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Expected Reasons of Population Decline in Honey Bee (*Apis mellifera*) Colonies

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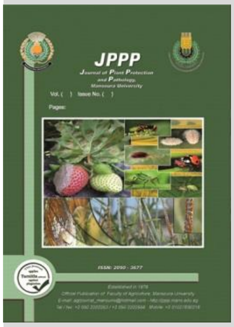

ABSTRACT

The study aimed to investigate the relationship between colony survival and some preventive procedures. The experiments were conducted in Sulemani governorate during August, September and October 2020. Seventy-two colonies were tested in four localities (Qaradax , Sulaimani center, Mergapan, and Sartake bamo); (18 colonies for each location). The tested colonies were treated with; probiotics, formic acid, eucalyptus, Tetracycline and Terramycin. Larger brood area was found in all treated colonies compared to untreated ones. Colonies provided with probiotics showed significantly more brood than untreated colonies in the four locations. Maximum brood area was 203.667 (inch)^2 in Sartake bamo followed by 199.667 (inch)^2 in Mergapan; then 179.000 (inch)^2 in Sulaimani center. While the brood area was not more than 15.667 (inch)^2 in all untreated colonies in the four tested apiaries. Colonies provided with probiotics showed significantly more density of adult workers than untreated colonies in the four locations. Maximum area covered with adult workers (density) was 6.667 Lf. (Langstroth frame) in Sartake bamo followed by 6.333 Lf. in Mergapan; then 6.000 Lf. in those treated with Formic acid in Sartake bamo. While the density of adult workers was not more than 1.000 Lf. in all untreated colonies in the four tested apiaries. Using probiotics and organic acid treatments were the best preventive measures.

Keywords: Honey Bee, Probiotics, Formic Acid, Brood Area

INTRODUCTION

Huge number of colony losses of managed honey bees in the recent years have disrupted beekeeping industry and bee researchers. The honeybee is not only pollinators of agricultural crops and wild plants, but also provide abundant bee products. In recent years, the dramatic reductions in bee colonies, causing significant economic losses, were reported from all over the world. The main reasons were diverse; agrochemicals, parasites, viruses, methods of planting structure and distribution, or their interaction factors (Vanengelsdorp et al., 2009).

Domestic apiculture industry in Iraq was destroyed during gulf war only feral colonies existed in the mountains. After 1991 beekeeping process began again and a large number of infested honey bee colonies were illegally imported from neighboring countries. *Varroa* mite infestation was first detected in Iraq in the mid-1980s (FAO). Many beekeepers, particularly those with traditional hives lost almost all their colonies. In 1990, *Varroa* mite was reported in all Arab countries (Haddad 2011). Although different kinds of acaricides from various sources were applied by beekeepers but still remains threat to the bee hives of the area. (Ayoub et al., 2014)

The single greatest threat to honey bee populations worldwide is the invasive mite Varroa destructor Andersen & Trueman. The life cycle of the varroa mites is tightly adapted to the development of the honey bees. Varroa mites are serious and devastating ectoparasites of the honey bee. During the phoretic phase, the varroa mites live on the bodies of honey bees and feed on their haemolymph. The reproductive phase of varroa mites happens exclusively in the capped cells of developing bee pupae (Ifantidis, 1983). Several studies have documented the negative effects of varroa infestation on honey bees including reduced lifespan (Kralj et al., 2007), decreased survivorship (Yang et al., 2007) and weight loss in drones (Duay et al., 2002).

The second threat to honey bees is American Foulbrood disease which classified on list B of the Office International de Epiozootic (OIE), the world organization for animal health. List B diseases are those diseases which have significant impact on the socio-economic and/or public health of the countries as well as international trade of animals and animal products (de Graaf et al., 2006). Colony Collapse Disorder (CCD) is a syndrome describing the large-scale loss of managed honey bees worldwide first reported in 2006–2007 (Vanengelsdorp et al., 2009). Several studies have investigated and reported various causes for this sudden decline is bees such as viruses (Dainat et al., 2012), varroa mites (Le Conte et al., 2010), microsporidean Nosema spp. and bacterial brood diseases (Paxton, 2010).

Due to the lack of definite causal agent of colony losses, it is being investigated extensively and it is becoming clear that a single causal agent is difficult to identify and these causes are possibly multiple and very complex (Dainat et al., 2012; Nazzi et al., 2012; Evans et al., 2012).

Beekeepers have shown their interest in chemical treatments that instantly show their effect on the pests rather than using natural products. Natural chemicals, such as formic

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acid, oxalic acid, lactic acid, thymol eucalyptus, camphor, menthol, thyme oil, laurel, and lavender oils have been recommended and used in recent years. Since organic acids appear to be less harmful to human health and are naturally found in the chemical structure of honey, they are suggested in the process of producing organic and healthy hive products (Esmen, Dodolog˘lu, & Genc¸, 2010).

According to European Union regulation 1804/1899 on organic production, the use of formic acid is authorized as a natural compound in organic apiculture standard management (Mato et al., 2006).

Aims of the study;

- This study aimed to investigate the relationship between colony survival and some preventive procedures.

-To find out and confirm the most obvious reasons of population decline in order to perform suitable solutions to preserve honey bee (*Apis mellifera*) colonies in our area.

MATERIALS AND METHODS

All experiments were conducted in Sulemani governorate during August, September and October 2020. Seventy-two colonies were tested in four localities (Qaradax , Sulaimani center, Mergapan, and Sartake bamo). Fifteen colonies were differently treated and compared to three untreated colonies in each locality (apiary). The treatments can be illustrated as the following;

The 1st treatment: three colonies were provided with probiotic, doses for probiotics were calculated from the manufacturer's instructions, considering an average body weight of 100 mg for individual bee. All doses were prepared in 50% sucrose syrup. This treatment was applied weekly for six weeks.

The 2nd treatment: three colonies were treated with formic acid; the evaporator pad was placed on a top of the frames in the brood chamber.

The 3rd treatment: three colonies were treated continuously with eucalyptus smoking during colony inspection.

The 4th treatment: three colonies were treated with Tetracycline (Bee tetracycline Alfarabi), 100 g of the product was mixed with 200 g of powdered sugar; each hive received 20 g of the mixture.

The 5th treatment: three colonies were treated with Terramycin, the product was combined with powdered sugar to make a dust

and applied to honey bee colonies for six weeks.

The 6th treatment (control): three untreated colonies compared to the previously mentioned colonies.

The total area of capped brood and the density of adult workers (area covered with bees) on both sides of the combs were considered as parameters of colony strength. These parameters were weekly measured during experimental period using standard Langstroth frame.

The results were analyzed statistically using factorial RCBD design with triple replicates and performed using XLSTA program (2017) m, Duncan̕s multiple range Test was used to determine the differences between means at P = 0.05.

RESULTS

Larger brood area was found in all treated colonies compared to untreated ones. Colonies treated with probiotic showed larger brood area in the four locations. Colonies provided with probiotics showed significantly more brood than untreated colonies. Maximum brood area was 203.667 (inch)^2 in Sartake bamo followed by 199.667 (inch)^2 in Mergapan; then 179.000 (inch)^2 in Sulaimani center. While the brood area was not more than 15.667 (inch)^2 in all untreated colonies in the four tested apiaries, table (1); fig (1,2,3, and 4).

Table 1. Effect of five different treatments on honey bee brood area (inch)^2 compared to untreated colonies in four locations.

Treatments	Locations (Apiaries)			
	Qaradax	Sulaimani center	Mergapan	Sartake bamo
Probiotic	167.333 a	179.000 a	199.667 a	203.667 a
Formic acid	144.667 ab	159.333 ab	167.667 ab	159.667 ab
Eucalyptus	144.000 ab	129.667 b	144.000 b	139.667 ab
Tetracycline	133.000 bc	153.000 ab	166.667 ab	166.000 ab
Terramycine	114.667 c	164.333 a	167.333 ab	165.000 b
Control	15.667 d	7.667 c	13.330 c	9.333 c

Means with the same letter are not significantly different.

More density of adult workers was found in all treated colonies compared to untreated ones. Colonies treated with probiotic showed higher density of adult workers in the four locations. Colonies provided with probiotics showed significantly more density of adult workers than untreated colonies. Maximum brood area was 6.667 Lf. (Langstroth frame) in Sartake bamo followed by 6.333 Lf. in Mergapan; then 6.000 Lf. in those treated with Formic acid in Sartake bamo. While the density of adult workers was not more than 1.000 Lf. in all untreated colonies in the four tested apiaries, table (2); fig (5,6,7and 8).

Using probiotics and formic acid treatments were the best preventive measures in all tested apiaries.

Table 2. Effect of five different treatments on honey bee density (Langstroth frame) compared to untreated colonies in four locations.

Treatments	Locations (Apiaries)			
	Qaradax	Sulaimani center	Mergapan	Sartake bamo
Probiotic	5.667 a	5.667 a	6.333 a	6.667 a
Formic acid	4.667 ab	5.000 ab	4.667 bc	6.000 a
Eucalyptus	4.333 b	4.000 b	3.667 c	5.000 b
Tetracycline	3.667 b	4.333 b	5.000 b	4.000 c
Terramycine	4.333 b	5.000 ab	5.667 ab	6.000 a
Control	0.333 c	1.000 c	1.000 c	0.667 d

Means with the same letter are not significantly different.

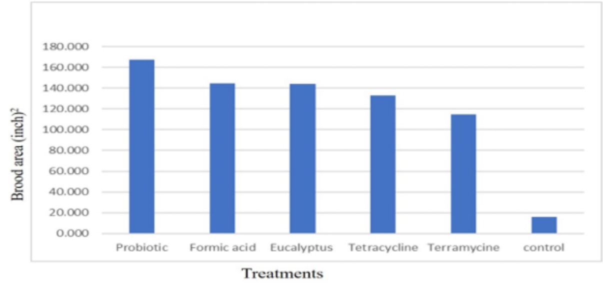

Fig 1. Effect of five different treatments on honey bee brood area (inch)^2 compared to untreated colonies in Qaradax.

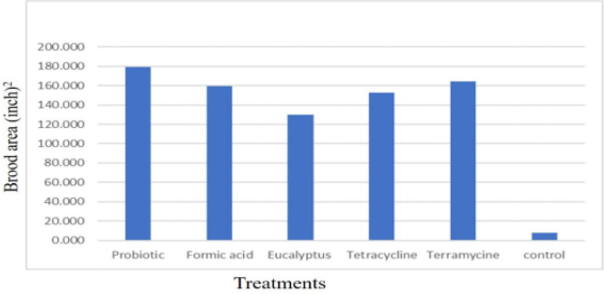

Fig 2. Effect of five different treatments on honey bee brood area (inch)^2 compared to untreated colonies in Sulaimani center.

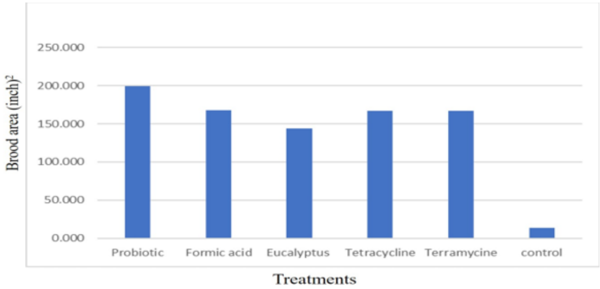

Fig 3. Effect of five different treatments on honey bee brood area (inch)^2 compared to untreated colonies in Mergapan.

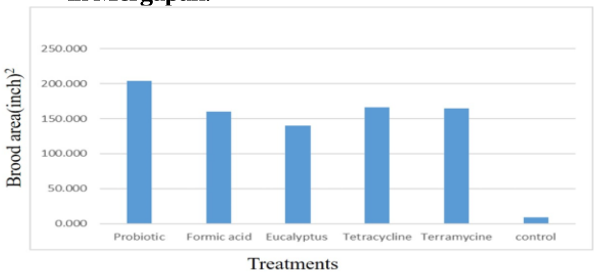

Fig 4. Effect of five different treatments on honey bee brood area (inch)^2 compared to untreated colonies in sartaki bamo.

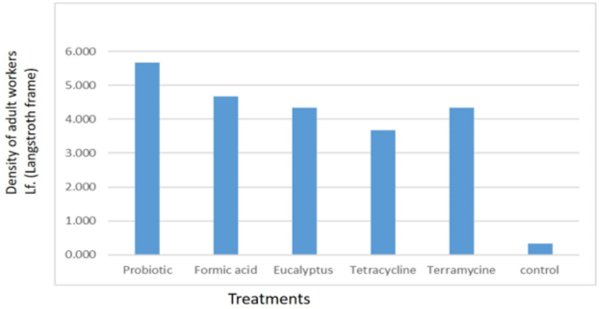

Fig 5. Effect of five different treatments on honey bee density (Langstrooth frame) compared to untreated colonies in Qaradax.

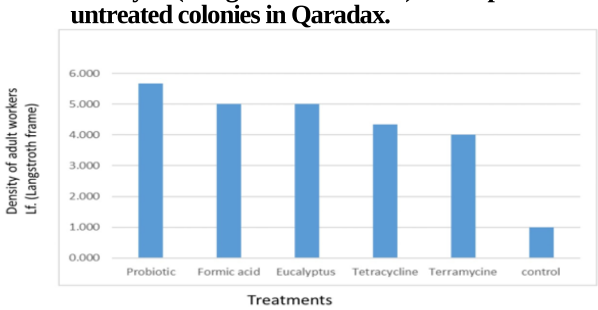

Fig 6. Effect of five different treatments on honey bee density (Langstrooth frame) compared to untreated colonies in Sulaimani center.

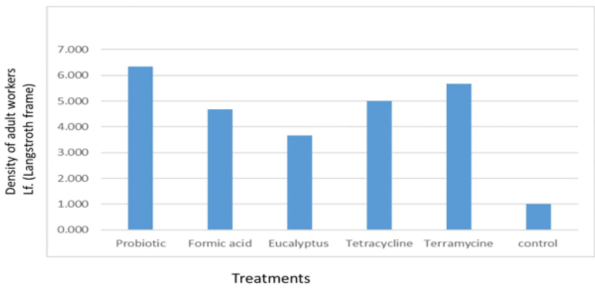

Fig 7. Effect of five different treatments on honey bee density (Langstrooth frame) compared to untreated colonies in Mergapan.

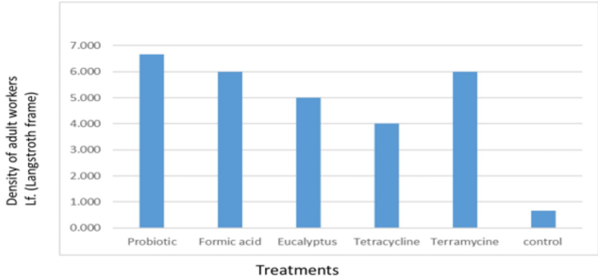

Fig 8. Effect of five different treatments on honey bee density (Langstrooth frame) compared to untreated colonies in Sartaki bamo.

DISCUSSION

Many pest and disease problems in managed honeybee colonies can be avoid by performing good sanitation and cultural controls. Prevention is the best way of defense against organisms that can harm our colonies.

There is no agreement on the definite reason(s) of the problem of honey bee colony losses and the inhibition of the population growth of the colonies (Zoran et al., 2019). Scientific community has been confirmed that colony losses and the decrease in population growth of the colony are a multifactorial issue (vanEngelsdorp et al., 2010; Neumann et al., 2010; Goulson et al., 2015).

Various non-specific factors (e.g., climate changes, agrochemisation and inadequate food) decrease the strength of the colonies; such colonies easily become susceptible for bacterial, and many microbial infections. Then these unhealthy situations diminish the immune system of the bee (Evans et al., 2004; Gätschenberger et al., 2013). Inadequate anti-varroa Management lead to significant health problems in honey bee colonies and cause the spread of viruses.

Our results are in agreement with recent studies that have found other natural compounds such as natural plant extracts, probiotics bacteria, and some organic acids that are very useful for maintaining the survival of honey bee colonies and supporting the population growth of the colonies. For example, the probiotics bacteria have antimicrobial activity against a large number of bacteria and fungi and produces large amounts of lactic acid (Kulhanek et al., 2017).

Because of this is a multifactorial issue, therefore the recommended solutions to the problem includes a sequence of activities and preventive procedures during beekeeping management leads to the protection of the large number of the susceptible colonies from expected pests and pathogens in our area.

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الأسباب المتوقعة لإنخفاض تعداد شغالات نحل العسل في طوائف *Apis mellifera*

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استهدفت الدراسة التحري عن العلاقة بين استمرارية بقاء طوائف النحل و بعض الأجراءات الوقائية خلال التربية. تم تنفيذ التجارب في محافظة السليمانية خلال الأشهر ؛ اب ؛ أيلول و تشرين الأول ٢٠٢٠. تم اختبار ٧٢ طائفة نحل في اربعة مواقع (قرداغ ؛ مركز السليمانية ؛ ميركه بان ؛ و منطقة سرتاكى بامو)؛ (١٨ طائفة في كل موقع) . تم استخدام البكتريا المفيدة ؛ حامض الفورميك ؛ اليوكالبتوس ؛ تتراسايكلين ؛ و تيرامايسين ؛ مع طوائف التجربة .كانت مساحة الحضنة اكبر في جميع الطوائف الخاضعة للأختبار مقارنة بالطوائف غير المعاملة (طوائف السيطرة). الطوائف المزودة بالبكتريا المفيدة أظهرت زيادة معنوية في مساحة الحضنة مقارنة بطوائف السيطرة. اكبر مساحة للحضنة ٢٠٣,٦٦ انج^{2} كانت في منطقة سرتاكى بامو؛ و بعدها ١٩٩,٦٦٧ انج^{2} في ميركه بان ؛ ثم ١٧٩,٠٠ انج^{2} في مركز السليمانية ؛ بينما لم تتجاوز مساحة الحضنة ١٥,٦٦ انج^{2} في جميع الطوائف غير المعاملة (السيطرة) في المواقع الأربعة.الطوائف المعاملة بالبكتريا المفيدة اظهرت زيادة معنوية في المساحة المغطاة بشغالات النحل مقارنة بطوائف السيطرة في المواقع الأربعة. أعلى قيمة للمساحة المغطاة بالنحل كانت ٦,٦٦٧ اطار لانكستروث في منطقة سرتاكى بامو؛ و بعدها ٦,٣٣٣ اطار لانكستروث في منطقة ميركه بان ؛ ثم ٦,٠٠٠ اطار لانكستروث في الطوائف المعاملة بحامض الفورميك في منطقة سرتاكى بامو. بينما لم تتجاوز كثافة النحل عن ١,٠٠٠ اطار لانكستروث في الطوائف غير المعاملة (السيطرة) في المواقع الأربعة.كل من البكتريا المفيدة و الحامض العضوي اعطت افضل النتائج عند استخدامها كأجراءات وقائية للمحافظة على طوائف النحل.