Overwintering capability and spring population size of honeybee colonies (*Apis mellifera* L.) in Hungary

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Summary: Honeybee races and ecotypes of different genetic background have different population development in spring. Some of them can reach the necessary population size by the beginning of *Robinia pseudoacacia* (black locust) blooming period. There were significant differences in the spring population development between the colonies of different genetic background. The Italian races *(A. m. ligustica)* and their cross-breeds over-wintered poorly in Hungary, their spring population was low and they collected small amount of Robinia honey. The Austrian improved Carniolan *(A. m. carnica)* colonies over-wintered well, they had the largest spring population in both years. There was no significant difference between the size of the spring population of the same colonies of different genetic background in 1995 and 1996. The rate of the population development of the colonies was different in the two examined years. There was strong correlation ($r = 0.8$) between the spring population size and the *Robinia* honey yield, and between the mid-April population size and the *Robinia* honey yield of the colony groups of different genetic background. Spring population size also important in the effective pollination of fruit tree species that bloom earlier than the black locust trees.

Introduction

Honeybee races have adapted to the climate conditions of the given area. It is possible to observe this adaptation in cases of the ecotypes of different races. *Louveaux* (1966, 1969, 1977, 1994) drew our attention to the fact, that there is significant difference between the production of the bees of different ecotype. In Hungary it was recommended to strengthen and unite the colonies before black locust, *Robinia pseudacacia* (*vulgarly: akác or acacia*) bloom, instead of the comparison and selection practice. Experiments comparing the colony features of the different races and ecotypes had started late, only in 1985 (*Nikovitz,* 1985). In his experiments at first he searched the best-producing colonies among the domestic honeybee stocks. Later – as being the next step – he also planned to import stranger brood-stock. *Radvánszki* (1991) carried out experiments with Italian honeybees (*Apis mellifera ligustica*) imported from North America, as the *A. m. ligustica* × *A. m. carnica* R3 cross-breed bees of 6.25% Italian gene proportion. Those bees collected more honey, than the domestic carnica bees (*A. m. carnica pannonica*). *Oláh* (1993) and *Bánka* (1991) had similar experiences. In *Halmágyi's* (1993) experiment the *A. m. ligustica* × *A. m. carnica* R3 cross-breed colonies of 6.25% Italian gene proportion collected 52.2% more honey, than the domestic carnica colonies (*A. m. carnica pannonica*). According to the examinations of *Khambash* (1988) the grey-coloured bees produced more honey than the other coloured bee-groups. *Wurm* (1994) compared the production of the improved carnica bees originating from Steiermark (Austria) to the production of the *A. m. carnica pannonica* bees of Gödöllő. The improved Austrian *carnica* bees produced 24.7% more Robinia honey than the Gödöllő bees.

Materials and methods

Achieving the determined targets comparative investigations were performed in an apiary of 150 colonies average during 1994–1996. The collected data were evaluated by the Electron Microscope Laboratory (EML) of the Agricultural Biotechnology Center, which exists as an OTKA Scientific Instrument Centre. The colonies were kept in the same type of hives and moved to the same bee pastures, as well as they were handled with the same technology. The compared bee colonies were the folows: 1. Western Transdanubia Group; 2. Southern Transdanubia Group; 3. South Plain 1. Group – Csanád area; 4. South Plain 2. Group – Sandy Area; 5. Gödöllő Hills Group; 6. Northern Mountains Group; 7. Austrian Carnica-Singer Group; 8. Italy-Piana Group; 9. Italian R1 Hybrid Group (*A. m. ligustica* × *A. m. carnica* R3 hybrid containing 25%

Italian gene proportion); 10. Italian R3 Hybrid Group (*A. m. ligustica* × *A. m. carnica* R3 hybrid containing 6.25% Italian gene proportion).

Survey of the population size of the colonies

The wintering and early spring population size was measured at the end of October and at the beginning of March at temperature of 7–10 °C when the bees did not fly and sat densely on the combs). The results were given by the usual unit of measurement as Bee Covered Comb (hereinafter: BCC). One BCC on a half-size NB frame (Nagy-Boczonádi frame, size 42 × 18 cm) equals about 1.500 bees (*Ludányi,* 1991).

The mid-April population was measured using the same method described above, but the temperature was higher, so the bees were flying then.

Determination of the overwintering capability

Overwintering capability =

$$= \frac{\text{Spring population (BCC)}}{\text{Autumn population (BCC)}} \times 100\ (\%)$$

Measuring the Robinia honey yield

After the black locust finished blooming, the amount of the Robinia honey was measured during the extraction. A half-size NB frame full of honey contains 1.9 kg honey, from which 1.5 kg is possible to extract.

Evaluation of the data

The data have been evaluated by variance analysis. The values of the Y = aX + b regression function was calculated in order to find out the correlation between the mentioned colony features and the honey yield. One-way analysis of variance was performed with the Statgraf Anova software. The tables and figures were produced with Microsoft® Excel 97 software.

Results and conclusions

Relationship between the overwintering capability and the spring population size of honeybee colonies

The early sprig population size depends not only on the autumn population size, but on the vitality of the bees also. In 1995 there was the highest winter loss of the bees in the Italy group among the colony groups. Only 35,33% of the bees had survived until springtime (*Figure 1*). *Ruttner* (1983) also observed the poor overwintering capability of the *A. m. ligustica* bees. The overwintering capability of the Italian R1 cross-breed group showed intermediate values compared to the groups of its origin. The R3 generation containing 6.25% Italian gene ratio wintered well, their

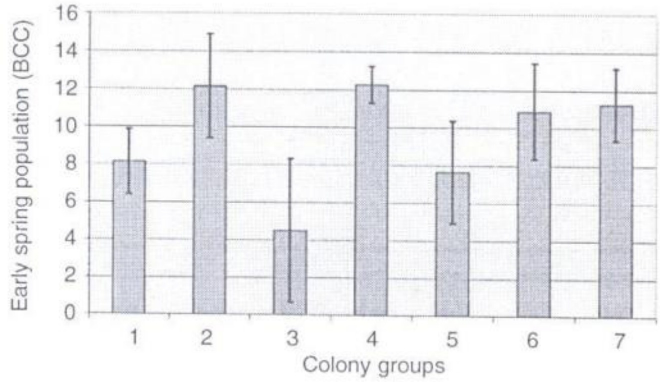

Figure 1 Early spring population in March, 1995
1. Italian R1 cross-breed; 2. Italian R3 cross-breed; 3. Italy Piana; 4. Austria Carnica Singer; 5. Western Transdanubian; 6. South Plain 1; 7. Gödöllő-Hills

colony populations were similar to the Carniolan colony populations. Among the Hungarian ecotypes only the Transdanubian group showed significantly lower early spring population. Perhaps it is due to the fact, that these colonies originated from the Keszthely area, where the winter climate is milder. Taken to another, colder winter climate area, these colonies showed weaker overwintering capability.

The difference in the adaptation of the colonies can be measured effectively by measuring the size of the population in the spring.

In 1996, considering the early spring population, it was possible to distinguish three groups at 95% confidency level (*Table 1*). In four cases there was overlapping between the groups.

Table 1 Determination of homogenous groups

Colony groups	Repeat	Avg [BCC]	Homogenous groups
Southern Transdanubian	7	8.57	A
Northern Mountains	9	8.78	A
South Plain 1	6	10.17	AB
South Plain 2	10	10.30	AB
Gödöllő–Hills	10	11.80	BC
Italian R3 cross-breed	7	12.00	BC
Austria Carnica Singer	4	13.75	C

The colony groups of different genetic background reached the spring in similar population size year by year and the ranking between them did not change significantly. Regarding the spring population there was the highest similarity between those colonies, whose geographical origin was close to each other. Bees of the colonies with better overwintering capability live also longer in spring. The Austria group was the best among the four best overwintering groups.

Under normal circumstances, 80% of those bees can survive until spring, which are adapted to the climate of the given area. At examining the overwintering capability in cases of three colony groups we experienced lower survival rate than the above mentioned level. In two cases the low survival rate can be assigned to the *A. m. ligustica* gene content, and in the case of the Western Transdanubian group from the origin of different climates. There is a strong correlation between the overwintering capability (*Figure 2*) and the early spring population (*Figure 1*). Accordingly, overwintering capability is greatly important from the point of view of the pollination of early flowering fruit tree species (almond, apricot and peach first of all) because the blooming period of these is earlier than the commencement of spring population increase of the honeybee colonies. These fruit crops can only be effectively pollinated with successfully overwintered honeybee colonies. Thus nothing else than well overwintered colonies may be used when honeybee colonies are moved to the commercial plantations for supplementary pollination of these fruit tree species.

In Hungary the sour cherry flowering period is the time, whenceforth the population of the colonies starts growing. Until then, only the senescent bees are replaced by the newly hatched bees.

The size of the April population of the colonies and the mid-April egg-laying of the queens are influenced by the phenologic stages of the bee-pasture and not by the calendar. The mid-April population size mainly depends on the early spring population. We observed difference only at that group, which had the best overwintering capability. It seems, that the bees of the well wintering colonies also lived longer in spring. Thus overwintering capability is also greatly important in the bee pollination of fruit tree species blooming later than the ones mentioned above. These are sweet cherry, sour cherry, apple, pear, plum and quince in the order of their flowering time in Hungary. The blooming time of the fruit trees mentioned here starts usually in early April (with sweet and sour cherry) and it is going on in mid-April (with apple, pear and plum) and in early-May (with quince). The spring population increase of honeybee colonies should be checked prior to the honeybee colonies are used to supplementary pollination at these fruit crops.

The correlation between the colony features and the honey yield

Parameters of the Y = ax + b regression line and the correlation co-efficient were calculated in order to determine the correlation between the colony features and the honey yield (*Tables 2–3*).

The value of the "r" were above 0.8 in all cases, which means that there is strong correlation between the early spring population size, the over-wintering capability, the mid-April population size and the honey yield.

The wintering experiments of the *A. m. ligustica* bees and their cross-breeds showed the same results as the observations of *Ruttner* (1983) and of the Hungarian *Bánka* (1991) and *Radvánszki* (1991). According to the observations, these bees are wintering poorly under the Hungarian circumstances. Most of the working bees are dying during wintertime.

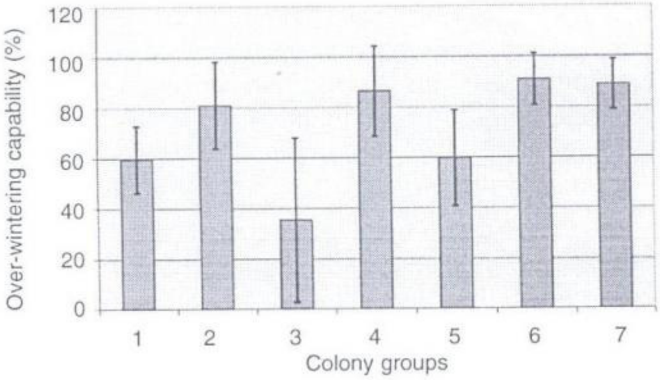

Figure 2 Overwintering capability, 1994–1995
1. Italian R1 cross-breed; 2. Italian R3 cross-breed; 3. Italy Piana; 4. Austria Carnica Singer; 5. Western Transdanubian; 6. South Plain 1; 7. Gödöllő-Hills

Table 2 Correlation between the colony features and the honey yield of the colony groups in 1995 (n = 52 colonies)

Correlation investigation of different colony features	Parameters of the Y = ax + b regression line and the correlation co-efficient
Early spring population – Robinia honey yield	a = 2.776 b = –5.484 r = 0.803
Over-wintering capability – Robinia honey yield	a = 0.457 b = –12.143 r = 0.943
Mid-April population – Robinia honey yield	a = 2.730 b = –6.318 r = 0.867

Y: Robinia honey yield of the colony
x: the investigated colony feature
r: correlation co-efficient

Table 3 Correlation between the colony features and the honey yield of the colony groups in 1996 (n = 53 colonies)

Correlation investigation of different colony features	Parameters of the Y = ax + b regression line and the correlation co-efficient
Early spring population – Robinia honey yield	a = 4.485 b = –12.399 r = 0,899
Mid-April population – Robinia honey yield	a = 3.811 b = –1.607 r = 0.881

Y: Robinia honey yield of the colony
x: the investigated colony feature
r: correlation co-efficient

The colonies starting from smaller spring population size cannot achieve satisfactory population growth until the Robinia blooming season. There was significant difference between the bees of the different Hungarian areas concerning the early spring populations and mid-April populations. These colony features showed strong correlation with the honey yields of the family groups of different genetic origin. These measurements can be performed easily by any bee-keeper.

The big honey yield differences show, that it is worth to deal with the comparative examinations of the ecotypes belonging to the Carniolan race. The Hungarian bee-keeping has enormous resources to be utilised. The improved Carniolan colonies can grow satisfactorily themselves by the Robinia blooming season, it is not necessary to unite colonies before this season.

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