CONFORMITY OF LAVENDER FLOWERS AND SUNFLOWER ON PESTICIDE RESIDUES FOR ORGANIC BEEKEEPING

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Abstract

The purpose of this scientific paper was to investigate the conformity of lavender and sunflower flowers in industrial agricultural fields, on the content of pesticide residues, for the practice of organic beekeeping. Scientific research was conducted in the Beekeeping Laboratory of the Institute of Zoology of the Academy of Sciences of the Republic of Moldova. In order to assess the conformity of honey flowers, regarding the content of pesticide residues, in order to practice organic beekeeping, lavender flowers (Lavandula angustifolia) and sunflower (Helianthus annuus) collected from industrial agricultural fields were researched. The results of the research showed that the site (field) with flowering lavender, researched by us, is compliant, in terms of pesticide residue content in the flowers of this etheric crop, and can be used for beekeeping and obtaining organic bee products, because neither in one of the flower samples tested did not detect any detectable residue concentrations of the 63 pesticides investigated. Based on this research we can predict that other lavender fields could be suitable for organic beekeeping, because the treatment of this etheric agricultural crop uses a small number of pesticides with low frequency of treatment. The site (field) with sunflower, researched by us, was heavily polluted with residues of some dangerous pesticides (Tiametoxam) in concentrations that exceed the MPL of EU norms by 82%.Therefore, the sunflower field is considered unsuitable for organic beekeeping and poses a danger of intoxication for both pollinators, especially honey bees and humans. Based on these, as well as other previous research, we can predict that other sunflower fields can be polluted with pesticide residues, being unsuitable for organic beekeeping, because in the treatment of this oily crop is often used a string of systemic pesticides.

Key words: conformity, lavender, sunflower, residues, pesticides, organic beekeeping

INTRODUCTION

Organic beekeeping provides the provision of bee families with sources of harvesting (nectar, pollen) organically from honey plants grown or cultivated in ecological conditions. This is one of the mandatory conditions laid down in the Law on Organic Agricultural Production [12]. To ensure these conditions, bee families are placed stationary or harvested in areas (areas) where the honey flora is unpolluted for bees within a radius of at least 3-5 km.

In our country, some agricultural producers, as well as some beekeepers, so far, have not realized that the uncontrolled use of pesticides in the treatment of agricultural crops and honey bees has an unbalanced impact on the homeostasis of natural ecosystems, with final consequences. reducing biodiversity and the safety of bee health, contaminating agricultural and bee products, and affecting human health.

Of particular concern, both in Europe and around the world, has recently been the main concern of systemic pesticides, which are used in agriculture to treat seeds and spray crops to control harmful insects, fungi and weeds.

According to an international scientific organization in the United States, Beyond Pesticides, neonicotinoid pesticides have neurotoxic, reproductive and mutagenic harmful effects on insects, birds, fish, freshwater snails, earthworms, dragonflies, mosquitoes, and vertebrates. is that "*neonicotinoids could represent the new*

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contemporary ecological disaster, being a threat to nature" [8].The World Health Organization (WHO) and the International Agency for Research on Carcinogens announced in March 2015 that some herbicides (*Glyphosate*) are carcinogenic with a harmful impact on the endocrine system [4]. Residues of these herbicides can be found in the urine and blood of animals as well as humans [9]. The harmful effects of systemic pesticides are confirmed by a number of researchers [1, 5, 6, 7, 14, 15, 19, 20, 21, 22].

According to some sources of information [7], some pesticides, such as the organochlorine insecticide *Fipronil*, are the components of the main chemical factors that spread the collapse disorders of bee colonies. Several researchers [1, 14, 15] have shown that there is a synergism of additive action when pesticides are applied in combination. For example, the neonicotinoid *Tiacloprid*, becomes about twice as toxic to honey bees when used in combination with the fungicide *Propiconazole,* and three times more toxic - in combination with *Trifumizole* [14].Other research has shown that there is a significant synergy between fungicides, neonicotinoid and pyrethroid insecticides, as well as the acaricides *Flumetrin, Cumafos* and *Fluvalinat* [15]. Along with the interactions of different pesticides, insecticides also show a synergism with other stressors, such as parasite infestations. For example, honey bee mortality was higher in those infested with the *Nozema* parasite and a synergistic interaction of factors was found, which reduce the enzymatic activity related to the sterilization of colony food [1, 15].

The EU Pollinator Initiative [10] defines the causes leading to the decline of pollinators, including the uncontrolled use of pesticides (insecticides, herbicides), in particular those restricted by EU bodies.

According to a report by MIEPO (Moldavian Investment and Export Promotion Organization), the purchase price of BIO (organic) honey is currently 90% higher than that of regular honey [16]. This is why beekeepers massively want to practice the BIO beekeeping system, but, unaware of the conditions and legislation of organic farming, apply the outdated technologies they know, activating in the traditional beekeeping system and thus the production obtained is not recognized as BIO, and its harvest decreases significantly. Therefore, the specific technologies of the organic beekeeping system absolutely require deep study in order to be used. It is necessary to know the anthropogenic impact caused by industrialization and intensification of agriculture, the most common pollutants, their distribution areas and the degree of pollution with residues (their concentration in environmental resources), which can affect both honeybees and main entomophilous pollinator, as well as the production obtained from them.

Based on this synthetic analysis of bibliographic information we can see that the assessment of the degree of pollution with pesticide residues of flowers of honey plants in areas expected for the location of bee families for harvesting or stationary and identification of ecological areas (sites, fields) suitable for beekeeping organic, is becoming a particularly important current issue.

In this context, the purpose of this scientific paper was to investigate the conformity of lavender and sunflower flowers in industrial agricultural fields, on the content of pesticide residues, for the practice of organic beekeeping.

MATERIALS AND METHODS

Scientific research was conducted in the Beekeeping Laboratory of the Institute of Zoology of the Academy of Sciences of the Republic of Moldova. In order to assess the conformity of the honey flora, regarding the content of pesticide residues, in order to practice organic beekeeping, lavender flowers (*Lavandula angustifolia*) and sunflower (*Helianthus annuus*) collected from industrial agricultural fields were researched. The flower samples of the lavender culture were taken from an industrial chain of an agricultural household from Râşcani district, which wanted to remain confidential. Samples of flowering sunflower crops were taken, at the request of a beekeeper, from an industrial chain of an agricultural household in the Ceadir-Lunga district, which was suspected of being contaminated with pesticides. Both the beekeeper and the sunflower grower also wanted to remain confidential.

In order to determine the pesticide residues, 5 flower samples were taken from the above-mentioned honey plants, cultivated in the respective industrial agricultural fields. For the sampling of flowers, each agricultural field was virtually divided into 5 equal parts, from the middle of each being sampled a flower. Each sample weighed at least 100g of flowers. The samples were packed in plastic bags and transported on the same day to the accredited laboratory of the State Enterprise "Center for Applied Metrology and Certification", in accordance with the Sanitary-Veterinary Norm on the methodology of sampling, processing, packaging and transport of samples laboratory examinations [13].

Each sample of floristic material taken was tested for the content of the most dangerous pesticide residues (63 names) more common in our country (Tab. 1).

Table 1 Names of pesticides tested for residue content in flower samples taken

No /o	Name pesticide and pesticide group	No /o	Name pesticide and pesticide group	No /o	Name pesticide and pesticide group
Neonicotinoid insecticides		22	*Malation*	44	*Kresoxim-metil*
1	*Acetamipirid*	23	*Permetrin*	45	*Benzanton*
2	*Chlothianidin*	24	*Pirimitos-metil*	**Dicarboximide fungicides**	
3	*Imidacloprid*	25	*Protenotos*	46	*Captan NIM*
4	*Thiacloprid*	**Carboxylic insecticides**		47	*Ciprodinil*
5	*Tiametoxam*	26	*Fenixicarb*	48	*Clorotalonil*
Pyrethroid insecticide		27	*Fipronil*	49	*Dimetomorf*
6	*Bifentrin*	28	*Indoxacarb*	50	*Folpet NM*
7	*Ciflutrin*	29	*Pirinicarb*	51	*Iprodion*
8	*Cipermetrin*	**Triazole fungicides**		52	*Procimidon*
9	*Deltametrin*	30	*Azoxistrobin*	53	*Spiroxamină*
10	*Fenvalerat*	31	*Bitertanol*	54	*Vindozolin*
11	*Lambda-Ghalotrin*	32	*Bromuconazol*	55	*Pirimetanil*
12	*Tau-fluvalinat*	33	*Ciproconazol*	**Herbicides**	
Organochlorine insecticides		34	*Difenoconazol*	56	*Haloxifop*
13	*Clorpirifos*	35	*Diniconazol*	57	*Glifosat*
14	*Endosulfan*	36	*Epoxiconazol*	58	*Pendimetalin*
15	*HCH izomeri*	37	*Flutriafol*	59	*Prometrin*
Organophosphorus insecticides		38	*Penconazol*	60	*Trifluralin*
16	*Diazinon*	39	*Picoxistrobin*		**Acaricides**
17	*Diclorvos*	40	*Propiconazol*	61	*Lufenuron*
18	*Dimetoat*	41	*Tebuconazol*	62	*Piridaben*
19	*Ethion*	42	*Tiadimeton*	63	*Propargit*
20	*Fenitrotion*	**Carboxylic fungicides**			
21	*Fosalon*	43	*Boscalid*		

The tests were performed by gas-chromatography-mass-spectrometric (GC-MS) and liquid-chromatography-mass-spectrometric (LC-MS) methods, described by LAZĂRI I. (2000) in the Collections of MS Standard Methods [11].

The test results, regarding the content of pesticide residues in the investigated samples, were compared with the rules of maximum permissible limits (MPL), according to the Sanitary Regulation on maximum permissible residue limits of plant protection products from / or on food and feed of plant origin and animal for animals, approved by the Decision of the Government of the Republic of Moldova no. 1191 of 23.12.2010 [17], adjusted to EU norms. As a result of the comparison, conclusions were made regarding the compliance of the environment of the respective sites for the practice of organic beekeeping.

If the concentration of residues of any pesticide exceeds the maximum permissible limit (MPL), according to EU rules, the flower sample was considered contaminated. According to some of our elaborations, depending on the size of exceeding the MPL level of the residue concentration of a pesticide in flowers, the degree of pollution was classified into three categories: slightly polluted - if the residue concentration exceeded the MPL by up to 20 %, polluted medium - if the concentration of residues exceeded the MPL from 20 to 50% and heavily polluted - if the concentration of residues exceeded the MPL by more than 50% [3].

The data obtained as a result of the research were statistically processed using the computer software "STATISTICS - 12" and their certainty was assessed, according to the biometric variational statistics, according to the methods of Плохинский Н.А., 1989 [23].

RESULTS AND DISCUSSIONS

Content of pesticide residues in lavender flowers (*Lavandula angustifolia*).

Lavender is a multi-annual, entomophilous agricultural crop, from which the essential oil of special perfumery is obtained and is requested both on the domestic market and for export. The lavender plant is widely used for therapeutic purposes in health resorts, as well as in the pharmaceutical industry. Lavender is a perennial honey crop from which, during the harvest period, essential amounts of nectar and pollen are obtained. It is important for beekeepers to know the conformity of the plantations of this crop, regarding the content of pesticide residues, in order to obtain organic bee products.

To date, no research has been conducted in the Republic of Moldova on the content of pesticide residues in lavender flowers.

The results of the laboratory tests of the 5 samples of lavender flowers, taken by us from an industrial chain, showed that at least the site (chain) of lavender we researched is ecologically clean of residues of the 63 pesticides mentioned above (Tab. 2).

Table 2 Pesticide residue content in lavender flowers, mg / kg

Name of the pesticide group	Results on each test				
	1	2	3	4	5
Neonicotinoid insecticides (5 pesticides)	n.d.*	n.d.	n.d.	n.d.	n.d.
Pyrethroid insecticide (7 pesticides)	n.d.	n.d.	n.d.	n.d.	n.d.
Organochlorine insecticides (3 pesticides)	n.d.	n.d.	n.d.	n.d.	n.d.
Organophosphorus insecticides (10 pesticides)	n.d.	n.d.	n.d.	n.d.	n.d.
Carboxylic insecticides (4 pesticides)	n.d.	n.d.	n.d.	n.d.	n.d.
Triazole fungicides (13 pesticides	n.d.	n.d.	n.d.	n.d.	n.d.
Carboxamide fungicides (3 pesticides)	n.d.	n.d.	n.d.	n.d.	n.d.
Dicarboximide fungicides (10 pesticides)	n.d.	n.d.	n.d.	n.d.	n.d.
Herbicides (5 pesticides)	n.d.	n.d.	n.d.	n.d.	n.d.
Acaricides (3 pesticides)	n.d.	n.d.	n.d.	n.d.	n.d.

Note: n.d. * - undetectable concentration

We would like to mention that we have tried a wide range of pesticides comprising the main groups of pesticides, used in agriculture to treat crops, such as: neonicotinoid insecticides, pyrethroid insecticides, organochlorine insecticides, organophosphorus insecticides, carboxylic acid insecticides, fungicides carboxylic fungicides, dicarboximidic fungicides, herbicides and acaricides.

None of the samples of lavender flowers analyzed on the residue content of the 63 names in the 10 pesticide groups recorded any detectable concentration of pesticide residues. This allows us to conclude that the lavender flowers in the field we are researching are compliant, regarding the content of pesticide residues, and can be used for beekeeping and production of organic bee products.

Based on this research, we can predict that other lavender fields could be suitable for organic beekeeping, because a small number of pesticides with a low frequency of treatment are used to treat this etheric agricultural crop.

The content of pesticide residues in sunflower *(Helianthus annuus)* **flowers.**

A completely different situation, regarding pesticide residues, was recorded in the flowers of the sunflower crop, taken by us from an industrial chain at the request of a beekeeper, who suspected the intoxication of bees caused by pesticides in the sunflower field.

The results of the laboratory tests of the flower samples of the sunflower culture showed that, out of the 63 pesticides investigated, detectable concentrations were recorded for 6 pesticides, which constitutes 9.5% (Tab. 3).

Table 3 Pesticide residue content in sunflower flower samples, mg / kg

Name of the pesticide and the group to which it belongs	MPL (UE)	Results on each test					M ± m
		1	2	3	4	5	
Pyrethroid insecticide							
Cipermetrin	0.2	0.2021*	0.118	0.1113	<0.005	<0.005	0.0883±0.0375
Deltametrin	0.05	0.0397	0.0515*	0.0621*	<0.005	0.0432	0.0403±0.0096
Neonicotinoid insecticides							
Imidacloprid	0.01	0.015**	<0.005	<0.005	0.011*	<0.005	0.0082±0.0021
Tiametoxam	0.01	0.0181***	<0.005	0.0514***	<0.005	0.0115*	0.0182***±0.0086
Triazole fungicides							
Difenoconazol	0.05	0.0173	0.0455	0.0261	<0.005	0.0432	0.0274±0.0077
Carboxylic fungicides							
Fluopiram	0.2	0.1514	0.3184***	0.202*	<0.005	<0.005	0.1363±0.0601
Imazamax	0.02	<0.005	0.0225*	0.0319***	<0.005	0.0115	0.0152±0.0052

Note: * - low pollutant concentration; ** - average pollutant; *** - highly polluting.

These refer to 2 pyrethroid insecticides (*Cypermethrin, Deltamethrin*), 2 neonicotinoid insecticides (*Imidacloprid, Tiamitoxam*) and 2 carboxylic fungicides (*Fluopiram, Imazamax*). The detectable concentration of a flower sample with residues of the triazole fungicide *Diphenoconazole* (0.0455 mg / kg) was quite close to the maximum permissible limit, according to EU standards (0.05 mg / kg). At the same time, in some pesticides, in some sunflower samples, collected from the industrial agricultural chain, slightly polluting concentrations were registered, which exceeded the maximum allowable limit, according to national and EU norms, by 1.1 - 24.2% (at *Cypermethrin* and *Deltamethrin*), polluting media, which exceeded the MPL by 50.0% (for *Imidacloprid*) and highly polluting, which exceeded the MPL by 59.2 - 514% (for *Fluopiram, Imazamax* and *Tiametoxam*).

However, most of the concentrations detected of residues (40-100%) in the sunflower samples, collected from the industrial agricultural chain, had values lower than the maximum allowable limit by 20.6-65.4%. The average residue concentration in most detected pesticides (except for the neonicotinoid insecticide *Tiametoxam*) was below EU standards (AML) by 18.0-56.3%.

We would like to mention that in other previous research of ours similar results were obtained, or less polluting [2]. In the sunflower samples, collected from an industrial agricultural field, detectable concentrations of residues were recorded in 17 of the 69 researched, which was 24.6%. In profile on the pesticide groups, they related to 6 triazole fungicides, 4 neonicotinoid insecticides, 2 pyrethroid insecticides, 1 organophosphorus insecticide, 2 dicarbosimide fungicides and 2 herbicides. In the sunflower samples, collected from the industrial agricultural field of that experiment, in 2 pesticides (*Pendimetalin* and *Petoxamid)* slightly polluting concentrations were recorded, exceeding the MPL, according to national and EU norms, by 7.0 - 20.0%. Based on those results, it was concluded that sunflower flowers in some industrial agricultural fields, in some cases may contain low levels of pollutant residues of some pesticides.

This year's research shows that some flower samples from sunflower crops in some industrial agricultural fields contain residues of dangerous pesticides (*Tiametoxam*) in highly polluting concentrations (0.0514 mg / kg), which exceed the MPL standards by 5.1 times. The average residue concentration of this pesticide in all 5 samples tested was 0.0182 mg / kg, which exceeds the level of MPL standards by 0.0082 mg / kg, or by 82.0%.

From these researches it results that the suspicions of the beekeeper, who requested the inspection of this sunflower field, came true. The results obtained eloquently demonstrate that the intoxication of the bees of this beekeeper was certainly caused by the highly polluting concentration of the residues of the neonicotinoid pesticide *Tiametoxam*.

We would like to mention that the European Union has banned, by EU Regulation no. 485/2013 [18], the use of three neonicotinoid pesticides (*Imidacloprid* - Bayer Crop Science, *Clothianidin* - Takeda Chemical, *Thiametoxam* - Bayier and Syngenta) and the treatment of treated seeds in the treatment of sunflower, rapeseed and maize seeds and plants with these pesticides.

As we can see, in our country the use of these extremely dangerous pesticides continues in the practice of agriculture, especially in the treatment of sunflower seeds. Therefore, for beekeepers who want to practice organic beekeeping, it is particularly important to know the compliance of honey flowers, especially plants in industrial agricultural fields (fields), on pesticide residues. For the placement of bee families at sunflower harvesting, it is recommended that beekeepers ensure the safety of this bee, by previously testing a few (5-7) flower samples on the subject of the residue content of the most dangerous pesticides more often. used by growers to treat this crop.

CONCLUSIONS

1. The site (field) with flowering lavender, researched by us, is conformable, in terms of the content of pesticide residues in the flowers of this etheric crop, and can be used for beekeeping and production of organic bee products.
2. Based on this research we can predict that other lavender fields could be suitable for organic beekeeping, because the treatment of this etheric crop uses a small number of pesticides with low frequency of application of treatments.
3. The site (field) with sunflower, researched by us, is heavily polluted with residues of dangerous pesticides (*Tiametoxam*) in concentrations that exceed the MPL of EU standards by 82%, is non-compliant for organic beekeeping and is at risk of intoxication both for pollinators, especially honey bees, and for humans.
4. Based on these, as well as other previous research, we can predict that other sunflower fields can be polluted with pesticide residues, being unsuitable for organic beekeeping, because in the treatment of this oil crop is often used a series of systemic pesticides.

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