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Describe the production system and measurement of the Hygienic behaviour of local honeybees in Aljabal Alakhder and Benghazi area, Libya.

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KEYWORDS:

Hygienic behavior, honey bee, Production system , selection

A B S T R A C T:

The study aims to describe the production system and measure the hygienic behaviour of sixty outcrossing hives of the local honey bee in the Aljabal Alakhder and Benghazi area. Therefore, 131 beekeepers were interviewed and completed a production system questionnaire. The out-crossing experiment was created with two beekeepers from Tokra and Gardena. Sixty hives were divided into four groups, and then the hygienic behaviour by using a needle to kill the larvae stage and geometric shape to give 100 hexagonal eyes (10 * 10) from the brood. Data was analysed using descriptive statistics and ANOVA test proportion by SPSS software. The study showed that a third of the beekeepers started rearing honey bees with a small number of hives, less than ten hives; they also prefer local bees and well as eighty-seven per cent of beekeepers rearing queens from the same apiary, and fifty per cent of them select queens by colour, and mating occurs randomly. Sixty-four per cent used artificial warming to increase the number of hives. Varroa and Nosema were the beekeepers' central diseases, and the low honey production ranged from 50 to 300 kg per year. The hygienic behaviour of sixty hives was height, and there was no significant difference between all groups. Improvement of honey production could be through increasing diversity initially, establishing queens, selecting and avoiding inbreeding.

توصيف لنظام التربية وقياس مستوي السلوك الصحي لنحل العسل المحلي في الجبل الأخر ومنطقة بنغازي

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المستخلص:

هدفت هذه الدراسة إلى وصف نظام التربية وقياس السلوك الصحي لنحل العسل المحلي في منطقة الجبل الأخضر وسهل بنغازي، وقد وظف الباحث المقابلة مع 131 مربي نحل، و استخدم الاستبانة لمعرفة نظام التربية، وقام بتحليل البيانات المتحصل عليها باستخدام الإحصاء الوصفي واختبار **ANOVA** بواسطة برنامج **SPSS** ، وأوضحت الدراسة أن ثلث النحالين بدؤوا بتربية نحل العسل بأقل من عشر خلايا، وقام سبعة وثمانون بالمئة منهم بتربية الملكات من المنحل نفسه، كما يستخدم أربعة وستون في المئة من النحالين تقسيم الخلايا لإكثارها. وتبيّن أيضًا أن طفيل الفاروا والنيوزيما هما من الأمراض الرئيسة التي تواجه المربين، وقد توصلت الدراسة إلى أن إنتاج العسل منخفض، تراوح بين 50 إلى 300 كجم سَنَوِيًّا. أما السلوك الصحي فكان مرتفعا ولا يوجد فرق معنوي بين المجموعات.

الكلمات المفتاحية:

السلوك الصحي، نحل العسل ، نظام التربية ،الانتخاب .

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INTRODUCTION

Honey bee colonies were estimated to be about 125.000 distributed over all details breeds; in an attempt to improve honey bees in Libya, 50.000 units (colonies package bees and queens) of Apis mellifera ligustica and some 3600 colonies of Apis mellifera carinnca were imported to Libya between the 1970 and 1990 (Al-Mahjoob, Al Tarhoni, Kosheim& Al Mattri 1999).In addition, a commercial hybrid line between A.mcarnica and Apis mellifera lamarckii called (Queen's Wadi) was marketed in Libya (Simonthomas and Simonthomas, 1980). The classical morphological analyses showed that Libyan honey bees sampled at coastal and desert locations were distinctly different from adjacent A.mintermissa bee populations of Tunisia and Algeria and those of A.mLamarckii of Egypt, and it was closely related to Apis mellifera sahariensis. In addition, wing variation angles showed affinities to Apis mellifera jementica (Elbanby, 1977 and; Shaibi et al., 2009). Also, four new haplotypes of oriental O evolution lineage were detected in local bees of coastal lines in Libya. In contrast, the European M lineage was rarely seen (Shaibi et al., 2009)—many attempts to import A.mligustica and A.mcarnica during the 1970s and 1990s (Al-Mahjoob et al. 1998). When talking about the production system to understand how beekeepers take care of their honey bee hives, beekeepers in Aljabal Alakdar and Benghazi area use local honey bees and some imported breeds to produce honey; many attempts were made by import different honey bees: Italian, cranial to improve regional honey bee but there was no discernible change. In addition, they are not applying any breeding program to enhance local honey bees. To succeed, the Production system depends on selecting better-performing honey bee colonies in the apiary and a control mating system. Therefore, selection objectives and criteria are essential for a beekeeper in an apiary's breeding program. An apiary's colonies could be chosen based on critical measurable characteristics, such as hygienic behaviour and disease resistance (Gregorc&Vzreja 2010).

Uzunov, Brascamp and Buchler, 2017). Explain the aims of any breeding program to improve one or more traits essential to the economy genetically. Beekeepers place a high value, among other things, on the spring building of the brood, the production of honey, and testing for hygienic behaviour. The selection of the appropriate breeding program is influenced by the degree of inheritance and selection pressure. As a result, the first step in developing a genetic improvement program is to define the breeding goals, measure them, and describe the honey production system in a particular region. It is demonstrated that several technological and scientific advancements were required for genetic improvement in honey bees. These included fundamental research into honey bee morphology, physiology, and behaviour, as well as the development of movable frames that permit colony growth control. These findings gave males more control during mating seasons and made it possible to control mating by varying the distance between apiaries. Beekeepers have difficulty comprehending and retaining the mating process due to honey bees' complicated reproductive biology, which requires queens to mate with many drones. Fundamentally, the most challenging aspect for beekeepers to comprehend is how selecting honey bees in one generation with desirable traits results in improved offspring in subsequent generations. (Wilson, 1910). Rothenbuhler (1958) The effective defence mechanism against diseases is one of the most important functions of the worker bees in a colony. The importance of hygienic behaviour in honey bees is a natural, heritable trait known for many years (Park, 1936). It is of great importance in resisting many diseases related to brood and in the detection and speed of resistance without using any drugs or chemical preparations. According to Woodrow and Holst (1942), hygienic behaviour is the honey bees primary natural defence against brood diseases like American foulbrood and Chalkbrood. Bees that behave in a hygienic manner can quickly identify, uncap, and remove infected bacterial and fungal broods.

In 1964, Rothenbuhler demonstrated that the "hygienic behaviour" of worker bees, which is their ability to identify dead broods and remove infected or damaged broods, is regulated by two pairs of recessive genes. This behavioural defence prevents parasites from penetrating bee colonies, killing or removing them. Spivak and Gilliam (1998) discovered that some honey bees perform a two-step "hygienic behaviour" process when they find dead or diseased larvae or pupae in the brood comb.

1. Remove the wax covering covering the brood cell by pulling the cover off.
2. In the brood cell, remove the dead body

According to Severson and Erickson (1989), middle-aged worker bees are an important intranidal task in honey bee colonies. It involves finding diseased broods in the larval and pupal stages and removing all infected broods to reduce infection rates. This behavioral defence prevents the bee colonies from being penetrated, killed, or removed by performing two tasks: removing the contents of the cells and uncapping them. The ability of worker bees to identify dead broods and then remove infected or damaged broods, regulated by two pairs of recessive genes, is known to correlate with disease resistance. Regardless, the queen honey bee is an essential member of a colony's survival and activities. Goncalves and Gramacho (2003) indicated that the successful selection of colonies of honey bees with hygienic behaviour is an option to reduce the incidence of diseases and a reduction in the use of chemicals. The queens of honey bees mate with many males; this mating increases the more genetically diverse a colony becomes. Empirical studies have demonstrated reduced disease incidence in genetically diverse colonies of honey bees relative to genetically uniform ones. The queen bee mates with numerous drones within the first week of her life. She receives an abundance of sperm from various genetic sources as a result. Compared to colonies created experimentally with queens mated to a single drone, studies have demonstrated that colonies with many distinct lineages are healthier and more productive. (Wray, Mattila, and Seeley 2011).

Materials and methods

In the study area (Benghazi, Tukra, AbuJarrar, and Persis), which represents the plain of Benghazi,(Al-Hamda, Farzouga, Al-Marj, Al-Bayda, and Shehat) stand for Aljabal Alakhder, we interviewed beekeepers. We collected responses to the questionnaire and represented the honey bee production system. The questionnaire includes the date of beginning breeding, number of hives, breed at the beginning of beading, method of getting queens, principles of queen selection, mating season, type of mating, winter nutrition, honey production, and diseases. The questionnaire was filled out at random131 beekeepers were interviewed from nine regions; there were 27 beekeepers in Tokra: 13 in Abujarrar, 12 in Persis, 15 in Benghazi, 13 in Al-Hamda, 5 in Farzouga, 18 in Al-Marj, 10 in Al-Bayda, and 18 in Shahat. Table (1)

(Table 1) Depicts the number of beekeepers in each region:

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Region	Tokra	Abujarrar	Persis	Al-Hamda	Benghazi	Farzouga	Al-Marj	Al-Bayda	Shahat
Number of beekeepers	**27**	**13**	**12**	**13**	**15**	**5**	**18**	**10**	**18**
Total	131								

Plan of reciprocal mating:

Sixty hives were divided into four groups and crossed reciprocally (Table 2)

Mating	Number of hives
Queen from Tokra apiary and drones from Gardena apiary	**15**
Queen from Gardena apiary and drones from Tokra apiary	**15**
Randomly mating at Tokra apiary (Control)	**15**
Randomly mating at Gardena apiary (Control)	**15**

The following how to measure hygienic behaviour:

A. A geometric shape to give 100 hexagonal eyes (10*10) from the brood.
B. A pin (Needle) was used to kill the larvae inside the cell in the capping brood.
C. The frame returned to the hive after killing the larva stage, and after 24 hours, an examination revealed that the honey bee worker had removed the dead brood.
D. Using the following equation, we determined the percentage of hygienic behaviour and the number of cleaned hexagonal eyes. Arathi*et al*., (2000)

Percentage of hygienic behaviour = 100 – Non cleaned hexagonal eyes of brood

Results

Through this study, the results of the statistical analysis showed that the beekeepers began with a small number of hives; the majority of beekeepers started with one to ten packs 67.2%, whereas 20.61% and 12.21% of beekeepers began with 11 to 20 and 21 to 50 hives which consider approximately good, to begin with to establish reasonable diversity. Most beekeepers, 98.47 per cent, use natural pasture and move their hives according to the seasonal foraging of natural vegetation, while 1.52 per cent of beekeepers keep their hives on a farm. Beekeepers provide honeybees with food divided into two types of protein food (candy and Nektaboll) and a different kind of carbohydrate (Sugar solutions) to preserve the life of the beehive. Like other living organisms, honeybees require food to perform their various functions, particularly during the winter months when there is a lack of nectar.

They rely on solid food like Candy and Nektaboll or liquid food like 1:1 and 2:1 sugar solutions for nutrition. In the study area, it was found that 81.76 per cent of beekeepers use sugar solution, 9.92 per cent use both sugar solution and candy solution and 8.39 per cent use Nektaboll alone. The checkup of hives is essential; most beekeepers check packs daily, weekly, and monthly. 93.12% of them check their hives weekly, and only a few beekeepers

(3.05%, 3.84 %) check hives daily or monthly.

Table (3) percentages of the number of hives, foraging, nutrition and checkup for beekeepers

Character	%
Number of hives at the beginning	
1-10	67
11-20	20.61
21-50	12.21
Foraging	
Seasonal fo	98.47
On-farm	1.52
Winter Nutrition	
Sugar solution	81.76
Nektaboll	9.92
Sugar and candy	8.39
Check up	
Daily	3.05
Weekly	93.12
Monthly	3.84

The study area has three breeds of honey bees:local, Italian, and Carniolan. 86.62% of beekeepers started with local bees, 12.21% used Italian honeybees, and 1.52% used Carniolan honeybees. Additionally, the % of beekeepers who rear their queens in the same apiary is 79.38%, while only 20.61 % of beekeepers raise their queens from a different apiary. In addition, beekeepers use four criteria to select queens: colour, size, the best at laying eggs, and honey production. 49.61 % of beekeepers choose colour, 24.42 per cent for size, 17.55 % for laying eggs, and 8.39 % for honey production. 64% of beekeepers (Division) used artificial swarming, 9.16% bought hives from others, and 26.7 % used natural swarming.

Table (4) Percentages of types of queen breed, queen rearing and queen selection used by beekeepers.

Character	%
Breed	
Local	86.62
Italian	12.21
Carniolan	1.52
Queen rearing	
Same apiary	79.38
Another apiary	20.61
Queen selection	
Color	49.6
Size	24.42
Strength of proudness	17.55
Honey production	8.39

Most beekeepers in the study area stated that drones and mating ware were not randomly selected. Spring and autumn are the two main mating seasons. Spring mating is considered the best by 84.73% of beekeepers, while 22.90% consider fall to be beast season. 64% of beekeepers used artificial swarming (Division), 9.16% bought hives from others, and 26.7% exploited natural swarming, according to 68.70% of beekeepers who used mating virgin queens inside the apiary and 31.19% of beekeepers outside the apiary. Season of spring working of the brood, which is the capacity of the sovereign to lay the most significant measure of eggs when suitable climatic circumstances are accessible, particularly in the spring when the temperature is a moderate and plentiful stockpile of nectar. The spring building of brood can be either natural, early, very early, or late: 82.44% natural (Beginning of March), 11.45% before, 0.76 very early and 5.34 % late.

Table (5) Percentages of honeybee mating, reproduction and spring building.

Character	%
Season of mating	
Spring	84.73
fall	22.90
Mating queen	
Natural at same apiary	68.73
Natural at another apiary	31.30
Reproduction	
Division	64
Buying	9.16
Natural swarming	26.7
Spring building	
Natural (march)	82.44
Early	12.21
Late	5.34
Very early	0.76

When asked about the overall number of brood frames throughout the year, 41.98% of beekeepers stated that there were few and that they represented approximately two frames of the hive; 37.40% of beekeepers noted that the number of brood frames was good and represented five frames from the pack; 14.50% of beekeepers pointed out that the number of brood frames was low and defined between three and four brackets and 6.10% of beekeepers stated that the number of brood depending on the number of beehives in the study area, beekeepers produce different amounts of honey each year. Honey production ranges from 50 kilograms to 1850 kilograms, with 43.51% of beekeepers producing 50 to 300 kilograms of honey annually, 30.53% having 301 to 600 kilograms annually, 18.32% making 601 to 900 kilograms annually, 2.29 per cent producing 901 to 1200 kilograms annually, 3.05 per cent producing 901 to 1200 kilograms annually, and 3.81% producing 1501 to 1850 kilograms annually. The parasites and diseases that were prevalent in beekeepers' apiaries. The highest rate of Varroa was approximately 45.03%, followed by Nosema at about 37.40%, foulbrood disease at 11.45%, and chalkbrood disease at the lowest rate was approximately 6.110 per cent of the study area.

Table (6) Percentages of brood strength, honey production and Parasites and brood disease.

Character	%
Brood frames	
A few	41.89
good	37.40
low	14.50
Excellent	60.10
Honey production/apiary/year	
50- 300kg	43.51
301-600kg	20.53
601-900kg	18.32
901-1850kg	7.63
Parasites and brood disease	
Varroa	45.03
Nosema	37.40
Foulbrood	11.45
Chalk brood	6.10

According to the study's findings (Table 7), there are no significant differences in the hygienic behaviour of local honey between queens mated with drones from outside the apiary and queens mated with drones inside the apiary. Outside and inside the apiary, the average percentages of hygienic behaviour were 0.87, while control values were 0.89 and 0.88.

Table (7) Percentage of hygienic behaviour:

1. Mating	2. Number of hives	3. Percentage %
4. Queen from Tokra apiary and drones from Gardena apiary	5. 15	6. 0.87 n.s
7. Queen from Gardena apiary and drones from Tokra apiary	8. 15	9. 0.87 n.s
10. Randomly mating at Tokra apiary (Control)	11. 15	12. 0.89 n.s
13. Randomly mating at Gardena apiary (Control)	14. 15	15. 0.88 n.s

(n.s):Means are not significant (P>0.5).

Fig(1) Hygienic behavior

Discussion

According to our study, the beginning of beekeepers started in 1974 in the area of study, then the number of beekeepers increased in the year 2001. This indicated that the interest in keeping has increased in recent years. Two third of beekeepers start breeding with less than ten hives, whereas one third of beekeeper start with eleven to fifty hives; this indicates that most beekeepers started with a small population size, which lead to genetic drift between subpopulation. most beekeepers do not rely on genetics, and honeybees breed at random, they also do not rely on mating of queens and selection, 86.62% of beekeepers in the study area used local honeybees, 12.21 % used Italian honeybees, and 1.52 %used carniolan honeybees. However, numerous attempts have been made to import Italian and Carniolan honeybees (Al-mahjoub et al., 1999). However, local honeybees dominate due to their adaptability to the local environment and resistance to regional diseases. Nine regions were included in this study, including the coastal areas of Tokra, Abu-jarrar, Persis, and Benghazi) and mountainous areas like (Al-hamda, Farzoga, Almarj, Al-bayda, and Shehat), 131 beekeepers filled out the questionnaire, and the majority of beekeepers said that other breeds like Italian and Caraniolan were introduced by importing queen bees. Still, these breeds disappeared in the local bees. The current number of beehives varies from beekeeper to beekeeper;33 have a small number of hives, twenty to fifty. They did not provide the required genetic diversity because they bred their hives from a single origin. we also noted that the number of beekeepers with more than fifty hives represents the largest number, with approximately 98 beekeepers, which provides a greater chance of genetic diversity this agrees with (Page and Laidlaw,1982). Raising queens is one of the most important steps. In the study area, 79.38 % of beekeepers raised queens from the same basic apiary. This causes inbreeding, which reduces the production of honey and brood in the spring (Ashleigh and Milner, 1989). However, approximately 20.61 per cent of beekeepers exchange queens between apiaries, introducing new queens with distinct genetic makeup into the basic apiary. Both honey production and the brood's spring-building level increase (Woyke 1976). The percentage of beekeepers who prefer local queens to adapt to environmental conditions is 82.44 %, 16.79% of beekeepers prefer Italian queens, and 0.76 % prefer Caraniolan queens. Because local queens are better able to adapt to their surroundings. Most beekeepers select queens based on their appearance, such as colour and size; this suggests they do not select queens with good genetic characteristics. Drones play a crucial role in the mating and generational transmission of genetic material, and male selection plays a significant role in genetic improvement. According to this study, beekeepers do not select drones through any process and mating is done randomly. This results in the accumulation of identical genes, resulting in a significant decline in brood due to the individual's death if his genes are identical (woke, 1976). Beekeepers in the study area stated that there are two mating seasons, which is important for genetic improvement. First, when the weather is mild in March, the hives produce drones to prepare for this season, and mating operations go well, which is the best time of year. Fall (September) is the second season. The mating of queens varies from beekeeper to beekeeper. We found that 68.70% of beekeepers in the study area prefer to mate with queens within the apiary and with males from the same apiary. This could result in a decrease in genetic diversity, an increase in homozygosity of alleles, and an increase in inbreeding. This is consistent with what Konenigor reported. 1986; Palmer and Oldroyd, 2000; and Tarpy et al.,2004). According to Rothenbuhler (1964), 31.29% of beekeepers report that queens mate outside the apiary, potentially increasing genetic diversity and affecting spring brood and honey production levels. The distances between the apiaries are vital in the mating seasons as most examinations detailed that they should be inside three km from all sides (Ashleigh and Milner,1988). Most beekeepers in our study keep one kilometre apart or 70.79 per cent. This resulted in mating between apiaries; only 10.49 per cent of beekeepers maintain the three-kilometre distance required for mating within apiaries. If a genetic improvement program is established, this will present challenges. The beekeepers in the study area depended on the artificial swarming (division) of hives and breeding from the same apiary; 64.12% of beekeepers used it to increase the number of hives, but genetically, this division led to the deterioration of hives, and the increase in inbreeding that leads to a decrease in brood and production of honey (Wray et al.,2011). However, 9.16% bought new hives from another beekeeper, which gives a greater chance of genetic diversity and 26.71% used natural swarming. This character was undesirable for beekeepers. This indicates the need for specialised queen breeders to provide improved queens adapted to local conditions. According to Zmarlicki, 1974, and Racys, 2002, the method of breeding and the number of hives and pastures affect annual honey production. About 43.51% of beekeepers in the study area produced between 50 and 300 kilograms of honey. In comparison, 30.53% produced between 301 and 600 kilograms, 18.32% produced between 601 and 900 kilograms, 2.29 % produced between 901 and 1200 kilograms, 3.5 per cent produced between 1201 and 1500 kilograms, and only 3.81% produced between 1501 and 1850 kilograms in the study area. This suggests that different beekeepers produce different amounts of honey. This is the basic variation that can be used by a genetic improvement program to boost productivity. Many diseases affect beekeepers, some of which are related to brood (such as Folbrood and Chalkbrood), some of which are parasitic (such as Varroa), and some of which are brought on by bacteria (such as Nosema). The insect-related rise in disease incidence and the decline in brood diseases. This suggests that hygienic local honeybees are resistant to brood-related diseases. Numerous studies, including those by Spivak Gilliam and Rothenbuller (1964) and Arathiet et al. (2000) On the speed with which workers clean the hexagonal eyes of honeybees indicate that workers between the ages of 15 and 20 days engage in this behavior. In 1997, Gramacho et al. emphasised that brood temperature is critical to distinguish between larval stages being alive or dead to be expelled from the hive. This behavior is also considered to be an immune system against brood disease. According to Park (1936) and Rothenpoller (1964), hygienic behavior is controlled by two recessive genes at distinct chromosomal locations that are simple to fix in an apiary. From genetically homogeneous beehives, Tarpy and Seeley (2006) also demonstrated that cell genetic diversity reduces the incidence of brood diseases. In the study area, it was found that 68.70 per cent of beekeepers were mating queens in their apiaries. This will increase homozygosity and lead to more hygienic bee behavior. Since these genes are passed down from generation to generation and are present in the local bees, we know they are responsible for this behavior. The incidence of Calkbrood disease was 6.1%. This indicates that the local bees have a high level of hygiene, resulting in a lower incidence of incubation diseases than the other diseases that beekeepers face. We observe that there is no significant difference between the four groups of local bees when measuring hygienic behaviour in the manner that the researchers mentioned in their literature review. This indicates that the local bees exhibit high levels of hygienic behavior

Conclusion

According to the study, a third of beekeepers began raising honey bees with fewer than ten hives, prefer to raise local bees, and 86.62 per cent raise queens from the same apiary. 50%

of beekeepers choose queens based on colour, mating occurs randomly, and the apiaries are close, less than three kilometres apart. Artificial swarming was used by 64% of beekeepers to reproduce. Seasonal forging is essential for beekeepers. The majority of beekeepers inspect the hives weekly. The most significant challenges to honey bee production were Varroa, Nosema, and foulbrood. The annual yield of honey ranged from 50 to 300 kilograms. Higher levels of hygiene behavior are found in local honey and are not affected by crossing.

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