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The Effects of Varroa (*Varroa destructor*) Infestation Level on Wintering Ability and Survival Rates of Honeybee (*Apis mellifera* L.) Colonies

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Abstract: This study was carried out to determine the effects of the Varroa (*Varroa destructor*) infestation level (in fall) on the wintering ability and survival rates of honeybee (*A. mellifera anatoliaca*) colonies. Four different infestation levels of varroa in honeybee colonies were tested in this study. Ten honeybee colonies in which infestation levels were similar were used for each group. A total of forty colonies were used. The average wintering abilities in low, medium, high and extreme groups were found to be 94.28, 91.42, 63.92 and 23.28%, respectively. An average survival rate for the low, medium, high and extreme groups were found to be 100, 100, 80 and 40%, respectively. Differences among the groups for wintering ability ($p<0.01$) were significant. A strong, negative correlation was found between the wintering ability, the survival rates and the level of varroa infestation ($r = -0.71$, $r = -0.69$). The colonies infested with high rates of varroa showed less wintering ability and lower survival rates than the low infested colonies.

Key words: Honeybee, Varroa infestation, wintering ability, survival rates

INTRODUCTION

The productivity of colonies in Turkey is below the world standard (Anonymous, 2008). Poor struggle against parasites and diseases of honeybees and bad management conditions could be the main reasons of this fact (Kumova, 2003). Varroa damage is one of the most important factors that increases the wintering loses (Akyol *et al*., 2006b). When the varroa infestation increases, resistance of the colonies decreases againist the bad conditions (Kumova, 2003). High levels of varroa infestation may reduce the pupae and adult weight of the honeybees >10% (Gueler and Kaftanoglu, 1999). One varroa fed with hemolymph of the honeybees could cause 0.1-0.2% loss of body weight every 2 h. It was found that the average adult weight of infested bees on emergence was 6.3-25% less than average weight of healthy bees (De Jong *et al*., 1982). It was reported that while un-infested bees during pupae lived an average 27.6 days, infested bees with two or more mites lived an average only 9 days (De Jong *et al*., 1982). Janmaat and Winston (2000) reported that honeybee workers began foraging at younger ages and had shorter lifespan when they were infested with varroa as pupae. Because of high varroa infestation and varroa damages, beekeepers lose a lot of colonies in the winter and most of their colonies begin the spring season with weak colony population sizes (Aydin *et al*., 2003; Imdorf and Carriere, 1996; Imdorf *et al*., 2003; Kumova, 2001).

The rate of varroa infestation is one of the most important factors that influence colony population, performance and wintering loses of the colonies (Genc and Aksoy, 1992; Goodvin and Eaton, 2001; Kaftanoglu *et al*., 1995). After genetic and morphometric analysis, the *Varroa* destructor which was found on *Apis mellifera* was identified as a different *Varroa* species (Anderson and Trueman, 2000). It was identified as Korean haplotype and was determined to be widespread and the most devastating species (Zhang, 2000).

This study was carried out in the fall season to determine the effects of the varroa infestation level on the wintering ability and survival rate of the honeybee colonies under middle Anatolia conditions.

MATERIALS AND METHODS

This study was carried out on 40 honeybee (*Apis mellifera anatoliaca*) colonies which were set in standard Langstrooth hives at the Taskent district of Konya province between 12 October 2007 and 24 May 2008. In order to determine the varroa infestation levels, samples of honeybees were collected from all colonies. Prior to the research, all colonies in the survey were equalized with regard to colony strength, sealed brood area and food stock. All of the survey colonies came from same genetic origins and had the same age queens. The queens had been reared by the grafting method described by Laidlaw (1979) and naturally mated in the same location.

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After determining the varroa (*Varroa destructor*) infestation level on the adult worker bees of all colonies, four experimental groups were formed. The low group consisted of colonies that had <1% ($\bar{X}$ = 0.67±0.11) varroa infestation. The medium group had between 1 and 3% ($\bar{X}$ = 2.20±0.23) varroa infestation. The high group colonies had between 3 and 5% ($\bar{X}$ = 4.30±0.28) varroa infestation. The extreme group colonies had >5% ($\bar{X}$ = 14.85±1.31) varroa infestation. Each group had 10 colonies which meant there was a total of 40 colonies used for the experiment. The wash and roll technique that is described by De Jong *et al.* (1982) was used to determine the varroa infestation level (%) on adult bees at both the beginning and the end of the experiment.

The average Wintering Ability (WA) was calculated as:

$$WA(\%) = \left(\frac{\text{The number of combs covered with bees after winter}}{\text{The number of combs covered with bees before winter}} \right) \times 100$$

The Survival Rates (SR) were calculated as:

$$SR = \left(\frac{\text{The number of colonies after the experiment}}{\text{The number of colonies before the experiment}} \right) \times 100$$

These formulas are described by Dogaroglu *et al.* (1992). The wintering abilities of the groups were statistically analyzed with randomized plot design (ANOVA). Group comparisons among the means were done with Duncan's multiple range test. Analysis of survival rates between the groups were performed by Chi square (χ^2) non-parametric tests (Cooley and Lohnes, 1971; Genc *et al.*, 1999; Little and Hills, 1975; Gorgulu and Sahinler, 2006). All colonies were wintered outdoors under similar conditions and the same management applications were applied to all colonies throughout the experiment.

RESULTS AND DISCUSSION

Average varroa infestation levels, wintering abilities and survival rates of the low, medium, high and extreme groups are shown in Table 1. The highest wintering ability and survival rate were found in the low infestation group and the lowest survival rate and wintering ability were found in the extreme infestation group.

Table 1: Infestation levels of varroa, wintering abilities and survival rates of the experimental group colonies (%)

	Average infestation level of varroa			
	Before experiment	After experiment	Wintering ability (%)	Survival rates
Groups	$\bar{X} \pm Sx$ (n)	$\bar{X} \pm Sx$ (n)	$\bar{X} \pm Sx$	Percentage
Low	0.67±0.11 (10)	4.87±0.5700 (10)	94.28±6.940^{a*}	100
Medium	2.20±0.23 (10)	5.86±0.3900 (10)	91.66±3.490^{a}	100
High	4.30±0.28 (10)	10.28±0.8500 (8)	63.92±17.20^{ab}	80
Extreme	14.85±1.31 (10)	12.88±0.5600 (4)	24.28±15.25^{b}	40
Average	5.50±1.31 (40)	7.5361±0.80 (32)	68.54±8.530	80

*:Different letters indicate significant differences among the means ($p<0.01$)

Wintering abilities and survival rates of the colonies were significantly affected (df = 3, M.S. = 5295.65, F = 7.19, $p<0.01$; Duncan, N = 10, $\alpha = 0.01$) by the varroa infestation level (Table 1).

The level of varroa infestation significantly ($p<0.01$) affected the wintering abilities and the survival rates of the colonies during the winter season (Table 1). Gueler and Kaftanoglu (1999), Akyol and Kaftanoglu (2001), Gul and Sahinler (2004) and Akyol *et al.* (2006a) had reported that the average wintering abilities of honeybee colonies were 73.6, 70.4, 86.2, 84.90 and 80.8%, respectively. Genc *et al.* (1999) and Dodologlu and Genc (2002) reported 64.2, 67.2 and 68.89% wintering abilities in the cold climate regions of Turkey. The average wintering abilities of the low and medium groups were found to be consistent with Akyol and Kaftanoglu (2001), Akyol *et al.* (2006a), Gul and Sahinler (2004) results but were found to be higher than Dodologlu and Genc (2002), Genc *et al.* (1999) and Gueler and Kaftanoglu (1999)'s results. The average wintering abilities of the extreme group were found to be lower than Akyol and Kaftanoglu (2001), Akyol *et al.* (2006a), Genc *et al.* (1999), Gueler and Kaftanoglu (1999) but the average wintering ability of the High group was found to be similar to Genc *et al.* (1999) and Gueler and Kaftanoglu (1999) results. Dogaroglu *et al.* (1992), Gul and Sahinler (2004) and Akyol *et al.* (2007) had calculated that the average survival rate of the honeybee colonies would be 64.29, 71.42, 83.3 and 90%, respectively. The average survival rate of the low, medium and high groups were calculated higher than Dogaroglu *et al.* (1992) but were found to be consistent with the findings of Gul and Sahinler (2004) and Akyol *et al.* (2006a). The average survival rate of the extreme group was found to be lower than Akyol *et al.* (2007), Dogaroglu *et al.* (1992) and Gul and Sahinler (2004).

CONCLUSION

Colonies infested with less or no mites showed better wintering ability and survival rates than colonies infested

with high rates of mites. The best wintering ability and survival rate were obtained from low and medium groups which had <3% varroa infestation before the experiment. The calculations showed that there was a strong relationship between the wintering ability, survival rates and the level of varroa infestation (r = -71, r = -69). These results support the previous data that the level of the varroa infestation is one of the most important factors affecting the wintering ability and survival rates of the colonies (Genc and Aksoy,1992).

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