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Effects of Queen Emergence Weight on Some Behavioral Characteristics and Colony Performance Parameters in Şanlıurfa Local Honey Bees (*Apis mellifera* L.)

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Abstract

It was aimed to determine the physiological and behavioral characteristics of the local honey bee genotype, which has been adapted to Şanlıurfa's climate and ecological conditions. Some physiological and behavioural characteristics such as the number of the frames covered with bees, development of brood areas, flight activity, honey production, overwintering success, swarming tendency, aggression and hygienic behaviour of the colonies established from queen bees produced from a breeding colony which represents Şanlıurfa local honey bees were determined. Queens were divided into two categories according to the emerging weights as light and heavy groups. The number of the frames covered with bees and the development of the brood areas were evaluated in 6 different periods. Some characteristics such as swarming tendency and aggression were determined in 3 different periods. The average emergence weight values were determined to be 170.36±2.688 mg for the light group and 211.67±5.523 mg for the heavy group (P<0.01). The average number of the frames covered with bees for the light and heavy groups were found as 3.56±0.103 and 3.07±0.098 respectively (P<0.05). The average brood areas were determined to be 1069.56±79.676 cm^2 for the light group and 823.89±79.333 cm^2 for the heavy group (P<0.05). The average flight activity number was 15.00±1.991 for the light group and 14.407±2.201 for the heavy group (P>0.05). The average value in terms of aggression was 3.21±0.330 pcs/min for the light group and 2.48±0.365 pcs/min for the heavy group (P>0.05). The average number of the cleaned brood cells for the hygienic behaviour test was determined to be 95.6±5.58 for the light group and 78.8±17.97 for the heavy group (P<0.05). There were no significant differences between the light and heavy groups with respect to average honey production values (P>0.05). The overwintering abilities were determined to be 46% for the light group and 83% for the heavy group. The vitality rate of honey bees during the trial was 86.95%.

Key Words: Honey bee (*Apis mellifera* L.), Brood area,Flight activity, Aggression, Hygienic behaviour

Ana Arı Çıkış Ağırlığının Şanlıurfa Yerli Bal Arılarında (*Apis mellifera* L.) Bazı Davranış Özellikleri ve Koloni Performans Parametrelerine Etkileri

Öz

Şanlıurfa iklim ve ekolojik koşullarına uyum sağlamış yerli bal arısı genotipinin fizyolojik ve davranış özelliklerinin belirlenmesi amaçlanmıştır. Şanlıurfa ilçelerinden satın alınarak seçilen bir koloniden ana arılar yetiştirilmiş, bu kolonilerde arılı çerçeve sayısı, yavru alanı gelişimi, uçuş etkinliği, bal verimi, kışlama yeteneği, oğul verme eğilimi, hırçınlık ve hijyenik davranış özellikleri incelenmiştir. Ana arılar çıkış ağırlığına göre hafif ve ağır olmak üzere iki grupta, yavru alanı gelişimi ve arılı çerçeve sayısı 6 dönemde, uçuş etkinliği, oğul verme eğilimi ve hırçınlık özellikleri ise 3 dönemde incelenmiştir. Hafif ana arı grubunda ana arı çıkış ağırlığı ortalaması 170.36±2.688 mg ve ağır ana arı grubu ortalaması

211.67±5.523 mg olarak elde edilmiştir (P<0.01). Hafif ana arı grubu arılı çerçeve sayısı ortalama 3.56±0.103 adet, ağır ana arı grubunda ortalama 3.07±0.098 adet olarak bulunmuştur (P<0.05). Hafif ana arı grubu yavru alanı ortalaması 1069.56±79.676 cm^2 iken ağır ana arı grubu yavru alanı ortalaması 823.89±79.333 cm^2 olarak ölçülmüştür (P<0.05). Uçuş etkinliği bakımından hafif ana arı grubu ortalaması 15.00±1.991 adet, ağır ana arı grubu ortalaması 14.407±2.201 adet olarak elde edilmiştir (P>0.05). Hırçınlık davranışı bakımından hafif ana arı grubu ortalaması 3.21±0.330 adet/dk, ağır ana arı grubu ortalaması 2.48±0.365 adet/dk olarak tespit edilmiştir (P>0.05). Hafif ana arı grubu hijyenik davranış testinde temizlenmiş gözlerin ortalaması 95.6±5.58 adet, ağır ana arı grubunda ise 78.8±17.97 olarak elde edilmiştir (P<0.05). Hafif ve ağır ana arı gruplarının bal verimi ortalamaları arasında fark bulunmamıştır (P>0.05). Kışlama yeteneği hafif ana arı grubu için %46, ağır ana arı grubu için %83 olarak belirlenmiştir. Deneme süresince yaşama gücü %86.95 olarak belirlenmiştir.

Anahtar Kelimeler: Bal arısı (*Apis mellifera* L.), Yavru alanı, Uçuş etkinliği, Hırçınlık, Hijyenik davranış

Introduction

The western honeybee (*Apis mellifera* L.) is a species of crucial economic, agricultural, and environmental importance (Gupta, 2014). Honeybees are also the most economically valuable pollinator of agricultural crops worldwide (Le Conte and Navajas, 2008). Honeybee populations have some differences in morphological, behavioural and population biological characters across their vast natural range from southern Africa to northern Europe. Many of these biologically distinct populations have been recognised as subspecies as a result of historical patterns of isolation and adaptation to particular habitats. There are at least 26 honey bee subspecies have been identified morphologically and geographically in the worldwide.Geometric morphometry and genetic studies also confirmed the existence of four distinct lineages (Adam, 1983; Ruttner 1988; Franck et al., 2000; Whitfield et al., 2006). The richness in biodiversity of races and ecotypes of Apis mellifera reflects a long lasting, continuous process of adaptation (Bühler et al., 2013). The demand for honeybee colonies with high economic performance and desirable behavior characteristics, has led to considerable changes caused by systematic bee breeding. These activities endanger regional races and ecotypes by promoting hybridisation (De la Rúa et al., 2009; Meixner et al., 2010).

Honey bees are social insects, generally regarded as super-organisms (Seeley, 1989). They have complex behavioral and physiological characteristics including food collection and storage, nest building, chemical and acoustic communication, orientation and navigation, age polyethism, defense of colony. The performance of a honey bee colony consists of all of these characteristics.

Turkey has wide range of climates and habitats rise from geographic variation, and exist many honeybee subspecies and ecotypes with different morphological, physiological and behavioral aspects (Ozmen Ozbakır and Fıratlı, 2013). Şanlıurfa is a city located in the south-east of Turkey, which has continental climate. In Şanlıurfa, 1817 tons of honey

areproducedfrom 107 000 honeybee colonies (Anonymous, 2016). The local honeybees in Şanlıurfa can be considered as an ecotype of the Anatolian honeybee (*A. mellifera anatoliaca*) however they exist in a mixture with Caucasus hybrids (*A. m. caucasica*) and Syrian honeybees (*A. m. syriaca*). In a previous detailed study, Şanlıurfa honeybees were similar to the Syrian bees in terms of morphological characteristics but did not form close cluster (Ozmen Ozbakır and Fıratlı, 2013).

Adaptation of honey bees to their environment is expressed by the annual development pattern of the colony, the balance with food sources and the host-parasite balance, all of which interact among each other with changes in the environment (Hatjina et al., 2014). There is a widely recognised need to encourage regional breeding efforts to preserve local adaptation, and to maintain local strains in isolated conservation apiaries. To attain this goal, it is necessary to have a reference base to identify strains to be used for breeding (De la Rúa et al., 2009). For this reason, it is aimed to determine the colony performance parameters and some behavioral characteristics of local honey bees adapted to Şanlıurfa region in first stage. Some physiological and behavioural characteristics such as the number of the frames covered with bees, development of brood areas, flight activity, honey production, overwintering success, swarming tendency, aggression and hygienic behaviour of the colonies established from queen bees produced from a source colony which represents Şanlıurfa local honey bees were determined.

Materials and Methods

Şanlıurfa local honey bee colonies of the study were obtained from beekeepers who were beekeeping with traditional and stationary methods for many years, who were not on the route of migratory beekeepers and who did not practiced queen replacement. In this direction, 6 colonies were purchased from the Şanlıurfa districts, honey bee colonies transferred from traditional hives to Langstroth hives together with the combs, and a mother source colony was selected based on queen-laying performance and colony development. The study was conducted in the apiary at Department of Animal Science (Harran University, Şanlıurfa) between April and September of 2016.

Four days before the transfer of the larvae, the queen of the source colony was confined with an empty honeycomb, and larvae were obtained between 0-24 hours. Two strong starter colonies were prepared on the same day and were checked queen cells regularly until transfer. 60 larvae were transferred from source colony. Accepted queen cells were distributed on the 10th day to the test colonies in cages (Table 1).

Table 1. Workflow

Çizelge 1. İş akışı

Work	Date
Confining queen in source colony *Larva kaynağı koloni ana arısının hapsedilmesi*	16.04.2016
Preparing starter colonies *Başlatıcı kolonilerin hazırlanması*	16.04.2016
Larvae transfer *Aşılama*	20.04.2016
Preparing test colonies *Deneme kolonilerinin hazırlanması*	27.04.2016
Distributing queen cells to test colonies *Ana arı yüksüklerinin deneme kolonilerine verilmesi*	30.04.2016
Emerging queens *Ana arıların çıkışı*	01-02.05.2016

Due to the insufficient numbers of queens emerging from the accepted larvae, queens were divided into two categories according to the emerging weights (mg) as light and heavy groups. Queen emerging weight was lower than 180 mg in the light group and higher than 190 mg in the heavy group. All test colonies were prepared and equalized to contain 2/3 bees, 4 days before the expected queen emergency date. The number of the frames covered with bees and the development of the brood areas were evaluated in 6 different periods. Other characteristics such as swarming tendency, aggression, flight activity were determined in 3 different periods. The number of the frames covered with bees and the development of the brood area measurements were determined every 21 days after the queens started laying eggs. Puctha method was used for brood area (cm^2) measurements (Fresnaye and Lensky, 1961). Bee flight activity was monitored by counting the number of flying workers at hive entrances. Swarming tendency was examined for the presence of queen cells on every comb. Aggression behavior was determined by counting the number of stinging bees to black ball that swinging for 60 s at the entrance of the hive. To test hygienic behavior a piece of cardboard with a square equal in size to 10 x 10 cells was laid over a patch of brood. The closed brood cells in this area are pierced with a needle and after 24 h cleaned cell numbers were identified.Honey yield (g) was found by weighing the frames at the end of the study. Survival rate was determined by the number of alive colonies during the study. For the evaluation of the obtained data, variance analysis was applied in the SAS package program and multiple comparisons were made by Tukey-Kramer test.

Results and Discussions

Results

In the control performed 24 hours after the larvae transfer, the transfer efficiency was 80% for starter colony 1

and 70% for starter colony 2. Due to the losses observed in the pupae, the queen bee emergence rate was 55.55%, and 2 of the 25 queen bees did not return the mating flight. The average of emergence weight values were determined to be 170.36±2.688 mg (n=11) for the light group and 211.67±5.523 mg (n=12) for the heavy group (P<0.01). General avarage of emergence weight of queens were determined as 191.91±5.373 mg. Pre-laying time of the queens in the test colonies was determined to 12-13 days on average.

The average number of the frames covered with bees for the light and heavy groups were found as 3.56±0.103 and 3.07±0.098 respectively (P<0.05). The average brood areas were determined to be 1069.56±79.676 cm^2 for the light group and 823.89±79.333 cm^2 for the heavy group (P<0.05). The average number of the frames covered with bees is given in Figure 1 and brood area of queen groups according to the periods is given in and Table 2.

Table 2. The average of brood area (cm^2) according to groups and periods
Çizelge 2. Dönemlere ve gruplara göre yavru alanı ortalamaları (cm^2)

Periods *Dönemler*	Light queen qroup (x±Sx) *Hafif ana arı grubu*		Heavy queen group (x±Sx) *Ağır ana arı grubu*		General (x±Sx) *Genel*	
	n	Brood area *Yavru alanı*	n	Brood area *Yavru alanı*	N	Brood area *Yavru alanı*
1	11	169.90±152.102	9	326.10±168.154	20	240.19±36.158
2	11	1173.79±152.102**	9	584.07±168.154*	20	908.42±134.017
3	11	1374.54±152.102**	9	1242.57±168.154**	20	1315.15±117.337
4	11	1410.93±152.102**	9	1159.88±168.154**	20	1297.96±131.013
5	11	1324.15±152.102**	9	934.84±168.154**	20	1148.97±144.132
6	11	964.05±152.102**	9	695.86±168.154**	20	843.36±100.792
General *Genel*	66	1069.56±62.095*	54	823.89±68.648*	120	959.01±57.394

*P<0.05, **P<0.01

The average flight activity number was 15.00±1.991 for the light group and 14.407±2.201 for the heavy group (P>0.05). The average value in terms of aggression was 3.21±0.330 pcs/min for the light group and 2.48±0.365 pcs/min for the heavy group (P>0.05). Flight activity and aggression results according to periods given in Figure 2.

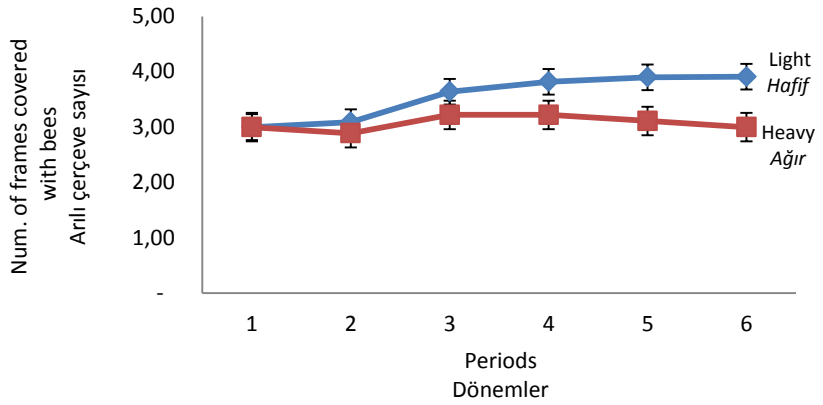

Figure 1. Avarages of number of frames covered bees according to groups and periods

Şekil 1. Dönemlere ve gruplara göre arılı çerçeve sayısı ortalamaları

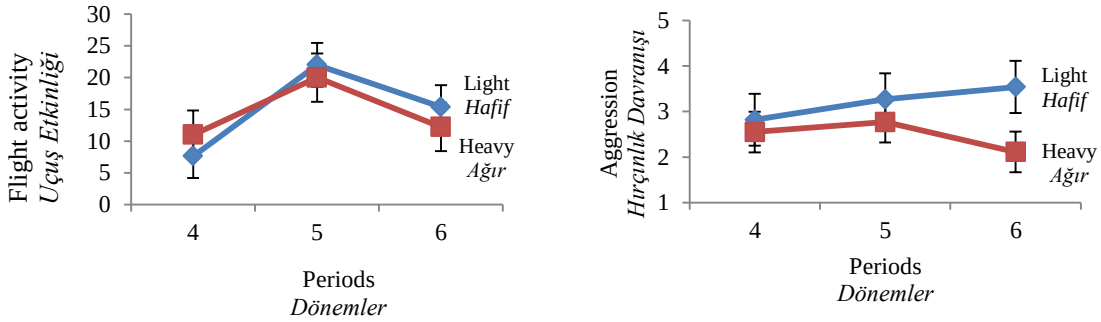

Figure 2. Flight activity and aggression results according to groups and periods

Şekil 2. Dönemlere ve gruplara göre uçuş etkinliği ve hırçınlık sonuçları

The average number of the cleaned brood cells for the hygienic behaviour test was determined to be 95.6±5.58 for the light group and 78.8±17.97 for the heavy group (P<0.05). Honey production was obtained 1.78 kg/colony in light group and 2.23 kg/colony in heavy group. There were no significant differences between the light and heavy groups with respect to honey production values (P>0.05). The overwintering success were determined to be 46% for the light group and 83% for the heavy group. The vitality rate of honey bees during the trial was 86.95%. Swarming tendency and robbing behavior were not seen in test colonies during the study.

Discussions

The queen emergence weight averages obtained in this study are similar to studies conducted with different regions and subspecies (Akyol et al., 2008; Kahya et al., 2008; Uçak Koç and Karacaoğlu 2011).

The average number of the frames covered with bees and brood area obtained in this study was found to be

lower than the studies performed (Fıratlı and Budak, 1994; Güler, 1995; Gençer, 1996; Shah, 1999; Dodoloğlu and Genç, 2002; Karaca and Özmen, 2012) in other regions and genotypes.

In the Southeastern Anatolia Region, the survival rate was determined as 90% by Kaftanoğlu et al., 1993. In Erzurum conditions, the survival rate of Caucasian and Anatolian breeds and their hybrids was determined as 86% in the Caucasian group, 93% in the CaucasianxAnatolian group, 93% in the AnatolianxCaucasian group and 86% in the Anatolian group (Dodoloğlu, 2000). The survival rate obtained from this study (86.95%) was found to be in agreement with the Anatolian group.

The local honeybees of the Southeastern Anatolia region were reported to be very agressive (Kaftanoğlu et al., 1993), but the agression was found to be low in this study. In Ankara conditions, the mean number of sting was 5.63±0.75 in the Caucasian honeybees (Gençer, 1996), 3.73±0.77 in the CaucasianXCaucasian honeybees (Akyol et al., 2003), and 4.14±0.77 in the Caucasian honeybees in Erzurum conditions (Dodologlu, 2000). In this study, average aggression was found 3.21±0.330 pcs/min for the light group and 2.48±0.365 pcs/min for the heavy group (P>0.05).

Honey production was also found quite low in test colonies. Honey yield depends on colony population development and floral sources. In Şanlıurfa where the study is conducted, the spring is very short and the long-hot summer period is dry, compared to many localities. Test colonies have shown positive results in the hygienic behavior test. Hygienic behaviour test was determined to be 95.6±5.58 for the light group. Contrary to literature reports, the light queen group performed better in many aspects. This may result in better response to adverse environmental conditions than the heavy queen group. Performance and behavioral characteristics of the experimental colonies were investigated in the present arid conditions, which were not transported to another region. For this reason, it was observed that colony population development and honey yield were very low as a result of the experiment compared to similar studies of other subspecies and ecotypes in other regions. Local honeybee subspecies and ecotypes are known to be relatively inefficient, but working with local ecotypes has great prospects for the development and sustainability of beekeeping in the long run. The selection of local honeybees that have adapted to the own region and the selection of breeding to increase the productivity and performance of the local honeybees requires local queen honeybee production in the ongoing process.

Conservation of genetic diversity is important for sustainable beekeeping and biological aspects. Honey bees are susceptible to inbreeding (Tarpy, 2003; Seeley and Tarpy, 2007). In Turkey, there is an important tendency and desire among the beekeepers to use Carniolan and Italian queens, especially and

generally Caucasian. For example, 94% in Adıyaman, 83% in Şanlıurfa, Caucasian and their hybrids are used in beekeeping (Özmen Özbakır, 2012; Özmen Özbakır et al., 2016). This tendency and beekeeping activities have led to the hybridization of Anatolian bees and local ecotypes, has created a genetic pollution. It has also led to a decrease in genetic diversity. For this reason, it is necessary to evaluate local honey bees according to beekeeping requirements, and to carry out breeding studies for their valuable characteristics for different regions.

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