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Influence of Prophylactic Preparations on the Growth Rate of Bee Colonies and the Level of their Honey Productivity in the Udmurt Republic

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ABSTRACT

The issue of organic beekeeping has recently become quite relevant, and preparations and supplements based on biologically safe natural ingredients have been introduced into use. The paper provides data on the study of the effectiveness of the use of preventive stimulating preparations in the beekeeping industry based on natural medicinal plant and mineral components. The studies were carried out from 2015 to 2020 at a stationary apiary of the Udmurt Republic, Russian Federation. Field experiments were carried out on three experimental groups consisting of 10 bee colonies each. The use of a prophylactic preparation made of garlic and iodine solution (experimental group No. 2) made it possible to obtain the best effect in terms of the growth rate of bee colonies and their honey productivity among the analyzed groups.

Key words : Honey bees, honey productivity, ascospherosis, brood

INTRODUCTION

In recent years, in connection with the development of trade between the countries, the global epizootic situation concerning bee diseases and pests has become complicated. The main problem of global beekeeping is the excessively high death rate of bee colonies (Domatskaya and Zinatullina, 2020; Yakimov *et al.*, 2020). Especially in the spring period of development, bee colonies are susceptible to various infectious and invasive diseases, since intestinal overflow during long wintering creates favourable conditions for the development of pathogenic and conditionally pathogenic microflora (Vorobeva *et al.*, 2020). Weakened colonies develop slowly in the spring, build up their strength with a significant delay and as a rule, do not provide marketable products in the year in question (Oskin and Blyagoz, 2018; Mishukovskaya *et al.*, 2020; Tawfik *et al.*, 2020).

Every year, the number of bee colonies around the world decreases due to the spread of such a dangerous disease as ascospherosis (Milea *et al.*, 2016). Ascospherosis (pericystosis, pericystomycosis, calcified brood, chalkbrood, drone brood) is an infectious disease caused by a fungus of the *Ascosphera* genus, *Ascosphera apis* species, which affects larvae at 3-4 days of age (Morawetz *et al.*, 2019; Castagnino *et al.*, 2020). The rapid spread of ascospherosis is facilitated by the wandering, buying and selling of queens and bee colonies (Ndaiishimiie, 2015). In addition, the decrease in the immune status due to the active, uncontrolled use of pesticides and antibiotics, which entails metabolic disorders and the emergence of new strains of the disease, is one of the high-risk factors (Liubimov *et al.*, 2020).

An important factor in maintaining the epizootic well-being of the beekeeping industry is the implementation of a complex of therapeutic and prophylactic measures since the epizootic situation with infectious and invasive diseases of bees in many regions of Russia remains difficult (Lozhkina, 2020). The main objective in beekeeping today is to improve the epizootic situation in apiaries and to obtain environmentally-friendly honey products. To accomplish this, it is necessary to use prophylactic and therapeutic solutions based on natural ingredients. It should be

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remembered that the remnants of preparations that contain chemical and antibiotic substances can get into honey products, which negatively affect the health of bee colonies and people.

In practical beekeeping, decoctions, infusions and tinctures from medicinal plants are used as part of stimulating and medicinal feedings for honey bees, which is associated with modern trends aimed at obtaining environmentally safe beekeeping products (Rozhkov *et al.*, 2015; Tauber *et al.*, 2019). In this regard, the work was aimed at studying the effect of prophylactic preparations based on natural organic components that prevent the spread of ascospherosis on the economically useful indicators of bee colonies.

MATERIALS AND METHODS

For field experiments, three groups were formed : control group (irrigation with water), experimental group No. 1 (a combination of common wormwood, garlic and vitamin C), and experimental group No. 2 (a combination of garlic and 5% iodine solution). In each group, 10 bee colonies were selected, equal in strength, the amount of brood, feed honey, the age of the queen bee (no more than two years), and the design of the hive (16 frame hives). The studies were carried out in 2015-2020 at a stationary apiary of the Udmurt Republic.

For prophylactic treatments, preparations with active substances, such as allicin, phytoncides (substances of plant origin that have the properties of destroying or slowing down the growth of microorganisms), and iodine were used. These medicinal solutions performed a therapeutic and prophylactic function and effectively combated the growth of the *Ascosphera apis* pathogenic fungus. Treatments with the preparations were carried out twice by the method of irrigation after 12 days by irrigating the walls, frames of the hive, bees and brood.

The economically useful indicators of bee colonies were studied, such as spring development of colonies, the amount of total and marketable honey productivity, as well as wax products.

The dynamics of changes in the brood of a bee colony and its strength were determined according to the number of cells occupied by the brood, using a grid frame (a 5 x 5 cm square includes 100 cells of bee brood). The counting was carried out three times, starting from the first spring survey every 21 days. The number of bees, honey and bee brood (open and sealed) were estimated.

Honey productivity was taken into account at the end of the main honey harvest. The yield of marketable honey was determined by weighing it on a scale. The amount of winter feed was determined by weighing the frames on a scale and visually, based on the fact that one frame measuring 435 x 300 mm contained from 3.5 to 4.5 kg of honey. The total yield of honey was determined by weighing the honey pumped out and left in the nest, as well as a safety stock of 5 kg per colony. The wax productivity was determined by the amount of built-up foundation during the summer season.

RESULTS AND DISCUSSION

The strength of the colonies (the number of brood) at the beginning of the experiment was taken into account in creating the control and experimental groups. The values were approximately the same and amounted to 82.9-83.3 hundred eggs in all the groups (Fig. 1).

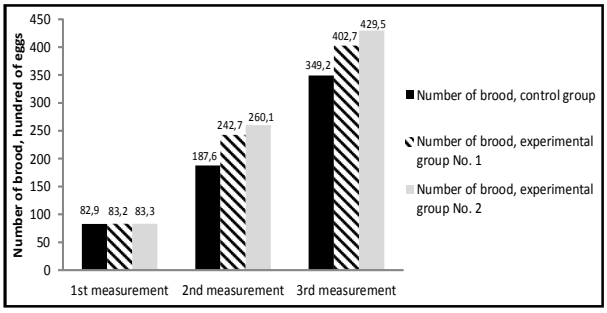

Fig. 1. The development of bee colonies in the spring/summer period in 2015-20 (on average per one bee colony).

The treatment with prophylactic agents was carried out in the experimental groups No. 1 and No. 2, while the control group was not subjected to treatments. After 21 days, the egg production of queen bees and the amount of brood in the studied groups significantly differed in comparison with the control group. In the control group, the number of brood was 187.6 hundred cells, which was 29.4% less than in the experimental group No. 1 and 38.6% less than in the experimental group No. 2 ($P \leq 0.001$). In the third measurement, the significant difference ($P \leq 0.05$) between control

and experiment groups amounted to 15.3 and 23%, respectively.

Nutritional supplements that were part of prophylactic preparations contributed to the resistance of larvae to damage by the *Ascosphera apis* fungus, and also had a stimulating effect, which led to increased egg production in queen bees. Table 1 shows the egg production of queens for the period under study.

Comparing the egg production of queen bees for the period under study, it can be concluded that the use of medicinal products based on natural ingredients had a positive effect. Thus, during the third measurement, the queen bees of experimental group No. 1 laid 402.7 hundred cells of brood with an egg production of 1917.6 eggs, which was 53.5 hundred cells or 15.3% more than the control group. As for the experimental group No. 2, the queens of bee colonies managed to lay 429.5 hundred cells with the queen's egg production of 2045.2 eggs (P≤0.001), which was 80.3 hundred cells or 23% more than in the control group.

In parallel with the study of the growth and development of bee colonies in the experimental groups, visual observations of the manifestation of clinical signs of the presence of ascospherosis were carried out (Fig. 2).

Visual inspection of the bee brood revealed no signs of the disease in experimental colonies

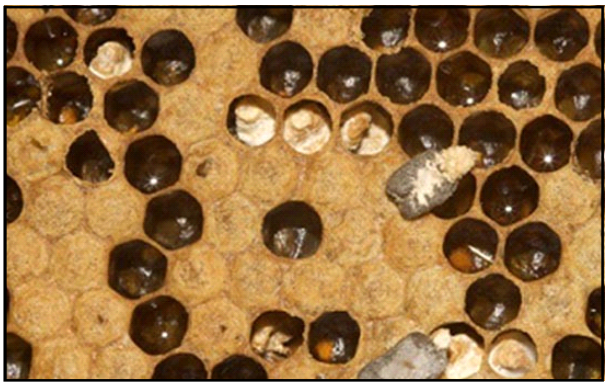

Fig. 2. Brood of a bee colony with signs of ascospherosis.

of group No. 2. In bee colonies of experimental group No. 1, the presence of a latent course of the disease was noticed and an insignificant number of dead honeybee larvae, since the amount of brood during spring/summer development was lower than in experimental group No. 1. However, there were no clear signs of the presence of mold-infected larvae in the bee colonies of this group. Analysis of the brood part of the bee nest in the colonies of the control group revealed the signs of ascospherosis in the amount of 5% of the total amount of brood, which can be attributed to a mild form of the disease.

The main economically useful characteristic of bee colonies was the receipt of total and marketable honey production, as well as the production of wax products. Table 2 shows the

Table 1. Average egg production of queen bees during the period of the study (eggs per bee colony)

Group of colonies	Indicator					
	1st measurement		2nd measurement		3rd measurement	
	$\bar{X}\pm m_x$	CV (%)	$\bar{X}\pm m_x$	CV (%)	$\bar{X}\pm m_x$	CV (%)
Control (n=10)	394.8±16.28	10.52	838.3±41.56	14.32	1662.9±61.47	11.68
Experimental No. 1 (n=10)	396.2±17.85	11.08	1155.7±42.24**	10.13	1917.6±49.62**	9.57
Experimental No. 2 (n=10)	396.7±21.47	9.83	1238.6±48.53**	13.71	2045.2±42.68***	7.98
t_d	0.09	-	3.86	-	2.78	-

**P≤0.05 and ***P≤0.01.

Table 2. Average honey and wax productivity for 2015-20 (kg per colony)

Indicator	Control group (n=10)		Experimental group 1 (n=10)		Experimental group 2 (n=10)	
	$\bar{X}\pm m_x$	CV (%)	$\bar{X}\pm m_x$	CV (%)	$\bar{X}\pm m_x$	CV (%)
Commercial honey (kg)	22.5±2.03	10.7	25.2±1.98	9.06	30.2±1.67**	8.9
Feed honey (kg)	24.1±1.22	7.5	25.7±1.13	7.3	23.3±1.31	7.8
Total honey (kg)	46.6±1.37	9.1	50.9±1.45*	8.6	53.5±1.42**	8.9

*P≤0.05 and **P≤0.01.

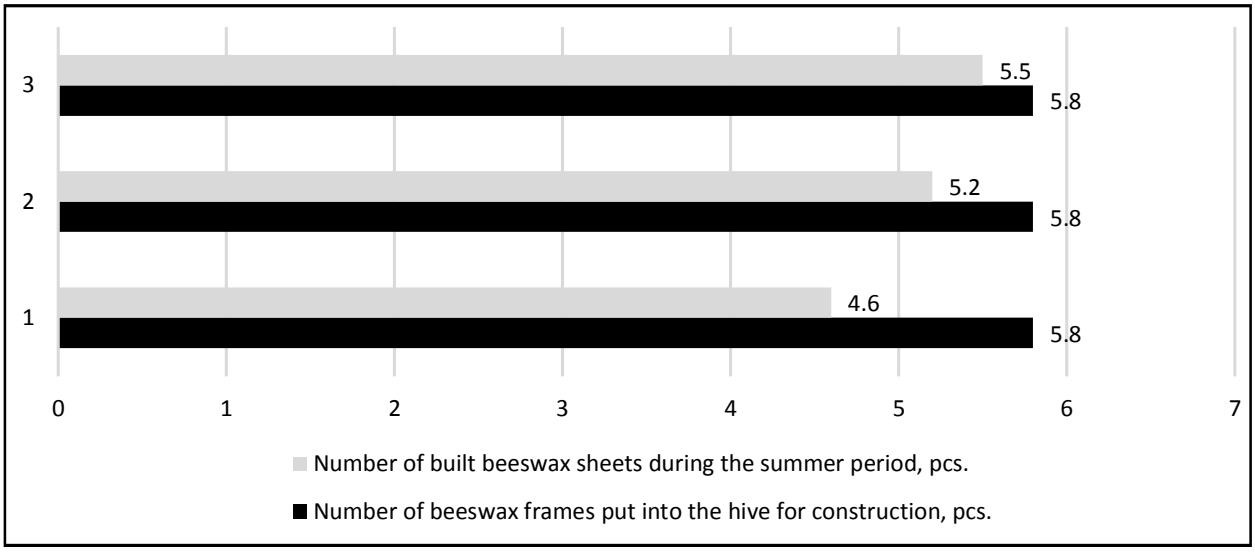

Fig. 3. The number of built-up beeswax in the experimental groups on average per one bee colony (2015-20).

productivity of bee colonies for the period of 2015-20.

Analyzing the obtained honey productivity for the period 2015-2020 from the bee colonies of the experimental groups, it was concluded that the colonies of experimental group No. 2 produced significantly more marketable and total honey. Bee colonies of experimental group No. 2 surpassed the colonies of the control group and experimental group No. 1 by 7.7 kg or 34.2% and 4.7 kg or 19.8% in terms of commercial production. In total productivity, this difference was 6.9 kg or 14.8% and 2.6 kg or 5.1%, respectively.

The use of prophylactic preparations based on natural ingredients contributed to the increase in the biomass of working honey bees, which also led to an increase in wax productivity, while they were performing their construction function (Fig. 3).

The wax productivity of bee colonies in the experimental group No. 2 showed the maximum value of 5.5 beeswax sheets out of 5.8 supplied beeswax sheets during the analyzed period, which was 19.6% more than in the bee colonies of the control group. Bee colonies of experimental group No. 1 surpassed the control group by 13% or 0.6 sheets.

CONCLUSION

The use of prophylactic preparations based on natural ingredients proved the effectiveness of their use. The number of worker bees increased and their summer generation became maximal, which made it possible to obtain the highest honey productivity during the main honey harvest.

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