IMPACT OF CLIMATE CANGE OF ATMOSPHERIC PRECIPITATIONS ON THE VITAL ACTIVITY OF BEES FAMILIES

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Abstract

The prezent study aims to determine the correlation between the parameters of monthly atmospheric precipitation at different times of the year and the evolution of morpho-productive characters of bee families, thus elucidating the impact of the climate change on atmospheric precipitations on the vital activity of bee colonies Apis mellifera. The scientific researches were performed at the experimental apiary of the Institute of Zoology of the Academy of Sciences of Moldova, located in the Center area of Moldavian Codri. The obtained results have demonstrated that the precipitation in February of this year had a weak and directly negative influence on the wintering resistance of the bee families (r_{xy}= -0.468±0.276; t_r=1.70; P<0.1) and the precipitation from July last year - indirect influence (r_{xy}= -0.482±0.271; t_r=1.78; P<0.1). The queen bee prolificacy is significantly negatively and directly influenced by the atmospheric precipitation in May and June of this year (r_{xy} = -0.811 ± 0.121; t_r= 6.70; P <0.001) and indirectly positive by the annual volume of atmospheric precipitation from last year (r_{xy}= 0.525±0.256; t_r=2.05; P<0.05). The colony strength is negatively and directly influenced by the precipitations in April of this year (r_{xy} = -0.564 ± 0.241; t_r = 2.34; P <0.05) and indirectly positive by the atmospheric precipitation in December of the previous year (r_{xy}= 0.629±0.214; t_r=2.94; P<0.01). The disease resistance of bee families is influenced negatively and directly by the atmospheric precipitation in January of this year (r_{xy} = -0.712± 0.174; t_r = 4.09; P <0.001), negative and indirectly by July precipitation (r_{xy}= -0.642±0.208; t_r=3.09; P<0.01) and, positively and indirectly, by the precipitation from August of last year (r_{xy} = 0.660 ± 0.199; t_r = 3.32; P <0.001), as well as by the annual quantity of atmospheric precipitation from the previous year (r_{xy}= 0.621±0.215; $t_{r.}$=2.89; P<0.01). The brood viability is influenced negatively and directly by the atmospheric precipitation in the months of January (r_{xy} = -0.557 ± 0.244; t_r = 2.28; P <0.05), February (r_{xy} = -0.573± 0.237; t_r = 2.42; P <0.05) and Mai (r_{xy} = -0.491 ± 0.268; t_r = 1.83; P <0.1) of current year, and positive and indirect by atmospheric precipitation in October (r_{xy} = 0.499 ± 0.265; t_r = 1.88; P <0.1) and November (r_{xy} = 0.648 ± 0.205; t_r = 3.16; P <0.01) of previous year. The production of honey, accumulated in the nest by the bee families, is negatively and directly influenced by the atmospheric precipitation from mounths of February (r_{xy} = -0.797 ± 0.128; t_r = 6.23; P <0.001), Mai (r_{xy} = -0.507 ± 0.262; t_r = 1.94; P <0.1) and June (r_{xy} = -0.507 ± 0.263; t_r= 1.93; P <0.1) of current year, and, positively and indirectly by atmospheric precipitation in September (r_{xy} = 0.732 ± 0.164; t_r = 4.46; P <0.001) and November (r_{xy} = 0.627 ± 0.214; t_r = 2.93; P <0.01) of the previous year.

Key words: bees, climatic changes, atmospheric precipitation, correlation, characters

INTRODUCTION

The notion of climate change means complex modification of air temperature, of atmospheric precipitation regime and of extreme weather phenomena, or irregular events such as drought, storms, tornadoes, hail, floods, etc [10, 14, 15, 17]. Numerous scientific researches [2, 11-13, 19] demonstrates that climate change is caused by global warming, which is a direct or indirect result of human activities (burning fossil fuels, changing land use, fermenting organic substances, etc.) that emit enormous quantities of greenhouse gases into the atmosphere. These determines the change in

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the composition of the global atmosphere, to which the natural variability of the climate, observed over a comparable period of time, is added. The greenhouse effect occurs because of the selective absorption by the greenhouse gas molecules of the thermal radiation emitted by Earth, and its isotropic reemittance in both the extra-atmospheric space and to the Earth. Increasing the concentration of these gases into the atmosphere, intensifies the greenhouse effect, which perturb the transport of energy and humidity in the system, wich determines imbalances in the climate system.

The impact of climate change are reflected in: increasing global average temperature with significant regional variations, reducing freshwater resources for the population, reducing the volume of glacier calving and increasing ocean levels, modifying the hydrological cycle, increasing arid areas, anomalies in the deployment of seasons, increasing the frequency and the intensity of extreme climatic phenomena, with a particularly negative impact on flora and fauna, expressed by reducing biodiversity, decreasing agricultural productivity etc. [3, 16, 20].

It is worrying that, despite the Paris Agreement - the United Nations Framework Convention on Climate Change [1] - greenhouse gas emissions and global warming continue to increase. Thus, in an official publication of the European Environment Agency (EEA), total greenhouse gas emissions in the European Union (EU) increased by 0.7% in 2017 compared with 2016. Greenhouse gases emissions in the EU are mainly due to higher industrial and transport emissions, the increasing of which have been recorded for the fourth consecutive year [13].

Along with global warming, there is concern over the climate change of atmospheric precipitation. Clouds, which represent the more condensed form of tiny water molecules suspended in the air, are the main source of atmospheric precipitation. Minuscule water particles play an important role in the way and duration of clouds formation, in the amount of solar radiation the clouds can reflect, and determine the type of generated precipitations. Concentrations and particle composition may even climate change the time and place where precipitation occurs [6].

Climate changes in the frequency and volume of precipitation has attracted the attention of multiple specialists and researchers in the field [5, 6, 21-23] as they cause real economic and social costs, affecting food production and their global price.

The report of the European Environment Agency „Climate change, impact and vulnerability in Europe 2012" reveals there are quite pessimistic forecasts of climate change that all regions of Europe are affected by climate change, and higher temperatures across Europe have been set, in combination with decreasing of precipitation in southern regions and increasing precipitation in Northern Europe. In addition, icecaps and glaciers are melting and sea level is rising. All these trends are expected to continue [11]. According to the same Report, climate change of atmospheric precipitation has a direct impact on the physiology, phenology, and biodiversity distribution of fauna and flora as well as on the overall human society.

The pessimistic predictions of climate change are complemented by Romanian researchers [3-6, 17, 19-23], who, for the most part, affirm that during the hot season there is a tendency for decrease the precipitation, which, generally, will be accentuated towards the end of the XXI century. Under these conditions, the trend of predictions is associated with the climate change signal, determinated by the increase of global greenhouse gas concentrations, with the regional signal of reducing of precipitations in the zone, as well as the negative impact on agriculture, natural ecosystems and society as a whole.

In Technical Report of Greenpeace Research Laboratories [10] it was mentioned that: „climate change, such as increasing temperatures, changes in rainfall patterns and more erratic or extreme weather events, will have impacts on pollinator populations. Some of these changes could affect pollinators individually and ultimately their communities, becoming reflected in higher extinction rates of pollinator species”.

In our previous research, it has been demonstrated that the excessively high summer-summer temperatures of a droughty year caused a drastic decrease in the values of the main morpho-productive bee family indices by 20-46% [7].

We also found that changes in air temperature in different months of the year have different impacts on the vital activity of bee families, depending on the period of the year and the air temperature [8].

Appreciating the research results of the above-mentioned multiple authors, we can report that they have provided useful information on the impact of climate change on ecosystems in general and on pollinators in particular. At the same time, in the accessible for us bibliographic sources, information on the concrete influence of changes in the atmospheric precipitation regime on the vital activity of bee families is missing.

In this context, the aim of our research was to determine the correlation between the parameters of monthly atmospheric precipitation at different times of the year and the evolution of morpho-productive characters of bee families, thus elucidating the impact of the precipitation regime on the vital activity of bee colonies *Apis mellifera.*

MATERIALS AND METHODS

The scientific researches were carried out on bee families *Apis mellifera carpatica,* at the experimental apiary of the Institute of Zoology of the Academy of Sciences of Moldova, located in the central part of Moldavian Codri, Forest District Ghidighici, Canton no. 8, Forest Sector no. 21. At the apiary there were a total of 50 bee families. During the years 2010-2018, each year, at the end of June, each bee family were individually evaluated the main morpho-productive reproduction and developmental characters (queen prolificity, family strength), wintering and disease resistance, brood viability, as well as productivity of honey accumulated in nest, according to our methods [9] described in the Zootechnical norme regarding breeding of bee families, the growth and certification of genitor beekeeping material, approved by Government Decision no. 306 of 28.04.2011 [18]. Then the average value of each evaluated morpho-productive character per apiary was calculated.

To study the impact of climate change on the vital activity of bee families, monthly and annual average of atmospheric precipitations data in the last 8 years (2010-2017), from the nearest hydrometeorological station in Bravicea, Dist. Călărași, at a distance of 27 km from the apiary, were used. During this period, for each month, Pirson's linear correlation coefficients were calculated between the monthly average of atmospheric precipitations and the average values per apiary of each of the 6 main morphoproductive characters of bee families, such as: queen prolificity, colony strength, wintering resistance, disease resistance, brood viability and honey production of bee families. For the months of the first half of the year, correlation coefficients were calculated between atmospheric precipitations and values of morpho-productive characters, evaluated in the same year at the end of June, with the exception of wintering resistance, which was assessed at the end of March. Given that in the second half of the year the climatic factors don't influence the morpho-productive characters, already evaluated in this year, the atmospheric precipitations variable in July-December was calculated in correlation with the value of the morpho-productive characters of the bee families from next year. The same correlation coefficients were also calculated for the average annual precipitations and the average values per apiary of the above-mentioned morpho-productive characters.

Pirson's linear correlation coefficient (r_{xy}) was calculated using the „STATISTICA 12” computer software. For each correlation coefficient the criterion of certainty of the correlation (t_r) and the certainty threshold (P) after Student was calculated in part.

The obtained in experience data were statistically processed and evaluated their certainty, according to variation biometric statistics, by methods of Плохинский Н.А. [24].

RESULTS AND DISCUSSIONS

The analysis of the research results showed that during the years 2010-2017, in the area monitored by us, climate change caused a quite various annual and monthly atmospheric precipitations (Tab. 1).

It was found that the annual quantity of atmospheric precipitation in the area ranged from 437.0 mm minimum in 2011 to 734.9 mm maximum in 2010. The difference between the volume of atmoshperic precipitation (variability) was 40.5%.

Table 1 Annual and monthly atmospheric precipitation registered at the Hydrometeorological Station „Bravicea”, Dist. Călărași, during the years 2010-2017, mm

Month of the year	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
January	87.3	19.6	18.1	31.4	51.1	26.5	32.8	29.5
February	40.8	45.7	78.1	33.8	5.9	21.3	27.4	22.5
March	18.7	24.8	15.0	65.1	12.9	57.7	25.7	30.8
April	41.4	27.6	84.2	29.1	55.1	41.8	39.8	112.5
May	97.0	22.9	44.1	62.1	88.3	12.6	64.5	42.9
June	147.2	119.8	64.3	142.8	27.4	34.8	188.0	89.7
July	64.0	64.6	44.1	9.5	91.7	83.2	19.6	85.5
August	43.4	50.5	39.7	78.2	18.9	38.0	120.7	33.9
September	49.7	12.2	6.3	114.6	10.3	20.2	9.0	29.7
Octomber	51.7	24.2	36.5	4.9	44.3	42.8	134.5	62.3
Noiember	37.1	4.9	23.3	60.7	91.8	56.6	36.5	31.7
December	56.6	20.2	99.2	6.6	41.3	2.7	11.2	81.2
Total annual	**734.9**	**437.0**	**552.9**	**638.8**	**539.0**	**438.2**	**709.7**	**651.6**

Data analysis demonstrates that over the years, the monthly volume of atmospheric precipitations varies considerably. In the analyzed period (2010-2017), the highest variability of the monthly precipitation volume was registered in December, ranging from 2.7 mm in 2015 to 99.2 mm in 2012, the variation constituting 97.3%. The lowest variability in atmoshperic precipitation was registered in April, ranging from 27.6 mm in 2011 to 112.5 mm in 2017, with a variation of 75.5%. Also, atmospheric precipitations during this period had significant variability in the months: October, from 4.9 mm in 2013 to 134.5 mm in 2016, with a difference of 96.4%; November, from 4.9 mm in 2011 to 91.8 mm in 2014, with a variation of 94.7%; September, from 6.3 mm in 2012 to 114.6 mm in 2013, with a variation of 94.5% and in February, from 5.9 mm in 2014 to 78.1 mm in 2012, with the variation of 92.4%. In the other months of the year, the variability in the quantity of atmospheric precipitation in this period (2010-2017) fluctuated from 79.3% in January to 89.6% in July.

During the monitored period, two terrible droughts were registered, in the years 2012 and 2015, the annual precipitations volume was relatively low, compared to the other years, but not the smallest. Terrible droughts were registered in the years when the least quantity of atmospheric precipitations fell during the warm period (May-August). Despite the fact that in 2011 the lowest quantity of annual precipitations (437.0 mm) was registered, the drought did not occur, because during the warm period of this year, fell sufficients quantity of precipitations (257.8 mm). However, in 2012 and 2015, when the lowest precipitation quantity during the warm period of all the monitored period, 192.2 and 168.6 mm respectively, was registered, the severe drought triggered.

The climate change in air temperature, atmospheric precipitation, as well as the extreme phenomena triggered in the area of location of experimental apiary have caused a significant variation in the vital activity of the bee families, expressed by different levels of morpho-productive characters development (Tab. 2).

From the presented data, it can be observed that the average per apiary of queens prolificacy varied during this period, from 1371 eggs/24ore in 2016, to 1806 eggs/24ore in 2011.

The variability of this character at bee families was 24.1%. The colony strenght, expressed by the amount of bees present in the nest, fluctuated from 2.20 kg in 2016 to 3.14 kg in 2018, with the variability of 30%. Wintering resistance varied, albeit to a smaller extent, from 80.1 percentage points in 2010 to 93.3 percentage points in 2014, with the variability being 14.2%. Of the researched morpho-productive characters, the brood viability had the slightest variability in this period, fluctuating from 85.1 percentage points in 2010 to 95.8 percentage points in 2015, with a variability of 11.2%.

Table 2 Average indices of morpho-productive characters in bee families at the experimental apiary of the Institute of Zoology, during the years 2010-2018

Year	Prolificacy, eggs/24 h	Colony strength, kg	Wintering resistance, %	Brood viability, %	Disease resistance, %	Honey production, kg
2010	1583	2.83	80.1	85.1	76.8	38.8
2011	1806	2.97	82.5	91.0	89.4	32.8
2012	1740	2.37	86.2	88.6	87.4	23.9
2013	1661	3.03	91.1	91.0	90.5	35.5
2014	1781	3.13	93.3	92.3	91.6	57.4
2015	1711	3.04	88.6	95.8	86.3	44.2
2016	1371	2.20	84.1	95.7	89.2	31.0
2017	1678	2.36	86.8	95.5	92.6	34.2
2018	1781	3.14	88.4	95.4	91.7	39.7

Resistance to diseases (hygienic instinct) of bee families oscillated, during the nominated period, from 76.8 percentage points in 2010 to 92.6 percentage points in 2017, the variability being 17.1%. On the whole, we notice that climate change during this period fas caused a quite obvious variability of honey production accumulated in nest, from at least 23.9 kg in 2012 to a maximum of 57.4 kg in 2014, the variability being 58.4%.

In order to elucidate the concrete relationships impact of the climate change atmospheric precipitation on the vital activity of the bee families, the linear correlation coefficients (r_{xy}) between the monthly quantity of atmospheric precipitation and the medium value per apiary of the morpho-productive characters of the bee families was calculated (Tab. 3).

Table 3 The correlation coefficient (r_{xy}) between the monthly quantity of atmospheric precipitation in the first half of the year and the medium value of morpho-productive characters bee families

Morpho-productiv character	rxy ± mr	tr	P
Precipitations in January			
Wintering resistance	-0.274±0.327	0.84	>0.1
Queen prolificity	-0.288±0.324	0.89	>0.1
Colony strength	0.227±0.335	0.68	>0.1
Disease resistance	-0.712±0.174	4.09	<0.001
Brood viability	-0.557±0.244	2.28	<0.05
Honey production	0.425±0.289	1.47	>0.1
Precipitations in February			
Wintering resistance	-0.468±0.276	1.70	<0.1
Queen prolificity	0.046±0.353	0.13	>0.1
Colony strength	-0.356±0.308	1.15	>0.1
Disease resistance	-0.303±0.311	0.97	>0.1
Brood viability	-0.573±0.237	2.42	<0.05
Honey production	-0.797±0.128	6.23	<0.001
Precipitations in March			
Wintering resistance	0.351±0.310	1.13	>0.1
Queen prolificity	0.105±0.349	0.30	>0.1
Colony strength	0.338±0.313	1.08	>0.1
Disease resistance	0.156±0.345	0.45	>0.1
Brood viability	0.359±0.308	1.16	>0.1
Honey production	0.012±0.353	0.03	>0.1
Precipitations in April			
Queen prolificity	0.097±0.350	0.28	>0.1
Colony strength	-0.564±0.241	2.34	<0.05
Disease resistance	0.292±0.323	0.90	>0.1
Brood viability	0.179±0.342	0.52	>0.1
Honey production	-0.198±0.339	0.58	>0.1
Precipitations in May			
Queen prolificity	-0.811±0.121	6.70	<0.001
Colony strength	-0.383±0.301	1.27	>0.1
Disease resistance	-0.335±0.313	1.07	>0.1
Brood viability	-0.491±0.268	1.83	<0.1
Honey production	-0.507±0.262	1.94	<0.1
Precipitations in June			
Queen prolificity	-0.811±0.121	6.70	<0.001
Colony strength	-0.383±0.302	1.27	>0.1
Disease resistance	-0.233±0.334	0.70	>0.1
Brood viability	-0.160±0.344	0.46	>0.1
Honey production	-0.507±0.263	1.93	<0.1

Research results have shown that January's atmospheric precipitation had a significant negative impact on disease resistance and brood viability. The coefficient of linear correlation of the quantity of atmospheric precipitation with disease resistance is negative at high level, having a significance of the highest threshold of certainty after Student (r_{xy}= -0.712±0.174; t_r=4.09; P<0.001). The correlation between the quantity of atmospheric precipitation in January and the viability of the brood is also negative at the medium level with the significance of threshold one after Student (r_{xy}= -0.557±0.244; t_r=2.288; P<0.05).

February's atmospheric precipitation provokes a significant negative impact on the brood viability and honey productivity of bee families. Thus, the linear correlation coefficient between the quantity of atmospheric precipitations in this month and the brood viability is negative on medium level and quite significant (r_{xy}= -0.573±0.237; t_r=2.42; P<0.05). At the same time, between the quantity of atmospheric precipitation in February and the honey production of bee families, a negative high level correlation was registered, with the highest threshold of certainty after Student (r_{xy}= -0.797±0.128; t_r=6.23; P<0.001). In addition, it was determinated a tendency of atmospheric precipitation of this month to negatively influence on the wintering resistance of bee families (r_{xy}= -0.468±0.276; t_r=1.70; P<0.1).

Research has shown that atmospheric precipitations in March does not exert any negative or positive influences on the vital activity of bee families, because the coefficients of linear correlations between the quantity of precipitation and the morpho-productive characteristics of bee families did not have significant values (P>0.1).

It was found that the atmospheric precipitations in April had a negative impact on the bee colonies strenght. The linear correlation coefficient of the quantity of atmospheric precipitation this month with this morpho-productive character is negative on medium level and quite significant (r_{xy}= -0.564±0.241; t_r=2.34; P<0.05).

It is important to note that the atmospheric precipitations in May had a particularly negative influence on the queens prolificity. The coefficient of linear correlation of the atmospheric precipitation quantity this month with the prolificity of the queens is negative at a relatively high level with a significance of the highest confidence threshold after Student (r_{xy}= -0.811±0.121; t_r=6.70; P<0.001). This negative impact is explained, by us, by the excessive increase in the humidity in the nest, caused by the intense atmospheric precipitation. In addition, the May atmospheric precepitations had a tendency to influence negative on the viability of the brood (r_{xy}= -0.491±0.268; t_r=1.83; P<0.1) and the quantity of honey accumulated in the nest. The correlation coefficient of the atmospheric precipitations with the last morpho-productive character is close to the significance of the first threshold of certainty after Student (r_{xy}= -0.507±0.262; t_r=1.94; P<0.1).

The atmospheric precipitations in June had a similar impact to May. Thus, the linear correlation coefficient between the quantity of atmospheric precipitations in June and the prolificity of the queens is negative, of a rather high threshold and with a significance of the highest degree of certainty after Student (r_{xy}= -0.811±0.121; t_r=6.70; P<0.001). This means that with the increase in the quantity of atmospheric precipitation in June, there will be a significant decrease in the prolificity of queens. At the same time, the quantity of atmospheric precipitations in June has a negative impact on the quantity of honey accumulated in the nest. The correlation coefficient of these two variables is negative, approaching the significance of the first threshold (r_{xy}= -0.507±0.263; t_r=1.93; P<0.1).

Generalizing the impact of climate change on atmospheric precipitation in the first half of the year, we can conclude that high quantity of precipitations during this period, especially in January, February and May, has a negative impact on the vital activity of bee families. The negative impact primarily influences the disease resistance, brood viability, prolificity of queens, colony strenght, and honey production. Under the influence of atmospheric precipitation, the humidity in the nest increases, inhibiting the development of most morpho-productive characters of bee families.

Beginning with the second half of the year, the July-December atmospheric precipitation can no longer impact the morpho-productive characteristics previously assessed (at the end of June), but may have a direct impact on the vital activity of bee families related to the consolidation of colonies strenght and their preparation for wintering, as well as indirectly on the evolution of morpho-productive characters in the next year (Tab. 4).

Table 4 Coefficient of correlation between the quantity of monthly atmospheric precipitation in the second half of the current year and the morpho-productive value of bee families in the following year

Morpho- productiv character	$r_{xy} \pm m_r$	t_r	**P**
Precipitations in July			
Wintering resistance	-0.482±0.271	1.78	<0.1
Queen prolificity	-0.126±0.348	0.36	>0.1
Colony strength	-0.021±0.353	0.06	>0.1
Disease resistance	-0.642±0.208	3.09	<0.01
Brood viability	0.255±0.331	0.77	>0.1
Honey production	-0.372±0.305	1.22	>0.1
Precipitations in August			
Wintering resistance	0.123±0.349	0.35	>0.1
Queen prolificity	-0.015±0.354	0.04	>0.1
Colony strength	0.346±0.311	1.11	>0.1
Disease resistance	0.660±0.199	3.32	<0.001
Brood viability	0.388±0.300	1.29	>0.1
Honey production	0.040±0.353	0.11	>0.1
Precipitations in September			
Wintering resistance	0.393±0.298	1.32	>0.1
Queen prolificity	0.284±0.325	0.87	>0.1
Colony strength	0.396±0.298	1.33	>0.1
Disease resistance	0.331±0.317	1.04	>0.1
Brood viability	-0.153±0.345	0.44	>0.1
Honey production	0.732±0.164	4.46	<0.001
Precipitations in Octomber			
Wintering resistance	-0.333±0.317	1.05	>0.1
Queen prolificity	-0.080±0.351	0.23	>0.1
Colony strength	-0.345±0.311	1.11	>0.1
Disease resistance	0.433±0.287	1.51	>0.1
Brood viability	0.499±0.265	1.88	<0.1
Honey production	-0.286±0.325	0.88	>0.1
Precipitations in November			
Wintering resistance	0.172±0.343	0.50	>0.1
Queen prolificity	0.008±0.354	0.02	>0.1
Colony strength	0.261±0.330	0.79	>0.1
Disease resistance	-0.262±0.330	0.79	>0.1
Brood viability	0.648±0.205	3.16	<0.01
Honey production	0.627±0.214	2.93	<0.01
Precipitations in December			
Wintering resistance	0.165±0.344	0.48	>0.1
Queen prolificity	0.334±0.317	1.05	>0.1
Colony strength	0.629±0.214	2.94	<0.01
Disease resistance	0.068±0.352	0.18	>0.1
Brood viability	-0.156±0.345	0.45	>0.1
Honey production	-0.061±0.352	0.17	>0.1
Total annual precipitations			
Wintering resistance	0.020±0.353	0.06	>0.1
Queen prolificity	0.525±0.256	2.05	<0.05
Colony strength	0.455±0.280	1.62	>0.1
Disease resistance	0.621±0.215	2.89	<0.01
Brood viability	0.143±0.346	0.41	>0.1
Honey production	0.350±0.310	1.13	>0.1

Analyzing the variability of monthly quantity of atmospheric precipitations in the second half of this year in correlation with the evolution of morpho-productive characters of bee families in the first half of the next year, we found that these (atmospheric precipitations) also had a a rather evident impact on the vital activity of bee families.

Thus, the quantity of atmospheric precipitations in July had a significant negative impact on the diseases resistance of bee families in the next year. The coefficient of linear correlation between the quantity of atmospheric precipitations in July and the diseases resistance of bee families is negative at the supramedia level and quite significant (r_{xy}= -0.642±0.208; t_r=3.09; P<0.01). At the same time, the precipitations of this summer month also had a endency to influence negative on the wintering resistance of the bee families in the following year (r_{xy}= -0.482±0.271; t_r=1.78; P<0.1).

August's atmospheric precipitation, on the contrary, had a positive impact on the resistance of bee families to diseases next year. The linear correlation coefficient between the quantity of atmospheric precipitations in August and the resistance of the bee families to the disease is positive above average level and quite significant, with the highest confidence threshold after the Student (r_{xy}= 0.660±0.199; t_r=3.32; P<0.001). This means that with the increase in the quantity of atmospheric precipitation in August this year, it will increase the diseases resistance of bee families in the following year.

Research has shown that the atmospheric precipitation in September of this year had a positive impact on the quantity of honey accumulated in the nest by bee families the following year. The linear correlation coefficient between the quantity of atmospheric precipitations in September and the quantity of honey accumulated in the nest by the bee families is positive at a high level and quite significant, with the highest certainly threshold after Student (r_{xy}= 0.732±0.164; t_r=4.46; P<0.001).

It was found that the atmospheric precipitation in October in general had no significant impact on the vital activity of the bee families, since, the linear correlation coefficients of this month's precipitations and the morpho-productive character of the families bees are not significant. Only a positive tendency to influence of the quantity of atmospheric precipitations this month on the viability of the brood was observed (r_{xy}= 0.499±0.265; t_r=1.88; P<0.1).

Research data analysis shows that November's atmospheric precipitations has a positive influence on the viability of brood and honey productivity in the coming year. Thus, the linear correlation coefficient between the quantity of atmospheric precipitations in November and the viability of brood in the bee families is positive at the supramedia level and quite significant, with the second threshold of certainty after Student (r_{xy}= 0.648±0.205; t_r=3.16; P<0.01). Also, the linear correlation coefficient between the quantity of atmospheric precepitations in November and honey production of bee families in the following year is positive and significant, with the second certainly threshold after Student (r_{xy}= 0.627±0.214; t_r=2.93; P<0.01). This means that as the quantity of atmospheric precipitations increases in November this year, there will be an increase in the viability of the brood and the productivity of honey accumulated in the nest by bee families the following year.

The atmospheric precipitations from the monht of December positively influences the vital activity of the bee families, which is related to the reproduction and developing characters of the brood, ultimately expressed through colony strenght. The coefficient of linear correlation between the quantity of atmospheric precipitation in December and the strength of the bee families in the following year is positive and very significant, with the second threshold of certainty after Student (r_{xy}= 0.629±0.214; t_r=2.94; P<0.01).

Regarding climate change the annual atmospheric precipitations, we have established that these have a concrete impact on some morpho-productive characters of bee families of the following year. It has been found that there is a positive correlation between the quantity of annual atmospheric precipitations, on the one hand, and the value of the queen's prolificity as well as the resistance to disease on the other. Thus, the linear correlation coefficient between the annual quantity of atmospheric precipitation and the prolificity of the queens is positive of medium level with the significance of the first threshold after Student (r_{xy}= 0.525±0.256; t_r=2.05; P<0.05). Between the annual quantity of atmospheric precipitation and disease resistance of bee families was revealed a positive linear correlation coefficient of the supramedia level with the significance of the second threshold after Student (r_{xy}= 0.621±0.215; t_r=2.89; P<0.01). In addition, it was observed that the annual quantity of atmospheric precipitation tends to have a positive influence on bee colony strenght in the following year (r_{xy}= 0.455±0.280; t_r=1.62; P>0.1). This means that with the increase of the annual quantity of atmospheric precipitations in the next year there will be an increase in the prolificity of queens, colonies' strenght and disease resistance.

Therefore, generalizing the data on the correlation between climate change atmospheric precipitation and the values of the main morpho-productive characters of the bee families, we can conclude that it (climate change) have a significant influence on functions of the vital activity of bee colonies. The variability in the quantity of atmospheric precipitation in different months of the year had a diferent influence on the development of morpho-productive characters of bee families. Moreover, climate change the atmospheric precipitation in the first half of the year directly influences the variability of the morpho-productive characters values assessed by the end of June, and the atmospheric precipitation in July-December indirectly influences the variability of the these values in the next year.

Knowing the impact of climate change on atmospheric precipitation and its influence on the variability of values of morpho-productive characters of bee families during different concrete times of the year, will enable beekeepers to undertake certain mitigation measures by applying of special procedures, and directed feeding of bee families according to the specific periods of the year.

CONCLUSIONS

1. The wintering resistance of bee families is low and directly influenced by the atmospheric precipitations in February of current year (r_{xy}= -0.468±0.276; t_r=1.70; P<0.1) and indirectly by atmospheric precipitation in July of last year (r_{xy}= -0.482±0.271; t_r=1.78; P<0.1).

2. The queen prolificity of bee families is negatively affected directly and significantly by the atmospheric precipitation in May and June of current year (r_{xy}= -0.811±0.121; t_r=6.70; P<0.001) and pozitive indirectly by the annual precipitations amount of the previous year (r_{xy}= 0.525±0.256; t_r=2.05; P<0.05).

3. The strenght of bee colonies is negatively and directly influenced by the atmospheric precipitations in April of current year (r_{xy}= -0.564±0.241; t_r=2.34; P<0.05) and indirectly positive by the atmospheric precipitation in December last year (r_{xy}= 0.629±0.214; t_r=2.94; P<0.01).

4. The disease resistance of bee families is influenced negatively and directly by the atmospheric precipitations in January of current year (r_{xy}= -0.712±0.174; t_r=4.09; P<0.001), negative and indirect by the atmospheric precipitation in the month of July previous year (r_{xy}= -0.642±0.208; t_r=3.09; P<0.01) and, positively and indirectly, by the atmospheric precipitation from August last year (r_{xy}= 0.660±0.199; t_r=3.32; P<0.001), as well as by the annual amount of atmospheric precipitations from the previous year (r_{xy}= 0.621±0.215; t_r=2.89; P<0.01).

5. The brood viability is negatively and directly influenced by the January (r_{xy}= -0.557±0.244; t_r=2.28; P<0.05), February (r_{xy}= -0.573±0.237; t_r=2.42; P<0.05) and May atmosferic precipitations precipitations (r_{xy}= -0.491±0.268; t_d=1.83; P<0.1) of current year and, pozitively and indirectly by the atmospheric precipitations in months Octomber (r_{xy}= 0.499±0.265; t_r=1.88; P<0.1) and November (r_{xy}= 0.648±0.205; t_r=3.16; P<0.01) of last year.

6. The production of honey accumulated in the nest by the bee families is negatively and directly influenced by the atmospheric precipitation in February (r_{xy}= -0.797±0.128; t_r=6.23; P<0.001), May (r_{xy}= -0.507±0.262; t_r=1.94; P<0.1) and June (r_{xy}= -0.507±0.263; t_r=1.93; P<0.1) of current year, and, positively and indirectly, by the atmospheric

precipitations in September (r_{xy}= 0.732±0.164; t_r=4.46; P<0.001) and November (r_{xy}= 0.627±0.214; t_d=2.93; P<0.01) of last year.

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