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SHORT COMMUNICATION

Techniques to Increase Queen Production in *Bombus terrestris* L. Colonies [1]

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Summary

To increase the production of queens in *B. terrestris* colonies, after the emergence of the first workers, colonies were randomly allocated to four groups as comprised 4 colonies in each of them. Colonies in control group (group 1) were formed without adding workers or pupae from a different colony, while colonies in group 2, group 3 and group 4 were designed by adding 60 pupae from a different colony, adding 60 workers from a different colony and placing two colonies (queens) together in the nest box, respectively. The two- queen colonies could not be developed because of aggressiveness towards each other. The average number of queens produced per colony in control, group 2, and group 3 colonies were 56.3±35.9, 72.5±25.0 and 145.3±61.8, respectively. The results showed that adding workers from a different colony can be used as a useful method in the rearing of bumblebee queens.

Keywords: *Bombus terrestris, Queen breeding, Colony management*

Bombus terrestris L. Kolonilerinde Ana Arı Üretimini Artırma Teknikleri

Özet

B. terrestris kolonilerinde ana arı üretimini artırmak için ilk işçi arıları çıktıktan sonra koloniler, her birinde dört adet koloni olacak şekilde rast gele dört gruba ayrılmıştır. Kontrol grubunu (grup 1) oluşturan kolonilere farklı bir koloniden işçi arı veya pupa eklenmemişken, 2. gruptaki kolonilere başka bir koloniden 60 adet pupa, 3. gruptaki kolonilere farklı bir koloniden 60 adet işçi arı eklenmiştir. 4. gruptaki koloniler ise tek bir yuvada iki ana arının (kolonin) birleştirilmesiyle oluşturulmuştur. Birbirlerine karşı saldırgan davranışlardan dolayı iki ana arılı koloniler geliştirilememiştir. Koloni başına üretilen ortalama ana arı sayısı kontrol grubu, 2. grup ve 3. grup kolonilerinde sırasıyla 56.3±35.9 adet, 72.5±25.0 adet ve 145.3±61.8 adet bulunmuştur. Elde edilen sonuçlar, farklı bir koloniden işçi arı ilavesinin bombus arısı ana arı yetiştiriciliğinde faydalı bir yöntem olarak kullanılabileceğini göstermiştir.

Anahtar sözcükler: *Bombus terrestris, Ana arı üretimi, Koloni yönetimi*

INTRODUCTION

Recently commercially reared bumblebee colonies are increasingly used in greenhouses and orchards for pollination of different crops. Commercial bumblebee rearing has expanded rapidly since 1987 and almost one million colonies are produced annually. Currently five species of bumblebees are reared commercially. The main species is the Eurasian *Bombus terrestris* L. Bumblebee producers today have reared colonies under standardized breeding conditions [1]. These producers have developed their own rearing systems which have become independent from field collected queens, but commercial breeders have not published any comparative data. One of the major problems of the breeding bumblebees is the production of queens for continuing the next rearing cycle [2]. *B. terrestris* colonies show much variation in the number of workers, males, and queens produced [3]. Some colonies produce only males or only queens, some colonies produce both males and queens, while some colonies produce neither males nor queens, even if colonies are maintained under similar controlled conditions [4-6]. In commercial rearing, one of the main criteria is how many

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of 100 queens can establish colonies of saleable quality (including around 50 workers). Early male and progeny queen producing in the colonies, mating, managing diapause and the founding of new colonies are major problems during the year round rearing of bumblebees. Major losses occur during these stages [1,2,3]. Although accurate information is not available, this ratio is estimated to be not more than 50% in commercial companies. Therefore, main difficulty for commercial *B. terrestris* rearing has been the production of young queens in sufficient numbers to meet the demand of a rapidly increasing market for colonies [7]. The objective of this study was to compare three different colony models; colonies with additional workers, colonies with additional pupae and two-queen colonies in order to improve queen production in *B. terrestris* colonies.

MATERIAL and METHODS

Experimental queens were obtained from *Bombus terrestris* L. colonies reared in the Animal Science Laboratory, Akdeniz University. After the mated queens had hibernated for two months in refrigerator at 4.0±0.5°C, they were anesthetized with CO_2 once for 30 min and placed separately in the small starting box with two callow honey bee workers to stimulate egg laying. All queens and colonies were kept in captivity in standard laboratory rearing conditions (27±1°C and 60±5% RH) and fed with the same sugar syrup and fresh pollen collected from honeybee colonies ad-libitum. After the emergence of the first workers, when the colonies comprised 10-20 workers and many diploid larvae, experimental colonies were randomly divided into four groups. The following groups were tested: (group 1) the control group (without adding workers or pupae from a different colony), (group 2) adding 60 pupae from a different colony, (group 3) adding 60 workers from a different colony and (group 4) placing two colonies (queens) together in the nest box. A total of four colonies were used for each group. Before the workers adding in group 3, workers were kept in a room without any queen and brood for 24 hours. In two queen group, to prevent aggressiveness towards each other, queens and workers from two different colonies were exposed to CO_2 for 5 min. Immediately afterwards, queens and workers from two different colonies were placed together in the nest box. Colony development was tracked by daily observation. During observations, produced new queens (gynes) were removed colonies and noted to calculate the total number of queens produced by each colony. Descriptive statistics relating to the total number of queens (gynes) produced by each colony were calculated by using MINITAB statistical program.

RESULTS

In this study, various methods have been tested to improve the production of queens in *B. terrestris* colonies. One of them is the two- queen method. A total of eight colonies were used for this method. As soon as the queens and workers from two different colonies were exposed to CO_2 for 5 min, two different colonies were placed together in the nest box. However, because of aggressiveness towards each other, one of the two queens died in the each nest box. Therefore two- queen colonies could not be obtained. *Table 1* shows the comparison of the other three groups. All the colonies that were added workers produced queens, but only % 50 (2/4) of control colonies produced queens. Colonies that were added workers produced a total of 581 queens, with an average of 145.3 per colony, whereas colonies that were added pupae produced a total of 290 queens, with an average of 72.5 per colony. Control colonies produced a total of 225 queens, with an average of 56.3 per colony.

Table 1. *Comparison of the numbers of queens produced in colonies*
Tablo 1. *Kolonilerde üretilen ana arı sayılarının karşılaştırılması*

Colony Number	Groups		
	Group 1 (Control)	Group 2	Group 3
1	0	0	36
2	0	79	64
3	75	105	173
4	150	106	308
Total numbers of queens produced	225	290	581
Means± SE	56.3±35.9	72.5±25.0	145.3± 61.8

DISCUSSION

Many factors such as split sex ratio, worker/larva ratio, food quality and quantity, diapause history of founder queen have an influence on male and queen production [4,8]. Previous studies showed that native *B. terrestris* populations tend to produce fewer queens than commercial colonies. Yeninar and Kaftanoglu [9] and Yeninar et al.[10] reported that the colonies founded by the queens collected from the field produced an averaged of 27.8±9.1 and 31.3±4.61 queens, respectively. Similarly, Ings et al.[11] found that commercial colonies produced significantly more queens than native colonies under identical field conditions. The high queen production of commercial colonies may be due to the short diapause and/or queen production process. This is because commercial companies are likely to minimize diapause length and have selected for high queen producing colonies to increase turnover [11]. Previous studies also demonstrated that queenlessness induced significantly earlier onset of queen production [5,6,8]. But Gosterit et al.[12] found that queen removal did not seem to have a direct influence on the number of gynes and males produced, although queenless colonies started to gyne production significantly earlier than queenright colonies. Queen and male production occur under several different social conditions; not only in the presence of the queen, but also

in the absence of queen [5]. Ruijter et al.[13] discovered that adding workers from different colony was a significant improvement in the rearing of bumble queens. Similarly in this study, colonies that were added workers reared more than twice as many queens as the control colonies. Therefore adding workers from different colony can become a useful method in the queen rearing of *B. terrestris*. But there is a notable variation among colonies in terms of the number of queen produced. To optimize queen production all the factors affecting queen production should be examined in detail.

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