PESTICIDE RESIDUES IN MELLIFEROUS FLOWERS FROM SITES WITH DIVERSE ANTHROPIC IMPACT

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Abstract

The purpose of the research was to assessment of environmental conformity regarding pesticide residues in the flowers of the main melliferous crops in different harvesting sites, with different anthropic impact for the practice of organic apiculture. Scientific research has been carried out on the pesticide residue content of acacia flower samples taken from the forest, apple flowers collected from the industrial orchard and the homegarden of the rural locality, as well as the flowers of sunflower crops from the industrial agricultural field and the homegarden of rural locality. It was established that in the samples of acacia flowers collected from the forest and sunflowers collected from the household garden of the rural locality, have not been registered value detectable residues of the investigated 69 pesticides, which allows us to consider that, organic beekeeping can be practiced in these sites, producing exclusively organic apiculture products. In the samples of apple flowers, collected from the industrial orchard, residues of 26 pesticides from the 69 researches were detected: 5 organophosphorus insecticides, 5 pyrethroid insecticides, 4 neonicotinoid insecticides, 4 triazole fungicides and 4 dicarbosimide fungicides, 2 organochlorine fungicides, 1 organochlorine insecticide and 1 herbicide. Most of the investigated pesticide residues (80.8%) in the apple flower samples collected from the industrial orchard had values below the maximum admissible limit from 2.0% to 238 times. At the same time, at 4 pesticides (5.8%) of the 69 researched in apple flower samples, collected from the industrial orchard, such as Azoxistrobin, Carbendazim-L, Dimetoat and Bitertanol, have average concentrations of residues exceeding the maximum admissible limits, according to EU norms with 40.0-62.5%. In the sunflower samples collected from the industrial agricultural field, detectable levels of residues were recorded in 17 pesticides among the 69 researched, including 6 triazole fungicides, 4 neonicotinoid insecticides, 2 pyrethroid insecticides, 2 dicarbosimide fungicides, 2 herbicides and 1 organophosphorus insecticide. Most of the investigated pesticides (88.2%) in sunflower samples collected from the industrial agricultural field had values below the maximum allowable limits from 12.0% to 114 times. At the same time, 2 pesticides (2.9%) of the 69 researched in the sunflower samples collected from the industrial agricultural field, such as Pendimethalin and Petoxamid, had slightly pollutant concentrations, exceeding the maximum admissible limit, according to the national and EU norms, with 7,0 - 20.0%. Based on the obtained results, it was concluded that, the apple orchard flowers and sunflower in the industrial agricultural field, in great majority (except in some cases), do not contain pollutant concentrations of pesticide residues. In any event, in order to protect the health of bee families and to ensure the safety of apiculture products, it is recomended previous testing of industrial orchard apple flowers and of sunflowers of industrial agricultural field to the residues of the most widely used pesticides.

Key words: residues, pesticides, flowers, organic beekeeping

INTRODUCTION

Innocuous bee products (honey, pollen) are increasingly demanding, both on the home and on the international market. Honey from the Republic of Moldova is the only product of animal origin accepted for export to the European Union. Annually, over 5.0 thousand tons of honey, including 3.5 thousand tons in the EU, worth more than 17 million USD, are exported in increasing quantities. This is possible due to the production of harmless apiculture products in several areas and sites of the country. At the same time, some internationally accredited laboratories identify some residues of inadmissible substances (antibiotics, pesticides) in some honey destined

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for export, leading to the rejection of export requests. In order to avoid deadlock situation of export and development of this branch beekeeping, beekeepers need healthy and strong bee families, as well as a harmless melliferous base. In this respect, environmental pollution with pesticide residues presents a real obstacle both in the development of organic beekeeping and in the conservation of the biological diversity of pollinators.

Particular concern, both in Europe and around the world, has, in the last few years, especially the systemic pesticides that are used in agriculture to treat seeds and spraying crops to combat harmful insects and weeds. According to information "Beyond Pesticides" (international scientific organization in the USA) [12], neonicotinoid pesticides are neurotoxic, have deleterious effects on reproduction and are mutagens for insects, birds, fish, freshwater snails, earthworms, dragonflies, mosquitoes, as well as vertebrates, noting that "*neonicotinoids could represent the new ecological disaster, being a threat to nature*." The World Health Organization (WHO) and the International Agency for Research on Cancer (IARC) announced in March 2015 that some herbicides (*Glifosat*) are carcinogenic and have negative effects on the endocrine system [13]. Residues of these herbicides can be found in the urine and blood of animals as well as humans [14]. Harmful effects of systemic pesticides are confirmed by a large number of researchers [1, 5-7, 11, 18, 19, 21, 22, 24, 26].

Insecticides in small doses also act on non-target insects, including pollinators. Although the relative role of insecticides in the overall decline of pollinators remains little studied, it is now evident that certain insecticides cause negative effects on the health of pollinating insects, both individually and at the colony level [9, 10, 25].

Some neonicotinoid insecticides, which act systematically, are applied directly to the seeds, to protect them from the moment of planting. When the seeds begin to germinate and grow, neonicotinoids are distributed in the stem and leaves of the plants, finally reaching the water released by the gutting process (drops of water produced by the sprout at the top of the young leaves). Bees often drink these drops, thus becoming exposed to these substances [8].

Some beekeepers report the mass mortality of bee families in the apiculture season, where only 10 families from the 54 bee families existing in the spring, after the active period, came to wintering. The author considers that the main cause of the depopulation phenomenon is the application in agriculture of neonicotinoid pesticides, which act negatively on the cerebral neuronal node of the bees, causing disturbances of the orientation system, losing the ability to return to their nest [28].

Regarding the harmful impact of *Imidacloprid* neonicotinoid, devastating effects have been observed, even on the development of bumble-bee colonies, especially on queens. It was found that bumble-bee who consumed food contaminated with *Imidacloprid* had a lower growth rate and as a result their colonies were smaller by 8-12%. The number of queens in a contaminated colony was 1-2 individs, compared with 14 individs in not exposed to pesticide colonies [25].

It has also been demonstrated that neonicotinoid *Imidacloprid* at low concentrations affects feed-seeking bees, causing delays in pickup flights and major losses when bees were exposed to sublethal doses of this pesticide [27].

Green-Peace International, a global non-governmental environmental organization, consider that eliminating the exposure of pollinators to pesticides listed above is a crucial step towards protecting them, as well as the ecological value of natural pollination. In addition, the expansion of integrated (biological) pest control and organic beekeeping systems, particularly in Europe, demonstrates that pesticide-free agriculture is entirely feasible, economically and environmentally safe [4].

Another study reported that a common neonicotinoid, *Thiacloprid*, becomes more toxic about 2 times for honey bees when used in combination with *Propiconazole*, and 3 times more toxic in combination with *Trifumizole* [15].

A report by the European Food Safety Authority (EFSA) has shown that there is significant synergy between fungicides, neonicotinoid and pyrethroid insecticides as well as *Flumethrin*, *Coumaphos* and *Fluvalinate* acaricides [23].

Along with interactions between different pesticides, insecticides have also shown interaction with other stress factors, such as parasitic infestations. For example, honey bee mortality was higher in those infested with *Nozema* parasite, and synergistic interaction between the two factors was found to reduce enzyme activity related to sterilization of colony food [1].

The scientific opinion argues that farming carried out in parallel with the maintenance of an increased biodiversity and without the application of any pesticide or chemical fertilizer, such as organic or organic farming methods, has repeatedly shown that it has benefits from the point of view of abundants of pollinators and pollination of agricultural crops, increasing the realization of the productive potential and expressing both the quantity and quality of production [2].

Organic and ecologyc farming systems can produce about the same amount of food and the same profits as conventional farming, while generating much less social and environmental damage [4].

The practice of organic beekeeping in the Republic of Moldova is problematic due to the poor association of both agricultural and beekeepers who can not influence the limitation of the massive application of pesticides and chemical fertilizers in agriculture. In the absence of sustainable crop pollination contracts as well as innovative collaboration with the scientific institutions, beekeepers do not have objective information on the degree of pesticide pollution of the areas of harvesting, in particular, about melliferous flora from sites with emphasized anthropic impact.

In this context, the purpose of the research was the assessment of environmental conformity regarding pesticide residues in the flowers of the main melliferous crops in different harvesting sites with different anthropic impact for the practice of organic apiculture.

MATERIAL AND METHODS

Scientific research has been directed to determine the pesticide residue content of melliferous flower samples, collected from sites with different anthropic impact. Given that organic apiculture is based on pure (unpolluted) melliferous flora of the main picking cultures, from which nectar and pollen are accumulated, we have researched the flowers of the white acacia (*Robinia pseudoacacia*), apple (*Malus domestica L.*) and sunflower (*Helianthus annnuus L.*). Flower samples were collected from 5 sites: acacia wood, apple industrial orchard, apple tree garden, sunflower industrial sunflower, and sunflower house garden. From each mentioned above site, 5 samples of flowers were collected from different places of different plants of the same species. In total, 25 samples of flowers of the honey plants were analyzed. The samples of acacia flowers were collected from the Ghidighici Silvic District, Canton no. 8, located 25 km northwest of mun. Chisinau. Samples of apple flowers were collected from an industrial orchard of a limited liability company from Calarasi district, as well as from the household from village of Rassvet, whoses name, at the request of the owners, remains confidential. The sunflower samples were collected from an industrial agricultural field of a limited liability company from Rezina district and from the household from Tarasova village, the owners of its also requested to remain confidential. The samples taken were packed in plastic bags and transported on the same day to the laboratory, according to the sanitary-veterinary norms on the methodology for sampling, processing, packaging and transport of samples for laboratory examinations [17].

Flower samples were analyzed for residue content of the 69 most common pesticides, including: 15 organophosphorus insecticides (*Acetoclor, Azoxistrobin, Carbendazim - A, Carbendazim – L, Clorpirifos, Diazinon, Diclorvos, Dimetomorf, Dimetoat, Ethion, Fosalon, Kresoxim-metil, Malation, Pirimifos-metil, Profenofos*), 7 pyrethroid insecticides (*Bifentrin, Ciflutrin, Cipermetrin, Deltametrin, Fenvaleratand, Lamda-Ghalotrin, Tau-fluvalinat)*, 7 organochlorine insecticides (*Endosulfan, Fipronil, Haloxifop, Suma HCH, Indoxacarb,* *Pirimicarb, Spirodiclofen*), 5 neonicotinoid insecticides (*Acetamiprid, Imidacloprid, Tiametoxam, Clotianidin, Tiacloprid*), 13 triazole fungicides (*Bitertanol, Bromuconazol, Ciproconazol, Difenoconazol, Diniconazol, Epoxiconazol, Flutriafol, Penconazol, Propiconazol, Tebuconazol, Triadimefon, Fenhexamid, Proticonazol*), 10 dicarbosimide fungicides (*Captan, Ciprodinil, Clorotalonil, Folpet, Pirimetanil, Procimidon, Spiroxamină, Vindozolin, Cletodim, Trifloxistrobin*), 3 fungicide organochlorine (*Boscalid, Imazalil, Iprodion*), 4 acaricides (*Clorbenzilat, Tetradifon, Tetraconazol, Tetradifon*) și 5 herbicides (*Pendimetalin, Picoxistrobin, Prometrin, Propargit, Petoxamid*).

The pesticide residues in the above-mentioned melliferous flower samples were determined on the same day in the accredited Laboratory for Pesticide Residue Determination of the State Enterprise "National Center for Verification and Certification of Vegetable and Soil Production" by Gas Chromatography - Mass Spectrometry (GC-MS) and Liquid Chromatography - Mass Spectrometry (LC-MS) methods, described by Lazari I. (2000) in the Standard Methods Collection [16].

The obtained results were compared with the maximum residue level (MRL) values according to the Sanitary Regulation on the Maximum Allowable Residue Levels of Phytosanitary Products in or on Food or Feed of Plant and Animal Origin for Animals, approved by the Decision of Government of Republic of Moldova no. 1191 of 23.12.2010 [20], adjusted to EU requirements.

Data obtained as a result of comparisons of two variables and their differences were statistically processed using computer software "STATISTICA - 6" and evaluated their certainty, according to variation biometric statistics, by methods of Плохинский Н.А. (1989).

RESULTS AND DISCUSSIONS

Laboratory analysis data showed that in all samples of acacia flowers collected from the forest and sunflower collection collected from the household garden of the rural locality have not been registered detectable value pesticide residues were found from the 69 researched. For comparison, we note that, according to our previous research [3] carried out in another forest site (Canton No. 9), have been registered detectable value residues of 14 pesticides were recorded in white acacia, including: 3 pyrethroid insecticides (*Cipermetrin, Deltametrin, Piretrin*), 1 neonicotinoid insecticides (*Clotianidin*), 1 organophosphorus insecticides (*Fenamifos*), 4 triazole fungicides (*Difenoconazol, Fenhexamid, Mepanipirim, Ciprodinil), 4* herbicides *(Amidosulfuron, Amitrol, Glifosat, Sulfosulfurol)* and 1 acaricide (*Fipronil*). However, detected concentrations of pesticide residues were below the maximum allowable limits according to national and EU standards.

In the samples of apple flowers, collected from the trees of the rural gardens, only one sample a detectable value of a single pesticide was recorded - *Imidacloprid*, which is a neonicotinoid insecticide. The concentration of this insecticide in the apple flower sample was 0.02 mg/kg, being less than 5 times to the maximum admissible limit (LMA = 0.1 mg/kg), according to the EU and national norms of the Republic of Moldova in this field [20]. Based on the obtained results, we can say that the white acacia honeyflowers collected from the forest site (in our case, the Silvic District Ghidighici, Canton No. 8), as well as the apple and sunflower flowers collected from the housegarden site of rural areas, do not contain pesticide residues that could affect the health of pollinating insects and the vital activity of bee families located in those places. Therefore, ecological beekeeping can be practiced in these sites with the production of exclusively organic bee products.

An entirely different situation, regarding pesticide residues, is in the samples of apple blossoms collected from the industrial orchard (Tab. 1).

Table 1 The content of pesticide residues in the apple flower samples collected from the industrial orchard (N=5), mg/kg

Pesticide name	LMA	M ± m	d (M - LMA)	d, % to LMA
Organophosphorus insecticides				
Azoxistrobin	0.05	0.072 ± 0.016	+0.022	44.0
Carbendazim-A	0.2	0.155 ± 0.017	-0.045	22.5
Carbendazim-L	0.2	0.325 ± 0.144	+0.125	62.5
Clorpirifos	0.5	0.061 ± 0.021	-0.439	87.8
Dimetoat	0.02	0.031 ± 0.002	+0.011***	55.0
Pirethroid insecticides				
Bifentrin	0.3	0.079 ± 0.009	-0.221	73.7
Cipermetrin	1.0	0.192 ± 0.010	-0.808	80.8
Deltametrin	0.2	0.163 ± 0.030	-0.037	18.5
Lambda-Ghalotrin	0.1	0.086 ± 0.029	-0.014	14.0
Tau-fluvalinat	0.1	0.100 ± 0.007	0.0	0.0
Organochlorine insecticides				
Spirodiclofen	0.05	0.049 ± 0.005	-0.001	2.0
Neonicotinoid insecticides				
Acetamiprid	0.8	0.013 ± 0.003	-0.787	98.4
Imidacloprid	0.1	0.098 ± 0.014	-0.002	2.0
Tiametoxam	0.5	0.005 ± 0.002	-0.495	99.0
Tiacloprid	0.05	0.041 ± 0.007	-0.009	18.0
Triazole fungicides				
Bitertanol	0.01	0.014 ± 0.003	+0.004	40.0
Diniconazol	0.1	0.011 ± 0.008	-0.089	89.0
Tebuconazol	1.0	0.692 ± 0.119	-0.308	30.8
Tiadimefon	0.2	0.174 ± 0.024	-0.026	13.0
Dicarbosimide fungicides				
Ciprodinil	1.0	0.085 ± 0.014	-0.915	91.5
Clorotalonil	1.0	0.012 ± 0.009	-0.988	98.8
Pirimetanil	5.0	0.021 ± 0.012	-4.979	99.6
Spiroxamină	0.05	0.038 ± 0.022	-0.012	24.0
Organochlorine fungicides				
Boscalid	2.0	0.141 ± 0.059	-1.859	93.0
Iprodion	5.0	0.256 ± 0.102	-4.744	94.9
Herbicides				
Clorprofan	0.01	0.006 ± 0.003	-0.004	40.0

*Note: *** - P < 0.001*

Of the 69 investigated, detectable residue concentrations were recorded at 26 pesticides. In all analyzed samples (100%), detectable residues of 18 pesticides were recorded (*Azoxistrobin, Bifentrin, Boscalid, Carbendazim-A, Carbendazim-L, Cipermetrin, Ciprodinil, Clorpirifos, Deltametrin, Dimetoat, Imidacloprid, Iprodion, Lambda-Galotrin, Spirodiclofen, Tau-fluvalinat, Tebuconazol, Tiacloprid and Tiadimefon*), which represents 26.1% of the total of the investigated pesticides.

The most common detectable levels of residues were recorded in organophosphorus insecticides with medium concentrations from 0.031±0.002 to 0.325±0.144 mg/kg, pyrethroid insecticides with medium concentrations from 0.079 ± 0.009 to 0.192 ± 0.010 mg/kg, insecticides neonicotinoids with average concentrations from 0.005±0.002 to 0.098±0.014 mg/kg, triazole fungicides with mean concentrations from 0.011±0.008 to 0.692±0.19 mg/kg and dicarbosimide fungicides with medium concentrations from 0.012±0.009 to 0.085±0,014 mg/kg. Less spread are organochlorine fungicides with average concentrations from 0.141±0.059 to 0.256±0.102 mg/kg, organochlorine insecticides with average concentrations of 0.049±0.005 mg/kg and herbicides at concentrations of 0.006±0.003 mg/kg.

Thus, we can say that of investigated by us pesticides, these 18 pesticides, detected in all analyzed samples, are the most widespread and most applied by the cultivators to the treatment of apple orchards. Besides, detectable values of neonicotinoid insecticide - *Acetamiprid* and triazole fungicide - *Bitertanol* were detected in 80% of the analyzed samples of apple flowers collected from the industrial orchard, in 40% of the samples were recorded residues of dicarbosimide fungicides - *Pirimetanil* and *Spiroxamine*, and pyrethroid insecticide - *Deltamethrin* and herbicide - *Chlorprofan* were detected in 20% of samples.

At the same time, it was found that most detected pesticide residue concentrations had values below the maximum admissible limit for 21 pesticides of the 26 detected, which is 80.8%. The average residue concentration of these pesticides was lower compared to the maximum admissible limit for *Spirodiclofen* and *Imidacloprid* with 2.0%, and up to 238 times for *Pirimetanil*. Thus, on the basis of these results, we can say that the industrial apple orchard flowers in great majority (except some cases) do not contain pollutant concentrations of pesticide residues. Only 4 pesticides, out of 69 studied (representing 5.8%), have average residue values exceeding the maximum admissible limit, according to EU rules. Among these are 3 organophosphorus insecticides (*Azoxistrobin, Carbendazim-L, Dimetoat*) and 1 triazole fungicide (*Bitertanol*), the average concentration of which exceeds the maximum admissible limit of 40.0-62.5%, of which only *Dimethoxylate* insecticide exceeds is significant (td = 5.5; P <0.001). One of the investigated pesticides (*Tau-fluvalinate*) in apple flowers, collected from the industrial orchard, recorded an average concentration at the critical level of the maximum admissible limit (0.100±0.007 mg/kg).

Therefore, based on theobtained results, we can say that in some industrial apple orchards in the country there is a danger of polluting the melliferous flora with some organophosphoric and neonicotinoid insecticides, as well as some triazole fungicides.

In this context, in order to protect the health of the bee families to be located at the pollination of apple orchards, as well as to ensure the harmlessness of the obtained apiculture products, it is recommended to test the apple tree in that orchard for the residues of the most widely used 18 pesticides above mentioned (insecticides and fungicides).

A less offensive situation regarding the presence of pesticide residues is observed in sunflower crops harvested from the industrial field. (Tab. 2).

According to the research, in the sunflower samples collected from the industrial agricultural field, detectable levels of residues of 17 pesticides from the 69 researches were recorded. Of these, residues of 14 pesticides were detected in all (100%) samples analyzed, 1 pesticide was detected in 80% of the analyzed samples and 2 pesticides were detected in 60% of the analyzed samples.

The most common pesticides in the sunflower samples collected from this site were triazole fungicides (*Bromuconazole, Ciproconazole, Fenhexamid, Proticonazole, Tebuconazole, Tetraconazole*) detected in concentrations from 0.017±0.002 mg/kg to *Proticonazole,* up to 0.080 ± 0.019 mg/kg to *Fenhexamid*; neonicotinoid insecticides (*Acetamiprid, Imidacloprid, Tiametoxam, Tiacloprid*) detected in concentrations from 0.007±0.001 mg/kg to *Acetamiprid* to 0.063±0.017 mg/kg for *Imidacloprid;* dicarbosimide fungicides (*Cletodim, Trifloxistrobin*) recorded in concentrations of 0.380±0.088 and 0.039±0.008 mg/kg respectively; pyrethroid insecticides (*Deltamethrin, Lambda-Ghalotrin*) detected at concentrations of 0.050±0.001 and 0.054±0.002 mg/kg respectively; the herbicides (*Pendimethalin, Petoxamid*) of 0.107±0.011 and 0.012±0.001 mg/kg respectively; and the organo-phosphorus insecticide *Carbendazim-A* detected in the concentration of 0.076±0.011 mg/kg.

Table 2 The content of pesticide residues in the sunflower, collected from the industrial field (N=5), mg/kg

Pesticide name	LMA	M ± m	d (M - LMA)	d. % to LMA
Organophosphorus insecticides				
Carbendazim-A	0.2	0.076 ± 0.011	-0.124	62.0
Pirethroid insecticides				
Deltametrin	0.2	0.050 ± 0.001	-0.15	75.0
Lambda-Ghalotrin	0.1	0.054 ± 0.002	-0.046	46.0
Neonicotinoid insecticides				
Acetamiprid	0.8	0.007 ± 0.001	-0.793	99.1
Imidacloprid	0.1	0.063 ± 0.017	-0.037	37.0
Tiametoxam	0.5	0.032 ± 0.007	-0.468	93.6
Tiacloprid	0.05	0.036 ± 0.008	-0.014	28.0
Triazole fungicides				
Bromuconazol	0.05	0.025 ± 0.011	-0.025	50.0
Ciproconazol	0.05	0.044 ± 0.010	-0.006	12.0
Fenhexamid	0.1	0.080 ± 0.019	-0.02	20.0
Proticonazol	0.02	0.017 ± 0.002	-0.003	15.0
Tebuconazol	1.0	0.046 ± 0.008	-0.954	95.4
Tetraconazol	0.05	0.035 ± 0.007	-0.015	30.0
Dicarbosimide fungicides				
Cletodim	0.5	0.380 ± 0.088	-0.12	24.0
Trifloxistrobin	0.05	0.039 ± 0.008	-0.011	22.0
Herbicides				
Pendimetalin	0.1	0.107 ± 0.011	+0.007	7.0
Petoxamid	0.01	0.012 ± 0.001	+0.002*	20.0

*Note: * - P < 0.05*

We note that slightly pollutant concentrations exceeding the maximum admissible limit according to national and EU norms were recorded only on the residues of the two *Pendimethalin* and *Petoxamid* herbicides whose value was slightly above the LMA by 7.0 and 20.0%, of which only the difference to the last pesticide was significant (td = 2.0; P <0.05) the one threshold of the prediction probability theory without error after Student [29].

In rest, residue concentrations of the other detected 15 pesticides were well below the maximum allowable limits, according to national and EU standards. The concentration of these pesticides was lower compared to EU standards, to the Carbendazim-A organophosphorus insecticide of 2.6 times, to the pyrethroid insecticides 1.8 - 4.0 times, to the neonicotinoid insecticides of 1.4-114.0 or triazolic fungicides of 1.4-114.3 times, at dicarbosimide fugicides of 1.28-1.31 times. Therefore, analyzing the results of the researches on the residues of the most widely spread pesticides in the sunflower collected in the industrial agricultural field, we can say that in this site the sunflowers are, generally, not polluted with pesticides, except of some herbicides.

In this context, in order to protect the health of the bee families to be located in the harvesting and pollination of the sunflower, as well as to ensure the harmlessness of the apiculture products expected to be obtained, it is recommended to test the sunflower, collected from the respective field, to the residue content of the most spread 17 up-nominated pesticides (herbicides, fungicides and insecticides).

CONCLUSIONS

1. In the samples of acacia flowers collected from the forest and sunflowers collected from the household garden of the rural locality, there were no detectable residues of the investigated 69 pesticides, which allows us to consider that, organic beekeeping can be practiced in these sites, producing exclusively organic apiculture products.

2. In the samples of apple flowers, collected from the industrial orchard, residues of 26 pesticides from the 69

researches were detected. The most common detectable pesticide residues were found in: 5 organophosphorus insecticides, 5 pyrethroid insecticides, 4 neonicotinoid insecticides, 4 triazole fungicides and 4 dicarbosimide fungicides. Less widespread are organochlorine fungicides, organochlorine insecticides and herbicides.

3. Most of the investigated pesticide residues (80.8%) in the apple flower samples collected from the industrial orchard had values below the maximum admissible limit from 2.0% to 238 times. Thus, on the basis of these results, we can say that the apple orchard flowers, in great majority (except in some cases), do not contain pollutant concentrations of pesticide residues.

4. At the same time, 4 pesticides (5.8%) of the 69 researched in apple flower samples, collected from the industrial orchard, including 3 organophosphorus insecticides (*Azoxistrobin, Carbendazim-L, Dimetoat*) and 1 triazole fungicide (*Bitertanol*), average values of residues exceeding the maximum admissible limit by 40.0-62.5%, according to EU, norms were recorded.

5. In the sunflower samples collected from the industrial agricultural field, detectable levels of residues were recorded in 17 pesticides among the 69 researches. The most widespread pesticides, in which detectable residue levels were found, were 6 triazole fungicides and 4 neonicotinoid insecticides. Less common were pyrethroid insecticides, dicarbosimide fungicides and herbicides.

6. Most of the investigated pesticides (88.2%) in sunflower samples collected from the industrial agricultural field had values below the maximum allowable limits from 12.0% to 114 times. Thus, we can say that the sunflower in the industrial agricultural field, in great majority (except for some cases), does not contain pollutant concentrations of pesticide residues.

7. At the same time, 2 pesticides (2.9%) of the 69 researched in the sunflower samples collected from the industrial agricultural field, had slightly pollutant concentrations, exceeding the maximum admissible limit, according to the national and EU norms, with 7.0 - 20.0%.

8. In order to protect the health of the bee families to be located in the harvesting and pollination of apple orchards and sunflower fields, as well as to ensure the harmlessness of the expected to be obtained apiculture products, it is recomended to analyze the residue content of the most widespread up-nominated pesticides in flowers of respective plantations.

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