Optimization of nest microclimate of bee families during winter period

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Abstract. In modern conditions, the improvement of technological methods in bee-farming significantly affects the production of bee-farming products. The concordance of technological operations of keeping bee families to climatic conditions of a particular region largely determines the production activity effectiveness of a beekeeper. Temperature differences in winter negatively affect the condition of bee families; humidity and excess condensate are accumulated in hives. The use of “zeolite” desiccant in winter allows improving microclimate inside the hive, contributing to more intensive development of bee families in spring and increasing marketable honey productivity due to its unique highly porous structure. Field studies were conducted during 2014-2016. Four groups of bee families were selected using the pair-analogue method in the course of the research: control group (without desiccant) and experimental groups № 1, № 2, № 3 where in winter, the desiccant was placed at the hive bottom in the amount of 100, 150, 200 g, respectively.

1. Introduction

Active work of a person with a honey bee has significantly expanded the habitat of this species. The distribution of bees in northern regions of the country is associated with the intensive development of agriculture, which requires pollination of agricultural crops, including enclosed spaces: greenhouses, glasshouses, etc. [1, 10]. This allowed increasing the natural and climatic zone of bees, and also led to an increase in the number of bee families. However, in connection with this, a development of negative consequences characteristic to other domesticated species happened, namely, the high dependence of this insect on human activity [7, 9].

One of the important stages in keeping bee families and an example of human interaction with a bee iswintering. Wintering is a crucial and difficult period in the life of honey bees. [4,5]. Effective wintering is the main condition for the use of bees in the spring-summer period at the main honey collection and pollination activities in full. In climatic zones with long winters, adverse wintering is the main cause of damage to bee-farming [8].

The search for ways to improve wintering associated with the justification of optimal temperature, humidity and ventilation regimes of a nest, which allows minimizing feed consumption and increasing the safety of bee families, is an urgent task today [2,3].
2. Materials and research methods
Zeolite as a mineral substance can be an effective solution in the fight against the appearance of excess condensate in winter, since it has a unique structure of a microscopic crystalline “sponge” with a pore number of up to 50% of the frame volume. Tetrahedral structural framework of zeolite consists of voids (caverns), which allow its use as an adsorbent.

The purpose is to determine the effect of zeolite used as a desiccant during the wintering period of bees, on vital indicators and productivity of bee families in the subsequent period.

Field studies were carried out in accordance with the approved methods of scientific research in bee-farming (Rybnoe, 2002) [6].

The analyzed groups of 10 bee families in each were formed by the pair-analogue method. Such indicators as the hive construction, queen bee age, family strength, the amount of carbohydrate and protein feed were taken into account when forming the groups. The studies were carried out in accordance with the following scheme (Figure 1).

Economically useful indicators, including the growth and development of families, as well as the amount of gross and marketable honey productivity, were analyzed.

The development of bee families was studied from early spring until the end of brood rearing (open and sealed) every 21 days.

| Control group | Experimental group 1 | Experimental group 2 | Experimental group 3 |
|---------------|----------------------|----------------------|----------------------|
| not applied   | dose – 100 g         | dose – 150 g         | dose – 200 g         |

Figure 1. Research scheme.

Honey productivity was taken into account at the end of the main honey collection, determining the yield of marketable and gross honey by weighing on a scale.

The obtained data were processed by the method of variation statistics with verification of the results reliability using the Student criterion.

3. Research results.

Table 1. Wintering results for bee families (control and Experimental group 1)

| Indicator                             | Group                               | Group                         |
|---------------------------------------|-------------------------------------|--------------------------------|
|                                       | control X±m                          | experimental group № 1 X±m    |
| Strength of families, bee space:      | 8.0±0.31                            | 8.0±0.31                      |
| autumn, spring                        | 5.8±0.58                            | 6.6±0.40                      |
| Attenuation degree of bee families, % | 26.8±7.9                            | 17.02±5.6                     |
| Amount of feed, kg: autumn, spring    | 29.6±0.24                           | 31.1±0.64                     |
|                                       | 9.2±0.86                            | 8.8±0.51                      |
| Feed consumption for winter, kg       | 20.4±0.81                           | 22.3±0.58                     |
| Feed consumption for 1 bee space, kg  | 2.6±0.21                            | 2.8±0.13                      |
| Humidity in bee nest, point           | 2.4±0.74                            | 1.8±0.58                      |
| Number of brood, hundreds of cells    | 60.4±5.8                            | 76.2±15.6                     |

Studies on bee families were carried out to develop an effective method for the use of the “zeolite” mineral in bee-farming in the Udmurt Republic from 2014 to 2016.
To determine the degree of influence of the “zeolite” preparation on the quality and quantity of spring brood, the results of bees wintering were studied. (Tables 1, 2).

**Table 2.** Wintering results for bee families (Experimental groups 2 and 3)

| Indicator                                      | Group                        | Experimental group № 2 | Experimental group № 3 |
|------------------------------------------------|------------------------------|------------------------|------------------------|
| Strength of families, bee space: autumn, spring| X±m                          | 8.0±0.54               | 8.0±0.71               |
| Attenuation degree of bee families, %          | X±m                          | 27.2±12.27             | 18.0±6.11              |
| Amount of feed, kg: autumn, spring             | X±m                          | 31.0±0.59              | 31.2±0.73              |
| Feed consumption for winter, kg                | X±m                          | 9.5±0.93               | 9.7±0.87               |
| Feed consumption for 1 bee space, kg           | X±m                          | 2.6±0.11               | 2.7±0.28               |
| Humidity in bee nest, point                    | X±m                          | 1.8±0.37               | 0.6±0.24               |
| Number of brood, hundreds of cells             | X±m                          | 79.2±0.17              | 97.4±10.14**           |

Note: **P≤0.01

When comparing the studied groups in the first spring inspection, it was found that the use of the zeolite preparation as a desiccant affects the resistance and strength of families very effectively. This is confirmed by the following digital material.

In groups using zeolite with 100 and 200 grams, the smallest decrease in weakening of bee families was revealed in comparison with the control group, where the preparation was not used by 9.78% and 8.8%, respectively.

Various indicators in these groups are observed when studying humidity in the nest. Accordingly, with an increase in the sample weight, humidity in the hive decreased to 0.6 points in families using 200 grams of zeolite.

The study of bee brood number shows the following results: the number of brood is 97.4 hundreds of cells in the third experimental group, while in the control group there are 37 hundreds of cells less, which is reliable with a probability of more than 0.01.

**Table 3.** Egg-laying production of queen bees during the spring-summer period (control and Experimental group 1)

| Indicator                                      | Group                        | Control            | Experimental group № 1 |
|------------------------------------------------|------------------------------|--------------------|------------------------|
| Egg-laying production, pcs. (first record period) | X±m                          | 299,04±37,05       | 362,8±74,1             |
| Egg-laying production, pcs. (second record period) | X±m                          | 995,2±88,7         | 1080,9±141,4           |
| Egg-laying production, pcs. (third record period) | X±m                          | 1938,1±112,7       | 2022,8±171,6           |

The analysis of the two subsequent record periods showed the dynamics of an increase in the egg-laying production of the queen bees. So before main honey collection the difference between the
analyzed groups (control and experimental group № 3) in terms of the number of larvae was 394.2 pcs., in favor of experimental group № 3 (Tables 3, 4).

Also, when analyzing the number of brood of bee colonies, a sharp increase in strength to the main honey collection can be seen. So, the difference between the first record and the second in the number of bee larvae was 2.3 times, and between the second and third measurements - 2.15 times.

**Table 4.** Egg-laying production of queen bees during the spring-summer period (Experimental groups 2 and 3)

| Indicator                                      | Group                        | X±m         | X±m         |
|------------------------------------------------|------------------------------|-------------|-------------|
| Egg-laying production, pcs.                    | experimental group № 2       | 377,1± 43,7 | 463,8± 43,7**|
| (first record period)                          | experimental group № 3       |             |             |
| Egg-laying production, pcs.                    |                              | 1027,6±124,4| 1082,8±93,4 |
| (second record period)                         |                              |             |             |
| Egg-laying production, pcs.                    |                              | 2012,4±105,6| 2332,3±59,1 |
| (third record period)                          |                              |             |             |

Note: **P≤0.01

These data indicate that the number of working bees to the main honey collection increases. The analysis of honey productivity of bee families is presented in Tables 5, 6.

**Table 5.** Marketable honey yield of bee families (per one bee family, kg)

| Group                      | X±m            | %   |
|----------------------------|----------------|-----|
| Control (n=10)             | 21.5± 1.8      | 100 |
| Experimental № 1 (n=10)   | 23.1± 1.8      | 107.4|
| Experimental № 2 (n=10)   | 29.7± 2.5      | 138.3|
| Experimental № 3 (n=10)   | 36.1±2.9***    | 167.9|

Note: ***P≤0.001

The table shows that the presence of zeolite in winter at the hive bottom affects marketable productivity of bees. On average, one bee family received 36.1 kg from bee families with zeolite weighing 200 g, which is 67.9% or 14.6 kg more than in the control group (P≤0.001). Experimental group № 2 and experimental group № 3 occupied an intermediate position in marketable honey productivity.

**Table 6.** Gross honey yield of bee families (per one bee family, kg)

| Group                      | X±m            | %   |
|----------------------------|----------------|-----|
| Control (n=10)             | 52.6±2.5       | 100 |
| Experimental № 1 (n=10)   | 54.6±2.3       | 103.8|
| Experimental № 2 (n=10)   | 63.2±2.5       | 120.2|
| Experimental № 3 (n=10)   | 69.4±1.4***    | 131.9|

Note: *P≤0.001

A similar tendency is observed in gross honey yield, which includes the amount of marketable and feed honey left for wintering bees. The difference between minimal indicators of the control
group and maximal of the experimental group № 3 is 16.8 kg or 31.9% with a reliable threshold of $P \leq 0.001$.

4. Conclusion

Thus, the presence of zeolite as a desiccant in the hives in winter affects the honey productivity in the summer period, due to the fact that bee families spend less energy on maintaining cleanliness in the hive in the spring-early period, and increase the number of young working bees for the main honey collection faster, which allows collecting nectar as fully as possible. The difference in the amount of marketable honey is up to 68%, which in turn affects the economic efficiency of production as a whole.

In this way, in winter, zeolite should be used as a desiccant in the amount of 200 grams for better development of bee families and increase their honey productivity.

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