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Research Article

Comparison of Wintering Ability and Colony Performances of Different Honeybee (*Apis mellifera* L.) Genotypes in Eastern Anatolian/Turkey Conditions

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Abstract

In this study, wintering ability and some physiological properties of Buckfast, Carniolan, Caucasian and Erzurum honeybee genotypes were investigated in Eastern Anatolian conditions. During the wintering season of 2014, a total of 48 colonies, 12 from each of Buckfast, Carniolan, Caucasian and Erzurum honey bee genotypes, were taken from the equilibrated colonies of Langstroth type wooden hives for wintering. In the 2015 production period, a total of 43 colonies,11 from each of Buckfast, Carniolan, Erzurum genotypes and 10 from Caucasian genotype were used in the study. In the production season, the average number of combs covered with bees in genotype groups were found as 11.72±0.63, 12.17±0.62, 9.52±0.51 and 10.72±0.55 per colony, and the average brood areas were found as 2713.7±237.9, 2797.6±238.3, 2036.5±166.4, 2364.3±197.2 cm2/colony (19.04.2015-4.10.2015). The difference between the groups was found statistically significant (P<0.01) in terms of number of combs covered with bees and brood areas. Averarage honey yields were determined as 28.08±2.37, 29.94±2.17, 19.28±2.13 and 23.36±2.15 kg/colony, respectively. The difference between groups in honey yield was found statistically significant (P<0.05).

Keywords: *Honeybee, Apis mellifera L., Wintering ability, Honey yield, Genotype*

Doğu Anadolu-Türkiye Koşullarında Farklı Bal Arısı (*Apis mellifera* L.) Genotiplerinin Kışlama Yeteneği ve Koloni Performanslarının Karşılaştırılması

Özet

Bu çalışmada, Doğu Anadolu koşullarında Buckfast, Karniyol, Kafkas ve Erzurum genotiplerinin kışlama yeteneği ve bazı fizyolojik özellikleri araştırılmıştır. Araştırmada Langstroth tipi ahşap kovanlardaki güçleri eşitlenmiş kolonilerden 2014 yılı kışlatma döneminde Buckfast, Karniol, Kafkas ve Erzurum bal arısı genotiplerinin her birinden 12'şer olmak üzere toplam 48 adet koloni kışlatmaya alınmıştır. 2015 yılı üretim döneminde ise 11'er adet Buckfast, Karniol, Erzurum ve 10 adet de Kafkas genotipine mensup toplam 43 adet koloni kullanılmıştır. Üretim sezonunda genotip grupların ortalama arılı çerçeve sayıları sırasıyla 11.72±0.63, 12.17±0.62, 9.52±0.51 ve 10.72±0.55 adet/koloni; ortalama kuluçka alanları 2713.7±237.9, 2797.6±238.3, 2036.5±166.4, 2364.3±197.2 cm2/koloni olarak bulunmuştur (19.04.2015-4.10.2015). Arılı çerçeve sayısı ve kuluçka alanı bakımından gruplar arasındaki fark istatistiksel açıdan önemli (P<0.01) bulunmuştur. Grupların ortalama bal verimleri; 28.08±2.37, 29.94±2.17, 19.28±2.13 ve 23.36±2.15 kg/koloni olarak belirlenmiştir. Bal verimleri bakımından gruplar arasındaki fark istatistiksel açıdan önemli (P<0.05) bulunmuştur.

Anahtar sözcükler: *Bal arısı, Apis mellifera L., Kışlama yeteneği, Bal verimi, Genotip*

INTRODUCTION

Turkey has several climatic and topographic regions and consequently it has many honeybee races and ecotypes adapted to the different climates and regions [1,2]. Caucasian bee *(Apis mellifera caucasia)* live at the northeast region, Persian bee *(Apis mellifera meda)* and Syrian bee *(Apis mellifera syriaca)* at the southeast region, Carniolan *(Apis mellifera carnica)* at Thracian region, subspecies of Anatolian bee *(Apis mellifera anatolica)* at the remaining areas in our country [3,4]. Local bees in Erzurum province are smaller yellow coloured and more aggressive than Caucasian and

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Anatolian bees [5]. This local bee ecotype is not commonly used by the beekeepers; it is only traditionally reared by the some local beekeepers. 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 [6]. Carniolan bee is native to Slovenia, southern Austria, and parts of Croatia, Bosnia and Herzegovina, Serbia, Hungary, Romania, and Bulgaria. Carniolan honey bee is spread worldwide, today. Due to its soft temper, adaptation to extreme low temperatures, good honey production, Carniolan honey bee is in many countries well accepted and popular honey bee variety [7]. Buckfast bees are actually a hybrid. They were developed in 20th century by Brother Adam. Buckfast bees are resistant to Tracheal mites and do well in cool climates. They are very gentle and easy to work with and are excellent honey producers. They have a low tendency to swarm and are economical in the use of winter stores [8,9]. In order to increase productivity in beekeeping, the comparative analysis of the physiological characteristics of genotypes in different regions should be made, and the appropriate genotype should be determined for each region. While searching for the suitability of a genotype for a region, survival and wintering ability are the main features of a genotype that should be laid emphasis on [5]. Because the vast majority of colony losses occur in the winter months [10]. It was reported in a study performed in the United States that wintering losses were above the ratio of 30% [11]. The losses ranging from 30% to 80% have been reported in various regions of our country [12-14].

The dead colony ratio was used as the indicator of survival ability in a study conducted with Caucasian, Anatolian, Mugla and Thrace bee groups in Thrace, and this rate was found as 35.71%, 38.46%, 28.57% and 36.36%, respectively for the groups [15]. The wintering abilities of Carniol, Mugla, Tokat, Italian, Caucasian-Camili and Caucasian-TKV genotypes were identified as 64.86%, 63.91%, 61.59%, 57.85%, 56.93% and 51.98% respectively [16].

The colony population size at the beginning of the production period should be higher in order to increase honey yield. It was reported in the studies conducted that the brood development of the colonies support the increase in the number of adult bees, and there is a positive relationship between adult bee development and brood production (r = +0.76) [16]. The correlation between the average brood production efficiency of the colonies and the honey yield was found as r = +0.817 in another study [15].

The mean honey yield per colony was reported as 30.62±3.22, 32.63±5.17 and 35.41±5.36 kg colony, respectively in the study conducted to determine the performance of Caucasian, Anatolian and Erzurum local ecotype in Erzurum conditions [5]. The average honey yields of Buckfast and European Black bee (local bee) colonies were reported as 38.49 and 26.76 kg/colony, respectively in a study conducted in Poland [9].

The average honey yields of Buckfast, Italian, Carniolan and Middle European (local bee) colonies were reported as 37.79, 38.1, 42 and 33.2 kg/colony, respectively in a study conducted for three years in Finland [17]. The mean honey yields of the Mugla, Nigde local ecotype, Caucasian and Carniolan genotypes in Nigde conditions were determined as 28.60, 15.40, 23.40 and 31.60 kg/colony respectively [18]. In a study conducted in Slovenia with carniolan bees, the average honey production was reported as 9.5 kg and the area of capped brood was 7061 cm^2 [19].

Due to the high yield of honey, Buckfast and Carniolan genotypes, widely used in the world have been used in our country, especially by migratory beekeepers. In recent years, these two bee genotypes have been shown great interest by beekeepers in Northeast Anatolia and Eastern Anatolia. In this study, it was aimed to identify the genotype suitable for the region by investigating the various physiological characteristics of Buckfast, Carniolan *(A. m. carnica)*, Caucasian *(A. m. caucasica)* and Erzurum domestic bees in Erzurum conditions.

MATERIAL and METHODS

The study was carried out at the apiary of Narman Vocational School (40°21'3.70" E longitude, 37°56'28" N latitude and 1650 m high) in Narman District of Erzurum Province in Eastern Anatolia Turkey. During the wintering season of 2014, a total of 48 colonies, 12 from each of Buckfast, Carniolan, Caucasian and Erzurum honey bee genotypes, were taken from the equilibrated colonies of Langstroth type wooden hives for wintering. In the 2015 production period, a total of 43 colonies, 11 from each of Buckfast, Carniolan, Erzurum genotypes and 10 from Caucasian genotype were used in the study.

The Buckfast and Carniolan queens were supplied from Germany, The Caucasian bees were supplied from Artvin-Camili, the Erzurum bees were supplied from local beekeepers in Erzurum. All of the colonies were investigated with regard to the properties such as colony development, brood area and honey yield for one season, and those, superior than others in the same conditions, were seperated to be used as a breeder.

The grafted larvae raised with Doolittle method were introduced into starter colonies. Larvae <24 h old were grafted onto royal jelly that was diluted with water in the proportion of 1:1. For each genotype, 4 starter colonies were used and 30 larvae were grafted into of them. During the experiment, queen bee rearing colonies were fed with sugar syrup [20,21]. The queen cells, which were accepted and inclosed by raising colonies, were harvested and then

transferred to mating hives 10 days later than larva transfer operation. The queens, transferred to the mating hives, were daily monitored as of 6th day, and then test groups were created with mating queens. The colonies' food consumptions in wintering were calculated by subtracting the weights of the colonies before wintering from those after wintering and their wintering abilities were calculated by using the following formula [22];

Wintering Ability = (The number of combs covered with bees managing to survive until spring/The number of combs covered with bees entering to wintering) x 100

The values, received from the combs covered with bees, existing in the test colonies equilibrated in terms of the presence of bees and broods, at intervals of 21 days during the period up to the honey harvest, were used as the measure of adult bee development [15,18]. The brood area was measured by the PUCHTA method (S = 3.14xA/2xa/2) in cm^2, taking closed brood areas over all combs with brood into account [18,23]. In order to determine the honey yield of the colonies, the amount of honey they made apart from their own needs were based on [5,15].

For the test groups' struggle to Varroa infestation in spring, 8 g crystal thymol was pulverized by means of a grinder and then mixed with 22 g powdered sugar and placed on the top of combs in each colony by the help of newsprint cut in 4x4 size [24,25]. For the the test groups' struggle to Varroa infestation in autumn, 44.8 g of oxalic acid was prepared by being supplemented with sugar-water solution in the ratio of 1:1 to 1000 ml in the late autumn. The prepared 3.2% oxalic acid solution was instilled with a large-scale syringe so that 5 ml solution would exist on each honeycomb with bees [25,26].

"SPSS 20.0 for Windows" package program was used in the calculations, and multiple comparison test was performed for the properties, considered to have significant effect. In order to determine the wintering ability of the groups; while (arcsine √y/100) arcsine transformation in the case of percentages was performed to the population decrease rates prior to the analysis of variance, directly variance analysis was applied to the values as to food consumption, number of comb with bees, brood area, honey yield [27,28].

RESULTS

Wintering Ability

During the wintering period, while the highest consumption of food occured with 8.40±0.70 kg at Erzurum genotype, the lowest consumption of food occured with 6.63±0.51 kg at Caucasian genotype. The difference between the genotypes is statistically insignificant in terms of food consumption. While the difference between Buckfast, Carniolan and Erzurum local ecotype was found as insignificant in terms of population decrease, the population decrease of colonies belonging to Caucasian genotype was found higher than other groups (P<0.05) *(Table 1)*. The numbers of combs with bees of genotype groups entering into wintering and getting out of wintering are given in *Table 1*.

Development of Adult Bee

In respect to adult bee development, colonies constantly increased throughout the season, reaching the highest population in August. Carniolan bee ranked first with respect to the speed of comb with bees, which was followed by Buckfast, Erzurum and Caucasian genotypes respectively *(Fig. 1)*. The differences between the groups in respect to the number of comb with bees were found statistically significant (P<0.01).

Development of Brood Area

The average brood areas for Buckfast, Carniolan, Caucasian and Erzurum local ecotype were determined as 2713.7± 237.9, 2797.6±238.3, 2036.5±166.4, 2364.3±197.2 cm^2/colony. The differences in brood production, observed between groups, were also found statistically significant (P<0.01). As it can be seen from *Fig. 2*, the brood output of the groups steadily increased and reached the highest level during the nectar flow.

Honey Yield

The average honey yields of Buckfast, Carniolan, Caucasian and Erzurum genotypes were determined as 28.08±2.37, 29.94±2.17, 19.28±2.13 and 23.36±2.15 kg/colony. The differences between groups in respect to honey yields were found statistically significant (P<0.05).

Table 1. *Mean and percantage values of wintering ability of genotype groups*

Groups	n	Food Consumption (kg/koloni) X±Sx	Before Wintering Number of Combs with Bees X±Sx	After Wintering Number of Combs with Bees X±Sx	Population Decline (%) X±Sx	Wintering Ability (%)
Buckfast	11	7.97±0.55^{is}	7.90±0.06^{a}	5.31±0.16^{a}	32.68±2.10^{b}	67.21^{a}
Carniolan	12	6.92±0.49^{is}	7.79±0.11^{a}	5.12±0.15^{a}	34.11±2.32^{b}	65.72^{a}
Caucasian	10	6.63±0.51^{is}	7.05±0.26^{b}	3.95±0.13^{b}	43.95±2.13^{a}	56.02^{b}
Erzurum	12	8.40±0.70^{is}	7.87±0.09^{a}	5.45±0.18^{a}	30.87±1.84^{b}	69.25^{a}
Total	45	7.51±0.30	7.67±0.08	5.00±0.12	35.08±1.26	64.55

^{a,b} Different letters indicate significant differences among the means (P<0.05), Duncan, is insignificant

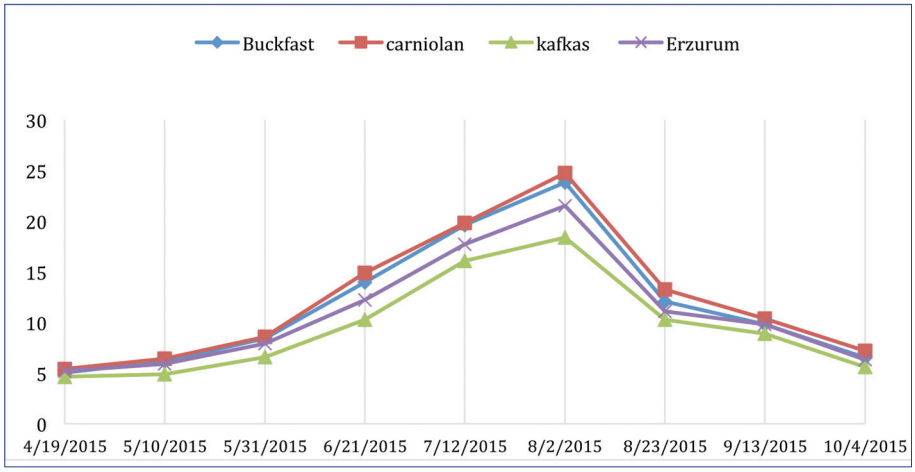
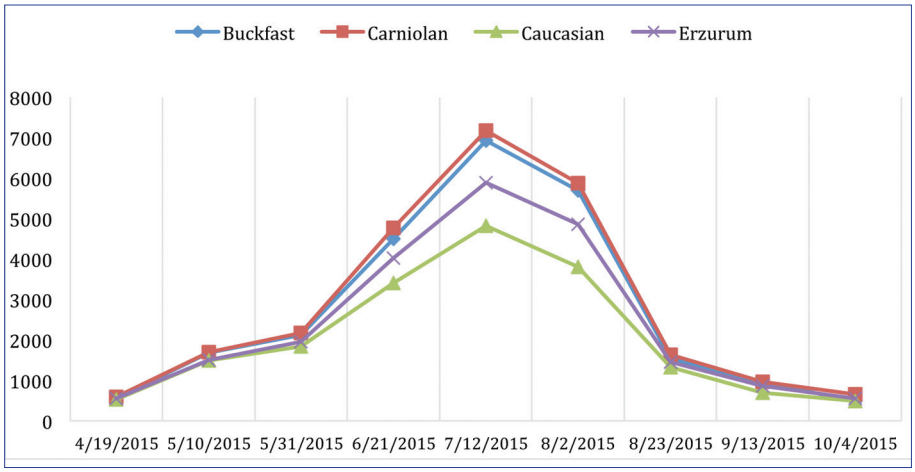


Fig 1. The average number of combs with bees of the genotypes

Fig 2. The average brood areas (cm²/colony) of the genotypes



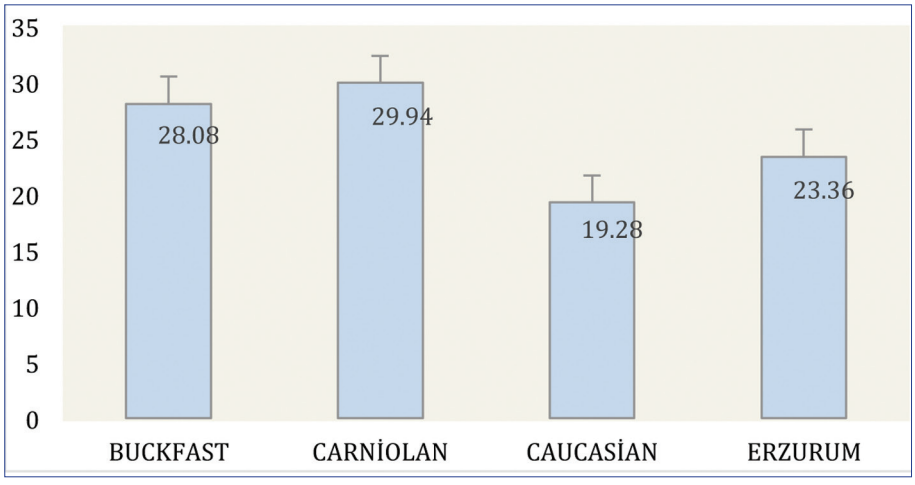


Fig 3. Average honey yield(kg/colony) of the genotypes

DISCUSSION

The results from *Table 1* show that wintering abilities of Buckfast and Carniolan bees are close to Erzurum bees, indigenous to the region. As a matter of fact, Buckfast and Carniolan bees consumed less food than Erzurum bees, but incurred more population losses than Erzurum bees. As well as the difference in population decrease between Buckfast, Carniolan and Erzurum bees was found statistically insignificant, the difference in population decrease between these three genotypes and Caucasian bee was found significant ($P<0.05$). When colony losses and population declines are taken into consideration, the lowest rate of wintering is obtained from Caucasian bees, consistent with the literature report [5]. The results of the wintering ability of the Buckfast, Carniolan and Erzurum groups are compatible with literature reports stating that these bees show high wintering ability [5,29,30]. Since an

increase in population losses of genotype groups means a decrease in existing food consumption, as a matter of course, less food was consumed in colonies where more bee losses occured. Having high wintering ability for a genotype means that colonies belonging to that genotype will manage to survive until spring with minimum bee loss and minimum food consumption. But, due to the fact that climate conditions differ every year, there is a need for more comprehensive studies to be made on this issue.

Buckfast and Carniolan adult bee developments are not different from each other, but the Erzurum group development is higher than Caucasus bee. It can be stated that in the research area, Erzurum group formed a larger population than Caucasian bees, and that Buckfast and Carniolan bees could gain more population development than region bees.

The average number of combs of Buckfast, Carniolan, Erzurum and Caucasian colonies in present study were found higher than result of Gençer [31] (informed as 7.64, 6.99, 7.90, 8.76, 8.23 number/colony). The results obtained from this study were found lower than result of by Genç et al.[5] (informed as 15.62, 17.08 and 18.49 number/colony), agree with the result of Akyol et al.[18] (informed as 11.24, 9.51, 8.11 and 12.38 number/colony).

The study's findings showed that Carniolan bees are the genotype, which produce the highest number of brood, which is followed by Buckfast bees, and Erzurum genotype produces more broods than Caucasian group. The Caucasian genotype ranked last in terms of this property evaluated.

The average brood areas for Buckfast, Carniolan, and Erzurum local genotypes and the Caucasian colonies in present study were found agree with the result of Akyol et al.[18] (informed as2825.0, 2160.6, 1701.9 ve 2883.0 cm^2/colony). The results obtained from this study were found lower than result of by Honko and Jasinski [17] (informed as 4002, 4091, 2750, 4035 and 3638 cm^2/colony), higher than result of Güler and Kaftanoğlu [32] (informed as 1112.6, 1184.8, 2387.5cm^2, 2030.2±188,6 cm^2, 1433.9 and 1501.5 cm^2/colony).

It was determined in a study that the brood and adult bee production of colonies support honey yield [33]; in another study, a positive and very significant (P<0.01) association r= +0.82 was found between colony population and honey yield [15].

Carniolan genotype produces more honey by 8.6%,36.27%, 55.29% than Buckfast, Erzurum local ecotype, Caucasian genotypes respectively under the same environmental and management conditions.

The average honey yield value, obtained for Buckfast bee, was found higher than the value reported by Olszewski [30], but lower than the value reported by Honko and Jasinski [17]. Carniolan group related average honey yield value was found consistent with the value reported by Akyol et al.[18] was found higher than the values reported by Arslan [16] and Gregorc and Locar [19]; was found lower than the value reported by Honko and Jasinski [17]. The average honey yield of the Caucasian group is lower than the values reported by Güler and Kaftanoğlu [32], higher than the values reported by Dodologlu and Genç [27], and consistent with the values reported by Gençer ve Karacaoğlu [34]. The average honey yield of Erzurum group was found lower than the value reported by Genç et al.[5], and consistent with the value reported by Cengiz [23].

The following results were obtained with the comparison of four honey bee genotypes in terms of food consumption, wintering ability and performance in Eastern Anatolian Turkey conditions.

1. Food consumption is not dependent on genotype in wintering, however, Caucasian and Carniolan group consumed less honey than Buckfast and Erzurum group.

2. While the differences between Buckfast, Carniolan and Erzurum genotypes were found insignificant in terms of population decrease, the population decrease at Caucasian genotype-related colonies was determined higher than other groups.

3. The highest wintering ability was found in Erzurum (69.25%) group, which was followed by Buckfast (67.21%), Carniolan (65.72%) and Caucasian (56.02%) groups respectively.

4. Development rate of the Caucasian bee is lower than other genotypes, and Buckfast and Carniolan genotypes have similar characteristics in this regard.

5. Carniolan and Buckfast genotypes, which produce the highest number of brood, have similar characteristics in respect to brood production, Erzurum genotype produces more broods than Caucasian group.

6. The differences between groups in terms of honey yield were found statistically important (P<0.01). The highest amount of honey was obtained from the Carniolan group while the lowest honey yield was obtained from the Caucasian group.

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