Effects of queen ages on Varroa (Varroa destructor) infestation level in honey bee (Apis mellifera caucasica) colonies and colony performance

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ABSTRACT

This study was conducted to determine the effects of queen age on varroa population levels in hives and performance of honey bee (A. mellifera caucasica) colonies. Levels of varroa infestation and performances of the colonies which had 0, 1- and 2-year-old queens were compared in mild climate conditions. Varroa numbers on adults and drone brood, number of frames covered with bees and brood areas were determined every month between 10 May and 10 October 2004. Overall average (± S.E.) % infestation levels of varroa were found to be 5.96 ± 1.42, 11.58 ± 1.46 and 15.87 ± 1.39% on adult bees and 21.55 ± 1.43, 31.96 ± 1.44 and 37.55 ± 1.45% in drone brood cells for 0, 1- and 2-year-old queen colonies, respectively.

The colonies which had 0, 1- and 2-year-old queens produced 2673.58 ± 39.69, 2711.75 ± 39.68, and 1815.08 ± 39.70 cm² overall average (± S.E.) sealed brood and 10.35 ± 0.24, 10.43 ± 0.26 and 7.51 ± 0.21 numbers of frame adult bees, respectively. Honey harvested from 0, 1- and 2-year-old queen colonies averaged 21.60 ± 5.25, 22.20 ± 6.55, and 14.70 ± 2.50 kg/colony, respectively. The colonies headed by young queens had a lower level of varroa infestation, a greater brood area, longer worker bee population and greater honey yield in comparison to colonies headed by old queens.

Key words: honey bee, Apis mellifera caucasica, Varroa destructor, Queen age, Colony performance.

RIASSUNTO

Lo studio è stato intrapreso per determinare gli effetti dell’età della regina sul livello di infestazione da varroa e sulle prestazioni produttive di colonie di ape mellifera (Apis mellifera caucasica). Sono stati confrontati il livello di infestazione da varroa e le prestazioni produttive di 30 colonie equamente divise in 3 gruppi in funzione dell’età della regina (0, 1 e 2 anni). Il livello di infestazione da varroa, il numero di favi...
Introduction

Turkey is one of the most suitable countries for beekeeping with its rich flora, suitable ecology and colony number. The productivity of the colonies is lower than the average world values (Akyol and Kaftanoglu, 2001). The main reasons for this fact could be the usage of old queens, bad management conditions, high rate of varroa damage and poor struggle against parasites and diseases (Kumova, 2003).

Besides genetic structure and environmental factors, queen age and quality are the most important factors that influence the brood production, colony growth rate, wintering abilities, pollination facilities and productivity of the colonies (Genc, 1992; Kaftanoglu et al., 1995). The laying ratio of old queens could decrease depending on the age and they may lay more unfertilised eggs than young queens. The colonies headed by old queens may produce more drone broods and drones than colonies headed by young queens (Genc, 1992).

Because of the more juvenile hormone levels, drone broods are preferred by the Varroa destructor to feed and breed (Kumova, 2003). In addition, the pupae period of drones is longer than that of workers and queens (Akyol et al., 1997; Goodwin and Eaton, 2001). While two or three varroa could become adults in a worker brood cell, four or five varroa might become adults in a drone brood cell (Goodwin and Eaton, 2001).

It was reported that colonies with a one year old queen have a larger colony population and produce 27-30% more honey yield compared to colonies with two year old queens (Woyke, 1971; Genc, 1992). Beekeepers either lose a great amount of their colonies in winter or they start with a weak colony population in the Spring season. The level of varroa infestation and the use of old queens could be the main reason for the loss of colonies in winter (Genc, 1990; Kaftanoglu et al., 1995). Varroa was first reported in Turkey in 1977. Since then damage caused by varroa mites has resulted in the destruction or weakening of thousands of colonies (Mimiglioli and Goksu, 1984; Akkaya and Goksu, 1990; Doganay, 1993, 1994).

This study was carried out in order to determine the effects of queen age on varroa infestation level and colony performance.

Material and methods

This experiment was performed in Mid Anatolia (at 37°29’20” N longitude, 34°37’42” E latitude and 1520 m altitude) between 10 May and 10 October 2004. Apis mellifera caucasica colonies were used in this experiment. The queens had been reared by Grafting method (Laidlaw, 1979), came from same genotype and naturally mated in the same location in different years. Experimental colonies were housed in standard Langstroth hives and equalized in
regard to colony strength (5 frames with bees, sealed brood areas and food stocks) on 10 May 2004. Each group consisted of 10 colonies and requeenled 0, 1- and 2-year-old queens. The same management applications were applied to all colonies throughout the experiment.

The colonies were controlled regularly at 30-day intervals between 10 May and 10 October 2004. The numbers of frames with adult bees, sealed brood area (cm²), the numbers of varroa in sealed drone cells and on the adult bees were recorded. The wash and roll technique (De Jong et al., 1982) was used to determine % varroa infestation level on adult bees. Two hundred capped drone cells on different frames were randomly selected and opened. The number of adult female varroas on drone prepupae and pupae were recorded. The acaricide treatments were done using fumigant strips (20 mg amitraz/strip, Vamitrat-VA®) three times with three day intervals after the honey yield in September.

The Puchta method was used to calculate the amount of brood areas (cm²) (Fresnaye and Lensky, 1961). Adult bee population was determined by counting the number of frames with bees (Dogaroglu et al., 1992). Honey yield was determined as described by Dogaroglu (1982).

Statistical analysis of colony characteristics (number of frames with bees, brood areas) and % Varroa infestation level in sealed drone cells and on adult bees were analysed by Repeated Measure (GLM), honey yield was analysed by randomised plot design (ANOVA). Box's M tests and Levene Statistic were used for testing homogeneity among dependent variables. Group comparisons among the means were done with Duncan’s multiple range test and different statistical groups were given different letters in tables (Little and Hills, 1975). SPSS (2006) software was used for statistical analysis.

Results and discussion

Varroa infestation on adult worker bees

The average (± S.E.) % number of varroa on adult worker bees in 0, 1- and 2-year-old queen colonies are summarized in Figure 1.

Overall average (± S.E.) % numbers of varroa on adult worker bees were found to be 5.96 ± 1.42, 11.58 ± 1.46, and 15.87 ± 1.39 for 0, 1- and 2-year-old queen colonies, respectively. Differences among the groups were found statistically significant (P<0.01, df:2, f:11.40).

Varroa infestation rates of the colonies headed by old queens increased more than the colonies headed by young queens. Queen age significantly affected the varroa infestation rates. The varroa infestation rate on adult worker bees increased up to 18.7, 41.1, and 58.2% in September in 0, 1- and 2-year-old queen colonies.

The findings of this study as respects the Varroa infestation rate on adult worker bees were in agreement with the results obtained by Ilikler and Yuzbas (1980), Akkaya (1996), Genc and Aksoy (1992), Akkaya and Vurusaner (1996) and Kumova (2001).

Level of varroa infestation in drone cells

Overall average (± S.E.) % numbers of varroa in the drone cells were found to be 21.55 ± 1.43, 31.96 ± 1.44, and 37.55 ± 1.45 for 0, 1- and 2-year-old queen colonies, respectively. Seasonal variation of % numbers of varroa on drone prepupae and pupae are shown in Figure 2.

Differences among the 0, 1- and 2-year-old queen colonies, % varroa infestation in drone
cells were found to be significant (P<0.01, df:2, f:32.11). The varroa infestation rate in the drone cells reached the maximum in September (75.9, 117.4, and 146.1%), but after the chemical treatment (amitraz) it decreased to 13.0, 22.4, and 29.7 % in 0, 1- and 2-year-old queen colonies, respectively. Ilikler and Yuzbas (1980) assumed the average rate of varroa infestation in drone cells between 31.0 and 44%. In this study, the varroa infestation rate that was found in drone brood cells was in agreement with the results obtained by Ilikler and Yuzbas (1980) and Genc (1994).

**Brood production**

Average sealed brood production of 0, 1- and 2-year-old queen colonies were found to be 2673.58 ± 39.69, 2711.75 ± 39.68, and 1815.08 ± 39.70 cm²/colony, respectively (Figure 3).

0 and 1-year-old queen colonies showed similar brood patterns during the research season. The brood production of 0 and 1-year-old queen colonies was 50 % higher than 2-year-old queen colonies. Differences among the groups on brood areas were found significant (P<0.01, df:2, f:166.96). The average brood production of 0 and 1-year-old queen colonies was found to be higher than the results obtained by Guler and Kaftanoglu (1999), Gurel (1995), Akyol et al. (1999), Akyol and Kaftanoglu (2001), Dogaroglu et al. (1992) (1184.8, 1806, 1616, 1698), but the results agreed with those obtained by Firatli and Budak (1994), Genc et al. (1999) and Arslan et al. (2004) (2570, 3055.6, 2864 cm²).

**Adult bee population**

The overall average number of frames of bees (± S.E.) were found to be 10.35 ± 0.24, 10.43 ± 0.26, and 7.51 ± 0.21 for 0, 1- and 2-year-old queen colonies, respectively. Ilikler and Yuzbas (1980) assumed the average rate of varroa infestation in drone cells between 31.0 and 44%. In this study, the varroa infestation rate that was found in drone brood cells was in agreement with the results obtained by Ilikler and Yuzbas (1980) and Genc (1994).
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population were found statistically significant (P<0.01, df:2, f:46.18).

The use of a young queen has a positive affect on the colony strength. Average adult bee populations of colonies headed by a young queen (0 and 1-year-old) were found higher than the results obtained by Firatli and Budak (1994), Gencer (1996), Guler and Kaftanoglu (1999), Akyol et.al. (1999), Akyol and Kaftanoglu (2001 (7.96, 7.90, 8.68, 8.90, 8.17 number/colony) and the results agreed with the previously reported data by Dogaroglu et al. (1992), Dodologlu and Genc (2001) (10.80, 10.88 number/colony). Average number of frame with bees of colonies with a 2-year-old queen showed similar results to those obtained by Firatli and Budak (1994), Gencer (1996), Guler and Kaftanoglu (1999), Akyol et.al.(1999), Akyol and Kaftanoglu (2001 (7.96, 7.90, 8.68, 8.90, 8.17 number/colony).

Honey yields

The colonies headed by 0, 1- and 2-year-old queens produced average honey yields of (± S.E.) 21.60 ± 5.25, 22.20 ± 6.55 and 14.70 ± 2.50 kg/colony, respectively (Table 1). Differences among the group means on honey production were found significant (P<0.01, df:2, f:6.79).

The colonies headed by 0 and 1-year-old queens produced approximately 40% more honey than those headed by 2-year-old queens. Average honey yield of the colonies which had 0 and 1-year-old queens were found in agreement with previously reported data by Dogaroglu and Pekel, (1982), Firatli and Budak (1994), Akyol et al. (1999), Arslan et al. (2004) and Guler and Kaftanoglu (1999) (20.54, 20.17, 24.6, 24.06, 26.56). Average honey yield of colonies with 2-year-old queens was found similar to previously reported data by Gurel (1995), Genc (1992) and Dodologlu and Genc (2001) (15.40, 11.69, 11.79).

Colonies headed by young queens produce smaller drone brood than colonies headed by old queens, as varroa cannot grow too much in these colonies (Kaftanoglu et al., 1995). Damage caused by varroa may be decreased by using young queens in honeybee colonies (Genc, 1994). In this experiment, colonies headed by young queens had more brood area, stronger colony populations, and more honey production than colonies headed by old queens. The level of varroa infestation is one of the most important factors that influence colony population and performance (Kumova, 2001). A significant, negative correlation was calculated between queen age and the level of varroa infestation on adult worker bees (r=-0.24), in drone cells (r=-0.15), in brood production (r=-0.28), colony strength (r=-0.30) and honey yield (r=-0.48).

Table 1. Average (± SE) honey yields (kg) of ♀ age groups.

| Groups | n. | Mean ± SE | Range |
|--------|----|-----------|-------|
| 0 Age | 10 | 21.60 ± 5.25 | 14-30 |
| 1 Age | 10 | 22.20 ± 6.55 | 14-35 |
| 2 Age | 10 | 14.70 ± 2.50 | 10-18 |

a, b: significant differences among the means (P<0.01, n = 10).

Conclusions

In this study, the average brood area, number of adult bees and honey yield of the colonies which had 0 and 1-year-old queens were found higher than those with 2-year-old queens. Many reasons for these results might be related to the use of young queens and to the low level of varroa infestations. These results showed that, the level of varroa infestation and damage caused by varroa could be decreased in colonies and the performance of colonies could be improved by using young queens.

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