Original Scientific paper
10.7251/AGRENG2001061N
UDC 638.1-02/-099

THE EFFECT OF THE ORIGIN OF THE QUEEN BEES AND THEIR INTERACTION WITH SURROUNDINGS ON THE DEGREE OF VARROA INFESTATION OF A BEE COLONY

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ABSTRACT

Honey bee endures significant losses due to the presence of *Varroa destructor* mite in bee colony. Because of its wide-spread presence in bee colony it can cause its complete destruction. Different breeding programmes regarding honey bee pay a great attention to bee resistance to varroa. The trial was conducted in 27 bee colonies. Three groups of bee swarms were formed and in each there were nine queen bees originating from three mutually distant producers. Then, in three distant apiares the queen bees were placed in bee swarms so that in every apiary the queen bees of three different genotypes were represented. During 2017 and 2018, during six different periods, by a powdered sugar method the infestation of bee colonies by varroa mite was inspected. The degree of varroa infestation in relation to origin of queen bees ranged from 0.269 to 0.327 and difference determined was not statistically significant (P>0.05). In relation to a location, the least average infestation of societies accounting for 0.140 was observed in an apiary in north-eastern Serbia, while the greatest infestation accounting for 0.452 was observed in colonies placed in western Serbia. Determined difference in varroa infestation in relation to a location of an apiary was statistically significant (P<0.05). Continual monitoring of the varroa infested colonies by use of powdered sugar method indicated the differences between examined groups and reduced damage threshold for bees.

Keywords: *Honeybee, Queen bees, Varroa infestation, Powdered sugar method.*

INTRODUCTION

Honey bee (*Apis mellifera* L.) is the most useful insect in the world and its social and economic benefits for man are great. By honey bee breeding we can make profit realised from direct bee products. On the other hand, through bee pollinating activity a considerably greater indirect profit is realised estimated to be more than €150 billion on the world scale. This sum represents 9.5% of the value of global agricultural production (Gallai *et al.*, 2009).

Honey bee is exposed to various negative factors which either separately or interactively may contribute to substantial loss in this most important insect

pollinator (Meixner *et al.*, 2010; Jacques *et al.*, 2017). One of the most significant factors referred as the cause of bee losses is ectoparasite *Varroa destructor*. This mite causes both direct damage by feeding itself on the fat body of the bee brood and adult bees and an indirect damage as a vector of different viruses (Ramsey *et al.*, 2019). Beekeepers worldwide most often try to suppress varroa by adding a chemically synthetized acaricides to bee colony which without adequate rotation contribute to varroa resistance (Gregorc *et al.*, 2018). However, the use of chemical treatments has a negative consequence of incidence of residuals in bee products (Buchler *et al.*, 2010). In such conditions honey bee seems unable to manifest its natural resistance potential to varroa. The European Union has taken steps to find new approaches through different projects like FP7-KBBE.2013.1.3-02 (SMARTBEES) to focus on identification, breeding and propagation of locally adapted honey bees with high performance and resistance traits to *Varroa destructor* (Uzunov *et al*., 2015). To include and improve desirable traits is the aim of many breeding programmes in bee breeding (Nedić *et al*., 2005; Uzunov *et al.*, 2017). Slow and limited varroa mite population growth is a fundamental criterion of resistant stock which can be used as a character for selective breeding on mite resistance (Buchler *et al.*, 2010).
Therefore, the goal of this pilot research was to study mite infestation level in three different honey bee genotypes.

MATERIAL AND METHODS

The trial was carried out in three mutually remote bee farms chosen previously among bee keepers. These bee farms were testing bee farms while records were monitored according to recommendations of and cooperation with SMARTBEES FP7.KBBE programme.2013.1.3-02/WP6 "Field testing and selection of local bee populations". The first testing bee farm was situated in Bela Crkva (BC) in the far east of Serbia where local queen bees of known origin were bred and they represented the first genotype (G1). The second beehive was located in Bajina Bašta (BB) in the far west of Serbia where queen bees of the second genotype were bred (G2). On the third beehive located in Lapovo (LA), in central Serbia, the queen bees of the third genotype were bred (G3). In the first stage of the research during the month of June, 2017, 9 standard bee swarms were formed on all three bee farms according to performance testing protocol (Uzunov *et al.*, 2015). After that the queen bees were exchanged among the bee keepers in such a way that on each testing farm the three queen bees of different genotypes were present but on each bee farm a group of queen bees which originated from the breeder's population remained. Formed and stabilized swarms in all three testing bee farms were in the beginning treated against varroa by the same chemical treatment. During further period of monitoring no treatment was applied against varroa on bee farms. The colony mite infestation level was monitored by means of "powdered sugar method" (Uzunov *et al.*, 2015). For calculation of the infestation levels they were expressed as the number of mites in 10 g of bees - about 100 bees by using the following formula: total number of mites x 10 / bees net weight (g). The level of infestation during 2017 and 2018 in six control examinations in different time periods during the course of the year was carried out. The results of the research were collected and statistically processed. Two way ANOVA with a descriptive statistical analysis were carried out and comparisons between different genotypes and locations were determined by Tukey (HSD) test.

RESULTS AND DISCUSSION

The results of the variance analysis of varroa mite infestation of bee colonies depending on genotype and location are shown in Table 1.

Table 1. Results of the ANOVA of varroa presence depending on genotype and location

Factors	df	Mean Square	F	p-value
Genotype	2	0.049	0.44	0.646
Location	2	1.316	11.73	0.000
Genotype*Location	4	0.064	0.57	0.682

Descriptive statistical values for varroa mite infestation of bee colonies depending on genotype are displayed in Table 2.

Table 2. Descriptive statistical values of mite infestation level depending on genotype

Genotype	Mean	N	SD	Min.	Max.
G1	0,269[a*]	54	0,30	0	1,20
G2	0,327[a]	54	0,42	0	1,80
G3	0,283[a]	54	0,34	0	1,11

*Means followed by same letter within genotype are non significantly different according to ANOVA

Descriptive statistical values for bee colonies mite infestation level depending on locations are displayed in Table 3.

Table 3. Descriptive statistical values of mite infestation level depending on location

Location	Mean	N	SD	Min.	Max.
BC	0,140[a]	54	0,26	0	1,11
BB	0,288[a]	54	0,22	0	1,00
LA	0,452[b]	54	0,46	0	1,80

*Means for the same characteristics followed by different letters within locations are significantly different ($P<0.05$).

The lowest varroa infestation level was established in bee colonies of genotype 1 (0.269) while the highest average varroa mite infestation was found in bee colonies of genotype 2 (0.327). The genotype did not statistically significantly affect ($P>0.05$) varroa mite infestation level of bee colonies (Table 2). This result can be considered in the context of bee-keeping management. Technology of bee-keeping in Serbia includes treating the bees against varoa after the last melliferous pasture. In early August, due to simple application, relatively low prices and good efficiency in majority of bee colonies a chemical treatment against varroa is applied. During winter period a single treatment by oxalic acid is applied. A practice that queen bees should be changed after every two or possibly three years in production should be observed as well. Under such long-term impact the bees in modern bee-keeping had no chance to develop resistance to varroa (Buchler *et al*., 2010), while on the other hand varroa surviving bees (VSB) were identified in untreated populations on some locations in Europe and America (LeConte *et al*., 2007; Seeley, 2007.).

The effect of location of apiary significantly affected ($P<0.05$) the average number of varroa in bee colony (Table 1). An average varroa mite infestation of bee colonies on location LA was significantly higher compared to bees on locations BC and BB (Table 3). The effect of the location of apiary on level of varroa presence in bee colony can be regarded in the light of environment conditions. The research of Correia-Oliveira *et al*. (2018) reported that colonies of Africanized honey bees located in areas with lower altitude and greater rainfall had higher level of varroa mite infestation compared to warm, higher altitudes. In our research the altitudes of locations on which the testing bee hives were situated were: BC (90 m), BB (257 m) and LA (96 m). Testing beehives in locations BC and LA were placed on almost same altitudes but with significantly different varroa infestation. For this reason the altitude in this case cannot be taken as a reason of established differences in the level of infestation. The effect of bee hive location on the presence of varroa in bee colonies can be a consequence of density of population, i.e. number of colonies in surrounding areas (up to 1.5 km). It is possible that drifting foragers, mite carriers, can contribute to their migration and increased infestation among colonies (DeGrandi-Hoffman *et al.*, 2016). Mites are able to rapidly infest honey bees by foraging at a feeder or at flowers (Peck *et al*., 2016). Testing bee hives in our research were stationary placed in the zones which were little loaded by presence of other bee hives. However, due to intensive migration in search of pasture and non-registration of apiaries, as well as possible feral colonies the effect of drifting foragers cannot be completely excluded.

Interaction between genotype and location did not significantly affect varroa mite infestation of bee colonies (Table 1).

The infestation value of bee colonies during different periods throughout the year is shown in Figure 1.

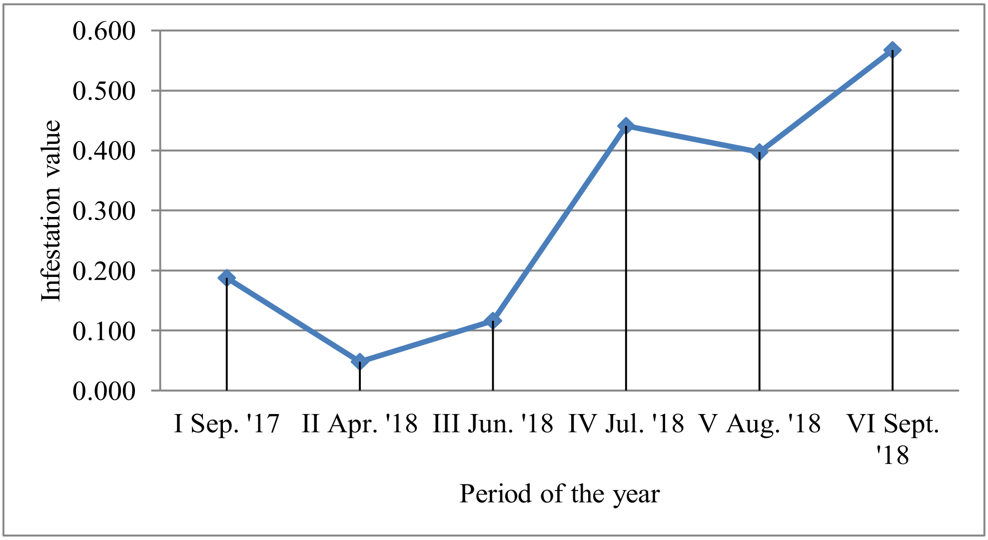

Figure 1. An average infestation of bee colonies depending on a year period

The average level of varroa mite infestation of bee colonies was lowest at control examination in April 2018 while highest average infestation was established at control examination in September 2018.

CONCLUSIONS

In this research a level of varroa mite infestation was monitored in three groups of sister queen bees of different genetic origin and on three different and spaciously remote apiaries in Serbia. In relation to genotype it was established that differences do exist and that level of infestation in colonies in G1 and G3 groups was by 17.74% and 13.46% lower compared to the colonies in group G2. The established differences were not significant. A location of apiaries significantly affected the average number of varroa in bee colonies. This factor should be further investigated in detail because it is a complex one and could be a consequence of area density populated with other apiaries or feral colonies and climate or geographical characteristics of the region. The established values indicate the existence of variability in regard to level of varroa mite infestation in bees of different origin. The research implicates the existence of bee colonies candidates with higher resistance to varroa mite. They could be a subject of further research in apiculture breeding programmes for the purpose of improving this trait in domestic honey bee population.

ACKNOWLEDGMENT

We are grateful for the support to Sustainable Management of Resilient Bee Populations – SMARTBEES FP7-KBBE programme.2013.1.3-02 / WP6 and to colleagues Prof. Dr. Kaspar Bienefeld, Dr. Ralph Buchler, Dr. Aleksandar Uzunov; we are grateful for the support of the programme III 46008.

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