Harnessing the Carniolan honey bee breed in maximizing productivity

Olga Zelenina[1*] and *Tatyana* Pimkina[1]

[1]Kaluga Branch of the Russian State Agrarian University - Moscow Timiryazev Agricultural Academy, 27, Vishnevskogo Street, Kaluga. 248007, Russia

Abstract. Climate warming has been observed everywhere in recent years, including the Kaluga region. This makes it possible to use more heat-loving, intensively developing bee breeds for the production of beekeeping products. The aim of the research is to evaluate the possibility of using Carniolan bees in apiaries for the production of commercial honey. The material of the research were 4-frame honeycomb packages of bees purchased in the Republic of Uzbekistan. Bee families were placed in 12-frame hives designed for a standard nest frame of 300 mm high and 435 mm wide. Bee family development was monitored weekly by counting the number of frames fully occupied by insects. Honey production was estimated by weighing the honey produced by each family. During the development, the bee families were divided into three groups according to the age of the mothers or their turnover. At the beginning of the main honey collection, the average number of bee families in the three groups was 11.8±1.41 frames, and at the end of the season it was 9.8±1.86 frames. From I group of bee families, which did not show tendency to swarming, 25.1±8.63 kg of honey was obtained; from II group of bee families, which replaced mothers by spontaneous change, without swarming – 15.7±7.13 kg, from III group, into which bee families were divided, taking into account productivity of formed broods - 4,4±6,16 kg. Honey collection per each family of bees at the beginning of the period averaged 15.4±12.44 kg. The increase in the number of bee families during the season, taking into account the formation of brood and culling, amounted to 10%. The results of the research allow to recommend the use of the Carniolan breed of bees in the apiaries of Kaluga region.

1 Introduction

Honey bee (*Apis mellifera*) is a socially living insect, it is used by humans to obtain valuable dietary products (honey, perga, pollen - bee pollen). Bees produce biologically active substances (royal jelly, propolis, bee venom, homogenate of trout brood), which are used as therapeutic and prophylactic agents for diseases of the pulmonary, cardiovascular, nervous systems, etc. [1].

* Corresponding author: o.zelenina2013@yandex.ru

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The main purpose of honeybees in nature is pollination of naturally growing and cultivated entomophilous plants. Bees maintain the species diversity of vegetation, provide plant products, and are used for pollination of cultivated honey plants [2, 3].

Currently, global climate change is occurring in all regions of the globe, which is reflected in changes in weather conditions both during the fall-winter resting period of bees and during their active life activity.

Global warming, which has been clearly manifested in the last decade, leads to changes in the timing of flowering of honey bee plants and the species composition of herbaceous and woody shrub plants.

Honeybees are sensitive to environmental changes, which affects their productivity and viability [4, 5]. The honey bee is susceptible to various infectious and invasive diseases, the most common of which is varroatosis. The development of this dangerous mite disease depends on climatic conditions, ecological well-being of the environment, strength of bee families, routine veterinary treatments and other factors [6, 7].

Untimely replacement of old honeycombs in the bees' nest also contributes to the weakening of bee families and increases the risk of disease spread, including varroatosis. Ecological conditions have a direct impact on the vitality of bee families. Deterioration of ecology leads to the reduction in the number, productivity and death of bee families [8, 9].

The growth of worker bees in spring and summer, as well as their productivity depend on numerous factors, including weather and environmental conditions, bee breed, age and quality of the queen bee, and so on. The lifespan of bee mothers can reach 5-6 years, but their egg production decreases by 20-30% in the second year of life and almost two times in the third year [10].

Increasing the yield of commercial honey per one bee family at the apiary contributes to higher profits from the sale of products and reduces its cost. Therefore, during the summer season apiaries cull low-productive, weak and motherless bee families. This process is called paratypic culling. Full-fledged bee families with young queens, as a rule, better tolerate unfavorable weather conditions during the fall-winter dormancy period and develop intensively in the spring [10, 11].

A large number of breeds (or races) of honey bees are used in different countries of the world to obtain beekeeping products. At the present time, research on studying their biological, morphological and economically useful (productive) qualities with regard to regional features of forage resources, climatic conditions and ecological situation continues. The results obtained during studying make it possible to assess the impact of various factors on the condition of bee families, the activity of their vital activity, to make recommendations for improving the habitat, the efficiency of using the breed or breed groups of honey bees [12, 13].

Honey bees of the Central Russian (*Apis mellifera mellifera*) and Carpathian (*Apis mellifera carpatica*) breeds are most widespread on the territory of the Middle Regions of the Russian Federation.

The Central Russian (or dark European) bee breed is distributed in the forest zone of the Russian Federation and in the countries of the European alliance.

The positive qualities of the Central Russian bees are their ability to tolerate a long flightless period and low winter temperatures, high honey production. At the same time, bees of the Central Russian breed swarm more often compared to other breeds, they are noticeably more aggressive, their spring development is not characterized by intensity.

Carpathian bees are featured by silver-gray coloring, average live weight and body size, honey seal is mostly white and dry. Carpathian bees are characterized by peacefulness, moderate tendency to swarming, intensive spring development, moderately resistant to diseases [14].

The genetic progress of the honey bee as a species is limited by the lack of control over the mating of uterus and trout, inbreeding, a number of other biological peculiarities, and environmental factors [15].

Kaluga region belongs to the regions with unstable and insufficient forage base for bees, so there are no large industrial (commercial) apiaries. The Carpathian and Central Russian bee breeds are mainly used for honey production in Kaluga Oblast. In recent years, the Carnica or Carnolian breed of bees has been gradually spreading in the region. It is used in many countries of the world and combines the best qualities of the Carpathian and gray mountain Caucasian breeds.

Carnica has a natural habitat in the mountainous and foothill areas of the Alps. Bees of this breed (*Apis mellifera carnica*) are similar to Carpathian bees in appearance, they have gray with silver coloring of the body. The live weight of a one-day bee is 105 mg; that of a fetal uterus is 205 mg. Bees are characterized by peacefulness, calm behavior when inspecting the nest, not prone to stealing. Biological peculiarity of carnolian bees is a tendency to "quiet" change of mothers, cohabitation of two mothers in a nest is possible.

The objective of the research is to observe the development and to estimate the yield of commercial honey from carnolian bee families.

2 Materials and methods

The research material was four-frame honeycomb packages of carnolian bees purchased in mid-May 2024 in Uzbekistan. The bees were housed at the apiary in standard 12-frame dadaan hives, which are designed for nesting frames of 435 x 300 mm.

During the honey collection season, bee families were inspected weekly, and as the families developed, their nests were expanded by adding nesting frames with artificial beeswax. Individual records of bee family development and condition were recorded in the apiary journal.

The strongest bee families were moved to 14-frame hives during the flowering period of the main honey plants. Taking into account the individual development of bee families, stores with frame size 435 x 145 mm were installed on their nests. When the first store was filled with honey, the second store was placed on the nest. After the bees had sealed the cells with wax, the upper store was removed for pumping out the honey.

Commercial honey yield was counted during the honey-gathering period by counting the selected store or nest frames. The frames removed from the nests were weighed before and after honey pumping. The total amount of honey obtained from each bee family was then counted.

The territory of the apiary is located in an ecologically favorable zone, away from settlements, industrial enterprises, as well as agricultural lands treated with chemical means of crop protection. In the radius of productive summer of bees there is a sufficient number of honey-bearing plants, including herbaceous, shrub and woody plants, both in terms of area and species diversity, to ensure honey collection.

The summer season of 2024 was favorable in terms of temperature, precipitation and blooming intensity of entomophilous plants, which ensured continuous collection of nectar and pollen by bees.

3 Results

The intensity of bee family development was recorded at each inspection. It is necessary for timely nest expansion, anti-swarming measures, installation of extensions or second houses, etc.

Changes in the number and development of carnolian bee families in the apiary during the summer season of 2024 are shown in Table 1.

Table 1. Changes in the population size, development of bee families.

Indicators	Beginning of the period	Broods made	Rejected	Beginning of the period	At the peak of honey harvest	At the end of the season
Number of bee families, pcs.	20	4	2	-	24	22
Strength of bee families, frames	-	-	-	4.0±0.0	11.8±1.41	9.8±1.86
Percentage to beginning of period	100	20.0	10.0	100.0	295.0	245.0

The total number of purchased bee packages at the beginning of the period was 20. During the summer season, four families with swarming broods were removed.

When accounting for marketable honey yields, bee families were categorized into three groups based on age, replacement or weaning of mothers - Table 2.

Table 2. Yield of marketable (commercial) honey from bee families, kg.

Indicators	Distribution of bee families according to age or replacement of queens				Total, on average, minimum/ maximum values
	group I with queens of the last year of birth, total, on average	II group who changed their queens by "quiet" change, total, on average	III group queens were weaned, broods were formed		
			total, on average	including broodstock	
Number of bee families, pcs.	9	3	8	4	-
Total honey produced, kg	226	47	35	28	308
Honey yield per 1 bee family on average, kg	25.1±8.63	15.7±7.13	4.4±6.16	7.0±7.81	15.4±12.44
Minimum / maximum individual honey production, kg	9…35	6…23	0…20	0…20	0…35

The first group included 9 bee families that did not change queens in the current season.

The second group included 3 families that did not show swarming instinct, but replaced queens by spontaneous or "silent swapping".

The third group consisted of 8 families and included 4 mother families and 4 broods, i.e., artificially formed swarms.

4 Discussion

During the flowering period of the main honey plants, the number of bee families reached 24 bee families due to four new families (broodstock) formed (Table 1). At the end of August, two bee families were culled due to lack of queen and poor development during paratypic selection.

The intensity of bee family development was assessed by counting nest frames occupied by bees. At the peak of honey harvest, the strength of families increased to 11.8±1.41 frames. The increase compared to the beginning of counting amounted to 7.8 frames. After the end of honey collection, bee families occupied 9.8±1.86 frames on average.

It is known that with the onset of the fall period the number of worker bees in nests gradually decreases. This feature is a biological adaptation of bees in preparation for the unfavorable autumn-winter period, as well as expulsion of worker bees after the end of honey collection.

Accounting of marketable honey yield from bee families of group I, in which queens of the last year of birth remained, showed that on average 25.1±8.63 kg of honey was obtained per family, the maximum individual value in the group was 35 kg.

Bee families of group II, which changed queens without swarm exit ("quiet change"), produced an average of 15.7±7.13 kg of honey. The individual honey yield of group II bee families varied from 6 to 23 kg.

The biological feature of bee families is that when queens are replaced, bees stop brood rearing for several weeks and their development intensity slows down. This leads to a decrease in the flight activity of worker bees, and, as a consequence, the honey productivity of queen replacement bee families decreases.

Bee families of group III produced an average of 4.4±6.16 kg of honey, including broodstock - 7.0±7.81 kg. It should be noted that due to the division of families in this group, their total number increased 2 times. When calculating the honey yield from 4 bee families that existed before the division, the total honey yield was 63 kg, each bee family yielded 15.8 kg.

The total honey yield from all carnolian bee families for the 2024 season was 308 kg. On average, 15.4±12.44 kg of honey was obtained per bee family (4 frame bee package) available at the beginning of the period.

The conducted research revealed the following:

1. Bee families of carnolian breed in conditions of Kaluga region intensively developed, at the peak of the main honey collection the number of nesting frames in hives, fully occupied by bees, increased 2.95 times.
2. On average, 15.4 kg of honey was obtained for each purchased 4-frame bee package during the season.
3. The number of bee families due to the formation of broodstock during the summer season increased by 10.0%.

The obtained results make it possible to recommend carnolian bees for use in apiaries in Kaluga region specializing in honey production.

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