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The Effects of Additive Feeding and Feed Additives Before Wintering on Honey Bee Colony Performances, Wintering Abilities and Survival Rates at the East Mediterranean Region

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Abstract: In this study; the effects of additive feeding with vitamin, fumagillin and pollen supplement on survival rates, wintering abilities, amount of adult bees and brood production were examined at subtropical temperate region before wintering. The wintering ability, survival rates, adult bees and brood areas were positively affected by feeding and feed additives. The lowest values of research components were observed on unfed control groups colonies.

Key words: Apis mellifera, fumagillin, sugar syrup, vitamin, pollen patties, temperate region

INTRODUCTION

Honey bees require carbohydrates, proteins, fats, minerals, vitamins and water for growth, development, maintenance and reproduction. The natural foods of the honey bees; consists of pollen, nectar, honeydew or honey and water. When these materials are not available in the field or the hive, supplementary feeding may help to colony survive, or to make it more populous therefore it may produce more honey or be able to pollinate crops better (Haydak, 1970; Somerville, 2000). Colony viability and growth rate can be limited by lack of pollen, nectar or honey stores and water (Todd and Bishop, 1940; Doull, 1980).

In temperate regions, the honeybees are being active during winter season. The flora is not sufficient for stimulating conditions in the hive. The colonies; losses the adult bee populations due to field activity in winter at temperate region. Usually brood rearing does not make up fully for the loss in adult bees and the colonies are weakened to some extent for the start of their early spring work in warm districts. In the warm districts the weather is usually more settled during early spring and the colonies, though somewhat weakened by winter activity, are able to build up rapidly. Preparation of colonies for pollination of crops in late winter or early spring, such as almonds, canola, etc, requires specialized management practices (Rhodes, 2000). Wintering of honeybee colonies at the warm sites and additive feeding are the important ways to enable a regular build up of bees for spring.

The essential requirements for successful wintering of honeybee colonies are an ample supply of sufficient food, a good cluster of young, vigorous bees with a young queen bee of a strain selected for wintering qualifications, free disease and parasites (Rhodes, 2000; Somerville, 1999).

Stored honey is the major carbohydrate or energy source of the bee colonies in winter. Honey is consumed by the colony to maintain brood temperatures, to enable workers to fly and for activities of bees requiring energy when fresh nectar is not available and essential for the colony's survivals. Without this, the colony will starve, as often happens in late winter and early spring. To provide enough honey stores for winter, the colonies should be fed in the autumn with thick (2/1 sugar/water ratio) syrup until the colonies had sufficient stores (Somerville, 1999 and Somerville, 2000). Colony winter stores which derived from sugar syrup will not granulate in winter season. Feeding the colonies with thin (1/1 sugar/water ratio) syrup regularly stimulates the colony to expand the brood area in early spring. If required, vitamin/mineral supplement can be added to either mixture at the rate of 1–2% of the total sugar syrup weight (Rhodes, 2000; Somerville, 1999; 2000).

Nosema apis, which causes nosema, a disease of adult bees, is particularly significant in an over-wintering situation and can be found world wide. Nosematosis associated with stress through nutrition deficiencies and manipulation. Protein deficiency is possibly a major cause of increased nosema levels. Colonies working late autumn

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and early winter flows are prone to developing high nosema levels when breeding becomes minimal as a result of protein deficiency. Autumn is an important time of the year to manage hives for the prevention of spring outbreaks of nosema disease. The most common control method of nosematosis, is the application of the antibiotic fumagillin (Fumidil B). It is treated in a sugar syrup mixture often prophylactically in the fall and spring. Fumagillin kills the active stages of *Nosema apis*, but not the spores and it's effect diminishes over time. In temperate climates, infections by *Nosema apis* must be considered a serious disease and it has negative effects on the production capacity of honey bee colonies in temperate climates (Fries, 1993; Fries, 1988; Rice, 2001; Somerville, 2005).

Naturally-collected pollen is the best source of protein for honey bee. Fresh or stored pollen stimulates the hypopharyngeal glands of older nurse bees to produce royal jelly for feeding to young developing larvae and the queen bee (Doull, 1980; Haydak, 1970; Maurizio, 1950). Todd and Bishop (1940) calculated that 100 mg of pollen is required to raise one bee and stated that 20 kg of pollen are required in one year or enough to raise c. 200,000 bees. Farrar (1934) found that spring populations in colonies wintered with no pollen were reduced by 78% and populations of 600 sq in of pollen colonies wintered with were reduced by only 6%.

This study was conducted to determine the effects of feeding and feed additives before wintering on survival rates, wintering ability and strength of colony in spring at coastal area of the East Mediterranean Region.

MATERIALS AND METHODS

The Experiments were carried out in the Hatay province, Samandag district (35°51'07"E longitude, 36°13'20"N latitude and 20 M altitude) at East Mediterranean region between October 2003 and May 2004 in Turkey. Total fifty Italian honeybee colonies (*Apis mellifera ligustica)* were used and randomly divided into five groups (each group consists of 10 colonies). The colonies were equalized with respect to colony strength, brood area, food stocks and colony weights before the research and housed in standard Langstroth hives. The colonies were wintered at subtropical temperate climatic conditions.

The colonies which are Sugar, Fumagillin, Pollen and Vitamin groups, were fed with sugar syrup ($^2/_3$-$^1/_3$ sugar-water (w/w) 1 L/day/colony (total 10 liters)) ten times with one day interval in fall before winter. Pollen groups were fed with extra 1.5 kg pollen patties (frozen pollen/powdered sugar/honey mixture ($^1/_5$-^{2}/ -$_5^3$ (w/w)) tree times with 15 days interval. Fumagillin groups were treated with 20 mg L^{-1}. Fumagillin (Bicyclohexylammonium fumagillin) in addition to sugar syrup. Vitamin groups were fed with sugar syrup including 5000 mg L^{-1} vitamin mixtures (Vit A, D3, E, B1, B2, B6, B12, C, K3, Niacin and Ca-d-Pantothenete, Vitamix Formula-TOPKIM). Top feeders were used for feeding and for additives. The control groups were not fed and no any additives were given. After wintering, the all group colonies were fed with totally ten liters sugar syrup (½-½ sugar water (w/w)) ten times with one day interval (from 5th to 25th March) in spring.

Sizes of brood area and number of frames covered with adult bees were recorded with 21 days interval. The size of brood areas were calculated according to Fresnaye and Lensky (1961) the wintering ability (population reduction) was calculated by Genc (1990) and survival rate was calculated by Doğaroğlu (1981). The number of frames covered with adult bees at the 21/11/2003 and 28/03/2004 dates were used for calculation of the percentage wintering ability of colonies.

Statistical analysis of colony characteristics (number of frames covered with adult bees and brood area sizes) were performed by Repeated Measure (GLM), randomized plot design (ANOVA) was used for wintering ability. Group comparisons among the means were done with Duncan's multiple range tests. Analysis of survival rates between groups were performed by Chi Square (χ^2) non-parametric tests (Cooley and Lohnes, 1971).

RESULTS AND DISCUSSION

The wintering abilities (population reduction) and the survival rates of the colonies were significantly affected ($df = 4$, $MS = 2821.7$, $F = 4.1$, $p<0.01$) by additive feeding and feed additives before wintering at temperate region (Table 1). Doğaroğlu (1981), Güler and Kaftanoglu (1999), Akyol and Kaftanoglu (2001) reported that the average wintering abilities of honeybee colonies was 73.6, 70.4 and 86.2%, respectively at coastal area of East Mediterranean region. Akyol *et al.* (1999), Genc *et al.* (1999) stated that wintering abilities at cold climates was 64.2 and 67.2% The average survival rates and wintering abilities of the groups except control were found higher other national researcher (Doğaroğlu, 1981; Güler and Kaftanoglu, 1999; Akyol and Kaftanoglu, 2001; Akyol *et al.*, 1999; Genc *et al.*, 1999). Wintering ability and survival rates of pollen, vitamin and fumagillin group colonies were found better than unfed control group colonies.

Table 1: Survival rates and wintering ability of the experimental groups

GROUPS	Wintering ability (%)	Survival rates (%)
Control	64.9b*	70
Sugar	80.8a	90
Fumagillin	100.0a	100
Vitamin	98.61a	100
Pollen	100.0a	100
Average	89.23	92

*: Different letter (s) indicate significant differences among the means (p<0,05).

Table 2: The average number of frames covered with bees through the experiment

Dates	Control (7)	Sugar (9)	Fumagillin (10)	Vitamin (10)	Pollen (10)
10.10.03	5.00±0.0	5.00±0.0	5.00±0.0	5.00±0.0	5.00±0.0
31.10.03	5.00±0.0	5.78±0.2	5.80±0.2	5.70±0.2	5.80±0.2
21.11.03	5.86±0.1	6.89±0.2	7.20±0.2	7.20±0.2	7.40±0.1
12.12.03	5.86±0.1	6.89±0.2	7.20±0.2	7.20±0.2	7.40±0.1
02.01.04	4.43±0.2	5.11±0.2	6.40±0.1	6.30±0.2	6.40±0.2
23.01.04	4.43±0.2	5.00±0.1	6.10±0.1	5.80±0.2	6.10±0.1
14.02.04	4.43±0.2	5.00±0.1	6.30±0.2	5.80±0.2	6.10±0.1
07.03.04	4.71±0.3	5.44±0.2	6.70±0.3	6.40±0.2	6.80±0.2
28.03.04	5.29±0.1	6.11±0.2	7.20±0.2	7.10±0.2	7.50±0.2
18.04.04	7.00±0.4	8.11±0.2	9.70±0.3	10.40±0.4	12.40±0.5
09.05.04	9.00±0.6	11.11±0.3	12.50±0.3	13.80±0.6	15.80±0.5
30.05.04	9.43±0.6	12.22±0.4	13.50±0.4	15.20±0.6	16.90±0.5
Average	5.87±0.2 a	6.89±0.2 b	7.80±0.2 c	7.99±0.3 c	8.63±0.2d*

*: Different letters indicate significant differences between the group means (Duncan = MS(Error) = 0.394, Harmonic sample size = 9.026, Alpha = 0.05).

Table 3: Average of brood area of the groups through the experiment (cm^2)

Dates	Control (7)	Sugar (9)	Fumagillin (10)	Vitamin (10)	Pollen (10)
10.10.03	1286±60.5	1268±63.5	1331±40.1	1265±55.8	1295±52.9
31.10.03	1543±64.9	1551±64.1	1750±47.1	1620±62.4	1791±68.1
21.11.03	1493±52.8	1522±50.1	1730±37.4	1670±52.8	1860±57.6
12.12.03	750±36.2	878±52.1	980±35.1	915±40.9	1090±42.7
02.01.04	229±30.6	294±25.6	410±22.1	375±23.9	470±18.6
23.01.04	29±13.6	76±19.5	115±7.9	90±8.8	130±7.9
14.02.04	108±19.1	221±29.3	290±13.7	253±13.6	357±23.4
07.03.04	407±31.7	559±33.1	652±21.7	647±19.1	860±24.7
28.03.04	1039±46.7	1811±71.1	1842±73.2	1941±63.7	2471±62.6
18.04.04	1957±100.3	3144±102.9	3511±123.2	4010±210.7	5325±153.8
09.05.04	2050±108.6	3278±90.6	3599±135.4	4090±199.3	5300±136.6
30.05.04	2136±103.9	3250±94.3	3560±138.6	4115±212.4	5300±103.3
Average	1085±55.49 a	1488±48.9 b	1648±46.4 c	1749±46.4 c	2187±46.4d*

*: Different letter (s) indicate significant differences between the group means (Duncan; MS(Error) = 21552.4, Harmonic sample size = 9.026, Alpha = 0.05)

Differences between group means of the overall adult bee populations (df = 4, MS = 114.07, F = 24.11, p<0.01) and brood area size (df = 4, MS = 16307965.91, F = 63.05, p<0.01) of the colonies were found statistically significant. The number of adult bees (Table 2) and brood areas sizes (Table 3) were positively affected by additive feeding and feed additives before wintering.

Amount of adult bees and brood production of colonies reached maximum in May. Pollen group colonies produced adult bees higher than unfed control, sugar, fumagillin and vitamin group colonies 55, 39, 26 and 11%, respectively in spring at subtropical East Mediterranean region. Growth rate of pollen group colonies were faster than the other groups at the spring. The higher colony populations were observed in May. The average overall amount of adult bees (13.73±0.43 (n = 46)) in May were found lower than Dogaroglu *et al.* (2000) which was 14.6; similar with Guler and Kaftanoglu (1999) which was 13.4 and higher than (Akyol and Kaftanoğlu (2001), Guler (1999) and Kumova (2000) which were 11.4, 10.6 and 9.8, respectively.

The average brood production of the pollen group colonies were higher than unfed control, sugar, fumagillin and vitamin groups 100, 45, 32 and 25%, respectively. The average amount of brood areas (3781.52±161.52 cm^2, n = 46) in May were found lower than Akyol and Kaftanoglu, (2001) which was 3910 cm^2, higher than Arslan (1987), Dogaroglu *et al.* (2000), Guler and Kaftanoğlu (1999), Kumova (2000) and Güler (2000) which were 3533, 3486, 3429, 3125 and 3059 cm^2, respectively.

The wintering ability and survival rates of honeybee colonies during severe winter months depends on colony strength, well laying queen, plenty of young bees, enough food stores, free parasites and diseases, good ventilation and suitable wintering area. Winter losses and the reduction of the adult bee population could be decreased with feeding colonies and good management practices in fall. In spite of the all care for wintering beekeepers usually lost over 10-25% of their colonies during winter season at different climatic conditions.

Results of this experiment showed that additive feeding and feed additives can increase wintering abilities, survival rates and spring colony growth brood production and adult bee population of honey bee colonies before wintering at coastal areas of subtropical regions.

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