in which queens started oviposition later than in the method with an isolator but earlier than in the method with a mailing cage.

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PORÓWNANIE TRZECH METOD PODDAWANIA MATEK PSZCZELICH W STACJONARNEJ PASIECE PRODUKCYJNEJ

Streszczenie. Oceniono trzy metody poddawania matek do rodzin produkcyjnych z użyciem: izolatora metalowego – jednoramkowego, okrągłego kołpaka metalowego oraz standardowej klateczki wysyłkowej. Ogółem poddano 60 matek *Apis mellifera carnica*, naturalnie unasiennionych ze sprawdzonym czerwieniem, po 20 w każdej z metod. Matki poddawane były w dwóch seriach po 10 w okresie pożytku towarowego oraz w okresie popożytkowym, podczas dokarmiania na zimę. Skuteczność poddawania matek w pełni sezonu wyniosła 95%, a w okresie popożytkowym 100%. W metodzie z użyciem izolatora ramkowego 65% matek rozpoczęło czerwienie do 24 godzin od momentu poddania. W metodzie z użyciem kołpaka metalowego do 48 godzin od poddania czerwiło 90,0% matek. W metodzie z użyciem klateczki wysyłkowej między 48 a 72 godziną od poddania 90,0% matek rozpoczęło czerwienie.

Słowa kluczowe: *Apis mellifera*, matka, wymiana, czerwienie

Accepted for print: 10.12.2015

For citation: Karwan, D. (2016). Comparison of three methods of queen bee introduction in a stationary commercial apiary. Acta Sci. Pol. Zootechnica, 15(1), 31–40.