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PAPER

Comparison of colony performances of Anatolian, Caucasian and Carniolan honeybee (*Apis mellifera* L.) genotypes in temperate climate conditions

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Abstract

This study was carried out to determine the performances of Mugla and Nigde ecotypes (*A. m. anatoliaca*), Caucasian (*A. m. caucasica*) and Carniolan (*A. m. carnica*) honeybee genotypes in the region of central Anatolia conditions. A total of 40 colonies (each genotype group consisted of 10 colonies) were used in the study. All queens were reared at the same time and in the same apiary and were instrumentally inseminated. The average numbers of combs covered with bees were found to be 11.24±0.59, 9.51±0.42, 8.11±0.31 and 12.38±0.72 per colony respectively; the average brood areas were found to be 2825.0±240.3, 2160.6±176.8, 1701.9±129.7 and 2883.0±104.4 cm^2 per colony respectively; and the average honey yields were found to be 28.60±0.88, 15.40±0.69, 23.40±0.54 and 31.60±1.12 kg per colony in Mugla ecotype, Nigde ecotype, Caucasian and Carniolan genotypes respectively. The mean differences among the genotypes for number of combs with bees, brood area and honey yield were significant (P<0.01). These results showed that the Carniolan genotype had the best performance and Nigde ecotype had the lowest performance in temperate climate conditions. Therefore, productivity of the Nigde ecotype can be increased by a crossbreeding programme with Carniolan and Mugla genotypes.

Introduction

Turkey is a gene pool for many insect and plant species with diversified topography, climate and ecology (Terzioğlu, 1994). Besides, it has a great beekeeping potential and consequently the beekeeping is becoming a popular agricultural enterprise among the villagers who has little or no land, low income and retired people (Kaftanoğlu *et al.*, 1988). Although there is a great beekeeping potential, the average production per colony in Turkey is lower than the average honey production in the world (FAO, 2010). The beekeepers or the beekeeping industry have many problems including the presence of bee diseases and parasites such as *Varroa destructor*, American and European foulbrood, chalkbrood and Nosema, lack of research, quality-queen production and education level of the beekeepers. Turkey has several climatic and topographic regions and consequently it has many honeybee races and ecotypes adapted to the different climates and regions (Fıratlı and Budak, 1994; Kandemir *et al.,* 2000; Akyol and Kaftanoğlu, 2001). The most common honeybee races are the Anatolian (*A. m. anatoliaca*) bees in central and western Anatolia, Caucasian (*A. m. caucasian*) bees in the north-east Anatolia, Iranian bees (*A. m. meda*) in the East, and Syrian bees (*A. m. syriaca*) in the south-eastern Anatolia. *A. m. anatoliaca* also has several ecotypes which are very different from one another morphologically, physiologically and behaviourally (Akyol and Kaftanoğlu, 2001). The Mugla ecotype is the most popular ecotype of the *A. m. anatoliaca* spreading along the Aegean Sea coast in the west. The performance of Mugla bees was studied extensively in different regions especially in the Mediterranean region (Doğaroğlu *et al.,* 1992; Güler and Kaftanoğlu, 1999; Karacaoğlu and Fıratlı, 1999; Akyol and Kaftanoğlu, 2001; Arslan *et al.,* 2004). The central Anatolian ecotype is the most common ecotype which was used in the Buckfast breeding programme developed by Adam (1983). Local bees in Nigde province are smaller yellow coloured and more aggressive than the central Anatolian and Mugla ecotypes. This local bee ecotype is not commonly used by the beekeepers; it is only traditionally reared by the some nomad beekeepers. There is no research conducted on these local bees yet. The Caucasian bees are native to north-eastern Anatolia and are the most popular honeybee genotypes in Turkey. They were adapted to the temperate climate and high elevation regions especially the north-eastern part of the country. The Carniolan bee is native to Slovenia, southern Austria, and parts of Croatia, Bosnia and Herzegovina, Serbia, Hungary, Romania, and Bulgaria. They are well known as one of the most gentle and productive bee races. Because of the gentleness and the productivity of the Carniolan bees they are distributed all over the world. They were selectively bred for gentleness, honey production and disease resistance in many countries and became one of the most popular bee races all over the world. Turkey also has Carniolan bees in the Thrace Region (Palmer *et al.,* 2000), but they have not been through any selection programme yet. Therefore, some beekeepers import Carniolan queens through their relatives from Europe mainly from Germany and Austria (Smith *et al.,* 1997).

Nigde province has a rich flora and very good beekeeping potential especially in the spring and summer seasons. It is very famous with the large plantation of apples, sweet and sour cherries, apricots, peaches, nectarines, plums and other fruit orchards. The average daily temperature of Nigde province is about 12°C, while the minimum and maximum temperatures are -23.9°C (in March) and 38.5°C (in July). The average annual rainy days is about 94 and the average annual rainfall is nearly 330 mm.

The aim of this research was to determine the best genotype among the Anatolian (Mugla and Nigde ecotypes), Caucasian and Carniolan honeybees for the Nigde province and to make suggestions to increase the honey production and the income of the beekeepers in the region.

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Key words: *Apis mellifera*, Genotypes, Colony performance, Comparison, Temperate climate.

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Materials and methods

The experiment was carried out in Nigde province of central Anatolia (at 35°05'08"E longitude, 37°56'28"N latitude and 1325 m altitude). Two ecotypes (Mugla and Nigde local bees) of the Anatolian (*A. m. anatoliaca*) bees, the Caucasian (*A. m. caucasica*) bees, and the Carniolan (*A. m. carnica*) bees were used in the experiment. The Carniolan queens were imported from a breeder in Germany. Caucasian colonies were obtained from the breeders in Georgian border (Posof-Ardahan) and the Mugla colonies were bought from the nomad beekeepers in Aegean region (Mugla-Marmaris). Nigde local colonies were obtained from the local beekeepers in Nigde province. They were observed all year around and the economically important characteristics (colony development and honey yield) were recorded. According to the preliminary observations and evaluations the best performing colonies in each genotype were selected as the breeder colonies. Sisters queens were reared from these genotypes by grafting one day old larvae and placing them in queenless cell builders as described by Laidlaw (1979). The queen cells were taken from the cell builders and each of them was given into the nuclei (small hive) one day before emerging. When the queens became 8 days old, they were taken from their nuclei, brought to the laboratory, and instrumentally inseminated with 10 µL semen of drones (8-15) obtained from the same genotype and different colonies by using Schley instrumental insemination apparatus at the same time. Instrumentally inseminated queens were identified with different colored tags and one wing was clipped and queen excluder was placed into the entrance of nuclei to prevent natural mating. The inseminated queens were housed again in original nuclei until laying. After this, the experimental colonies were equalised with regard to adult bee, brood and food stocks in full-size Langstroth wooden hives. Each group consisted of 10 colonies and total 40 honeybee colonies were used to test the performance of instrumentally inseminated Caucasian, Carniolan, Mugla and Nigde local ecotypes. The colonies were checked regularly, the amount of adult bees from the number of comb with bees and the brood area calculated by using Puchta method and were recorded at 21-day intervals (Fresnaye and Lensky, 1961; Kandemir *et al.,* 2000) from 20th April to 5th October in 2009. Honey was harvested at the end of the season and honey yields of colonies were determined by description of Tahirov *et al.* (2010) and nearly 10 kg honey was left for each colony for winter. Statistical analysis of colony characteristics (number of combs covered with adult bees and size of brood areas) was performed by repeated measures; ANOVA was used for analysing of honey yield. Duncan's multiple range tests were used to compare the means among the genotypes (Görgülü and Şahinler, 2006; Ergün and Akta , 2009).

Results and discussion

The mean values for the brood areas, number of combs covered with bees and honey yield of the genotypes are presented in Figures 1, 2 and 3, respectively. The amount of brood area of the colonies is one of the most important criteria to determine the colony development (Fresnaye and Lensky, 1961; Genç *et al.,* 1999). The average brood areas of Mugla, Nigde local ecotype, Caucasian and Carniolan genotypes were found to be 2825.0±240.3, 2160.6±176.8, 1701.9±129.7 and 2883.0±104.4 cm^2/colony, respectively (Figure 1). The group means for brood area were found statistically different from each other (P<0.01).

Mugla and Carniolan genotypes produced approximately 45% more brood than Caucasian genotype and 30% more brood than Nigde ecotype. The brood areas of Mugla and Carniolan genotypes obtained in this study were in agreement with findings of Genç *et al.* (1999), Akyol and Kaftanoğlu (2001) and Arslan *et al.* (2004) (informed as 3055, 2862 and 2702 cm^2/colony) Average brood area of Caucasian genotype in present study was in accordance with finding of Gençer and Karacaoğlu (2003) and Bayram *et al.* (2003) (informed as 2008 and 1676 cm^2/colony), and lower than reported by Genç *et al.* (1999) and Akyol *et al.* (2007) (informed as 3055 and 2673 cm^2/colony).

The average numbers of combs covered with bees in Mugla, Nigde local ecotype, Caucasian and Carniolan genotypes were found 11.24±0.59, 9.51±0.42, 8.11±0.31 and 12.38±0.72 number/colony respectively (Figure 2). The group means for numbers of combs with bees were found statistically different from each other (P<0.01).

The developmental rate of the Carniolan and Mugla genotypes were found better than both Nigde local ecotype and Caucasian genotype (P<0.01). Average numbers of comb of Mugla colonies in present study were agree with the results of Akyol and Kaftanoğlu (2001) and Dodoloğlu and Genç (2002) (informed as 11.57 and 10.88 number/colony). Average number of combs of Caucasian genotypes in present study were agree with previous results reported by Fıratlı and Budak (1994) and Akyol and Kaftanoğlu (2001) (informed as 7.96, 8.17 number/colony). Average number of combs of Carniolan genotype in this study was found higher than the results of Bayram *et al.* (2003), Arslan *et al.* (2004) and Şahinler and Gül (2004) (informed as 8.6, 10.40 and 7.53 number/colony).

The average honey yield of Mugla, Nigde local ecotype, Caucasian and Carniolan genotypes were found as 28.60±0.88, 15.40±0.69, 23.40±0.54 and 31.60±1.12 kg/colony respectively (Figure 3). The group means for honey production were found statistically different from each other (P<0.01). Average honey yield of the Mugla colonies were found agree with previously reported results by Doğaroğlu *et al.* (1992), Gençer and Karacaoğlu (2003), (informed as 23.17, 23.0 kg/colony) but they were lower than findings by Güler (1999), and Akyol and Kaftanoğlu (2001) (reported as 50.16, 53.9 kg/colony). Average honey yield of the Caucasian colonies were found agree with previously reported data by Güler and Kaftanoğlu (1999), Genç *et al.* (1999), and Akyol *et al.* (2007) (informed as 26.56, 26.30, 22.20 kg/colony), Average honey yield of the Carniolan genotypes in present study was higher than previously reported findings by Bayram *et al.* (2003), Şahinler and Gül (2004) and Arslan *et al.* (2004) (informed as 8.60, 24.00 and 19.40 kg/colony).

The average honey yield of the Carniolan and Mugla genotypes was 35% higher than that of the Caucasian genotype and 105% higher than the Nigde ecotype.

The genotype, environmental conditions and the management of the honeybee colonies are very important factors for the colony development and honey production (Hatjina *et al.,* 2014). Any genotype might perform better in a place but it may not be proper for others (Pankiw and Page, 2001). Therefore, it is necessary to determine the performance of the genotypes of the bees at different climatic and geographic regions. The Carniolan and Mugla genotypes showed a good performance with high brood production, adult bee population and honey production in central Anatolia region. The Carniolan and Mugla genotypes produced nearly 100% more honey than the Nigde local ecotype in the same environmental and management conditions.

Since the Carniolan bees were obtained from a European breeder, they had probably gone through a selection for colony development and honey production. The other genotypes used in this study did not go through any selection programme. Their performance can

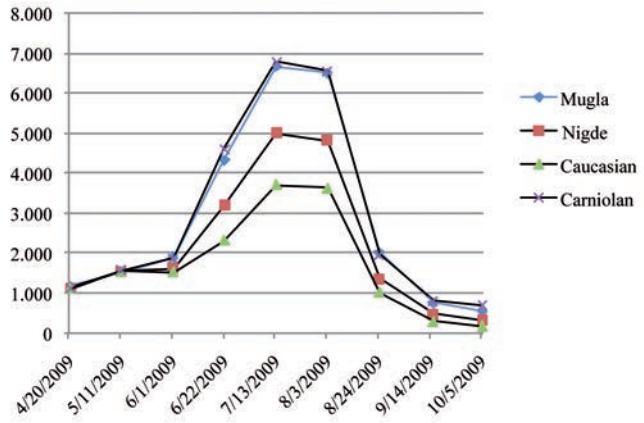


Figure 1. The average brood areas (cm^2/colony) of the genotypes.

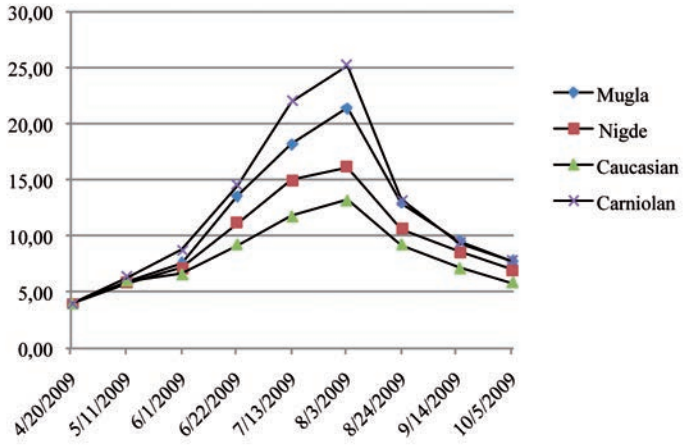


Figure 2. The average number of combs covered with bees of the genotypes.

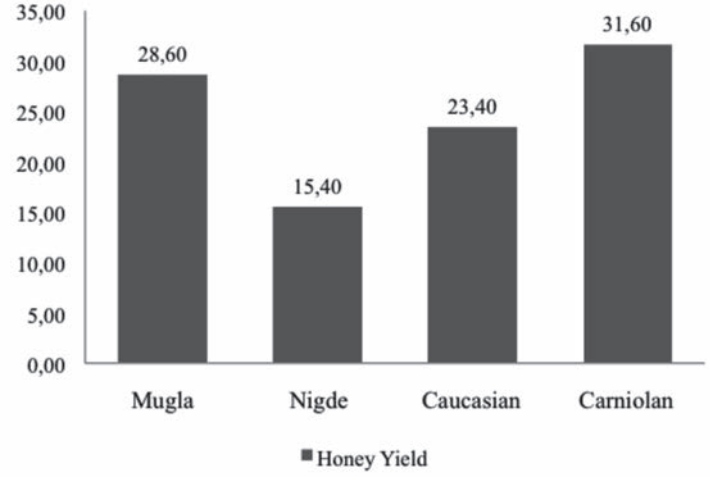


Figure 3. The average honey yield (kg/colony) of the genotypes.

also be increased by a good selective breeding programme. Caucasian bees are very gentle bees and produce much honey. However, they are not suitable to the Mediterranean and Aegean regions especially in the lowlands. All the researches had unanimous results that the Caucasian bees are not suitable to the hot climates (Doğaroğlu *et al.,* 1992; Arslan *et al.,* 2004). However, their crosses with the Mugla bees show hybrid vigor and can be used in different regions (Akyol and Kaftanoğlu, 2001). They should have a breeding programme to improve the quality of other bee genotypes.

Conclusions

The results obtained from this study show that the Nigde local ecotype honeybees are not as productive as the Carniolan, Mugla or Caucasian genotypes in Nigde province. Still, productivity of the Nigde local honeybee populations could be increased by specific breeding programmes.

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