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ОЦІНКА РИЗИКУ ВПЛИВУ БІФЕНТРИНУ НА ЗДОРОВ'Я НАСЕЛЕННЯ ПРИ СПОЖИВАННІ КУКУРУДЗИ, ВИРОЩЕНОЇ ЗА ІННОВАЦІЙНОЮ ТЕХНОЛОГІЄЮ 3RIVE 3D

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RISK ASSESSMENT OF THE BIFENTHRIN INFLUENCE ON THE POPULATION HEALTH WHEN CONSUMING CORN GROWN USING THE INNOVATIVE 3RIVE 3D TECHNOLOGY

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Pesticides are widely used in agriculture to prevent or reduce losses from diseases and pests, which improves yield and product quality. They are an economically beneficial, effective and labor-saving tool for pest control [1].

Despite the short-term advantages of agricultural crops chemical protection, there are long-term disadvantages, such as residues of chemical plant protection agents (CPPs) in crops, increased resistance of target objects, negative effects on non-target organisms, and dangers to the environment and human health [2].

Plants, especially perennial crops, are also capable of accumulation and enzymatic degradation

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Система внесення пестицидів 3RIVE 3D, розроблена FMC і Micro-Trak Systems Inc., дозволяє зменшити кількість використовуваних пестицидів, підвищуючи їхню ефективність. Завдяки запатентованій технології ця інноваційна платформа доставки перетворює традиційну технологію великооб'ємного внесення у малооб'ємну.
***Мета роботи** – оцінка ризику впливу біфентрину на здоров'я населення при споживанні кукурудзи, вирощеної за інноваційною технологією 3RIVE 3D.*
***Матеріали та методи.** Розраховано показники стабільності біфентрину (діючої речовини препарату Брігейд 3Rive 3D, SC) у кукурудзі, вирощеній за інноваційною технологією 3RIVE 3D (внесення у ґрунт з одночасним висівом насіння кукурудзи). Брігейд 3Rive 3D, SC засто-*

of pesticides [3]. An integrated approach to the selection of plant protection methods involves balancing the biological, economic and ecological effectiveness of measures[4].

The study of the dynamics of pesticide content in plants makes it possible to obtain reliable qualitative and quantitative information about the process of pesticide application, considering all experimental points. In addition, such studies make it possible to evaluate the influence of various environmental factors on the behavior of pesticides in plants and to compare the results of studies conducted in different conditions and with different target objects. Based on the obtained data, it is possible to predict the behavior of pesticides in plants with the aim of their effective application, substantiation and development of new ecologically safe plant protection methods, reduction of economic costs for the pesticides application and preservation of public health [5].

The 3RIVE 3D pesticide application system developed by FMC and Micro-Trak Systems Inc. It allows to reduce the amount of pesticides used increasing their effectiveness. This innovative delivery platform converts the traditional high-volume application technology into a low-volume one thanks to the patented technology [6].

The purpose of the work is risk assessment of the bifenthrin influence on the population health when consuming corn grown using the innovative 3RIVE 3D technology.

Materials and methods. We calculated the stability indices of bifenthrin (the active ingredient of the Brigade 3Rive 3D, SC formulation) in corn grown using the innovative 3RIVE 3D technology (introduction into the soil with simultaneous sowing of corn seeds). Brigade 3Rive 3D, SC is used as an insecticide on corn crops with a maximum consumption rate of 1.2 l/ha, once.

Bifenthrin behavior was studied in natural experiment with selection of plant samples according to [7] starting from the first day of treatment, and subsequently at regular intervals during the vegetation period of the crop until harvesting. The study of the bifenthrin residual amounts dynamics in the green mass of plants and corn seeds was carried out by the chromatographic method in accordance with [8]. Control samples were taken from untreated corn crops.

The destruction rate constants (K) and quantitative stability parameters (τ_{50}, τ_{95}, τ_{99}) were calculated using regression analysis methods based on the actual levels of bifenthrin content in the green mass and corn seeds [9]. The results of bifenthrin persistency in plants studies were evaluated according to State Standard 8.8.1.002-98 [10].

At the final stage, the integral index of hazard when consuming pesticides contaminated food products (IIHCPCF), proposed by [11], was calculated and evaluated.

Research results and their discussion. In all control samples of grain, green mass of plants and corn harvest, bifenthrin was not determined above the limit of quantitative determination of the method [8].

When studying the dynamics of bifenthrin residual amounts in corn grown with

совують як інсектицид на посівах кукурудзи з максимальною нормою витрати 1,2 л/га одноразово.

Результати дослідження та їх обговорення. *При вивченні динаміки залишкової кількості біфентрину у кукурудзі, вирощеній з застосуванням препарату Брігейд 3Rive 3D, SC за технологією 3Rive 3D, встановлено, що протягом вегетації вміст біфентрину у кукурудзі поступово знижувався і за 50 діб у качанах був нижчим за межу кількісного визначення методу.*

Інтегральний індекс шкідливості при споживанні харчових продуктів, забруднених пестицидами, становить (IIHCPCF) = ДДД+С+τ_{50} = 2+2+2 = 6 балів. Тобто за цим показником біфентрин можна віднести до сполук 3-го класу небезпеки (помірно небезпечні сполуки), оскільки його помірна токсичність (величина ДДД) поєднується з помірною стійкістю у сільськогосподарських культурах і відносно низькою кількістю кукурудзи у харчовому раціоні українців.

Висновки. *Встановлено, що відповідно до ДСТУ 8.8.1.002-98 біфентрин належить до 3-го класу небезпеки – помірно стійкі сполуки. За значенням інтегрального показника небезпеки при споживанні забруднених пестицидами харчових продуктів біфентрин можна віднести до 3-го класу небезпеки (помірно небезпечні сполуки). Оскільки застосування препарату Brigade 3Rive 3D, СК за технологією 3Rive 3D для захисту кукурудзи не несе ризику забруднення посівів та споживання кукурудзи населенням, погіршення екологічної ситуації, він також має значні агроекономічні переваги популяційної безпеки. Застосування пестицидів за технологією 3Rive 3D є дуже перспективним і у майбутньому буде активно та широко впроваджуватися у сільськогосподарську практику України.*

Ключові слова: пестицид, біфентрин, харчові продукти, ризик споживання, період напіврозпаду.

the Brigade 3Rive 3D, SC formulation application using 3Rive 3D technology, it was established that during the growing season the content of bifenthrin in corn gradually decreased and after 50 days in the ears of corn it was below the limit of quantitative determination of the method (fig.). When harvesting the corn crop, the content of bifenthrin in the grain was also below the limit of quantitative determination of the method and did not exceed the maximum allowable level (MAL) established for bifenthrin in corn – 0.2 mg/kg (limit of quantitative determination by gas-liquid chromatography (GCh) – 0.2 mg/kg), corn oil – does not require (the limit of quantitative determination with GCh is 0.5 mg/ kg) [8].

Figure

Dynamics of the bifenthrin content in corn when apply the Brigade 3Rive 3D, SC formulation using 3Rive 3D technology

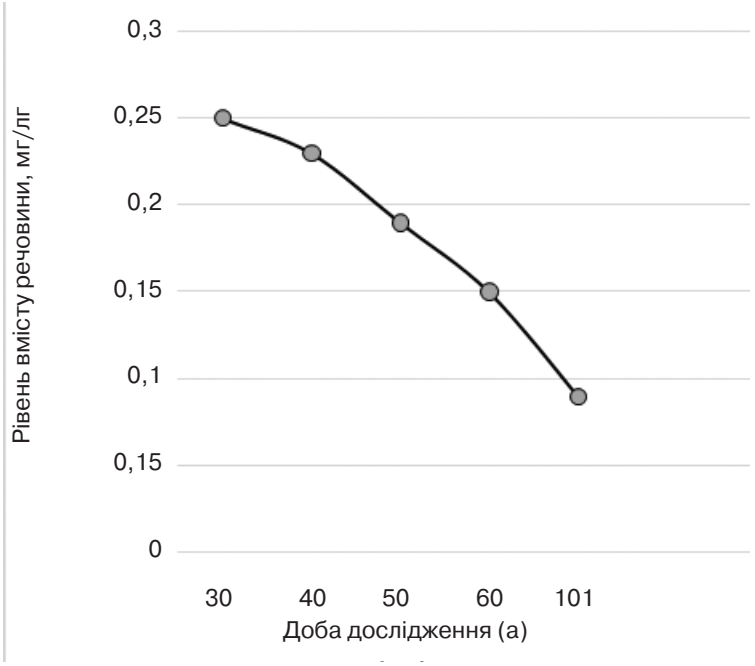

Table 1

The rate of bifenthrin destruction in corn plants

Object	Indices of degradation in plants				
	k^{-1}, day	τ_{50}	τ_{95}	τ_{99}	τ_{50}*
soil	0,194±0,031	3,55±0,965	15,38±2,134	26,66±4,64	26,0-86,8
corn	0,06±0,01	11,3±1,5	48,8±5,2	75,0±9,6	2-14

Notes:
k^{-1} – is the destruction rate constant;
τ_{50} – the period of 50% of the substance initial amount decomposition;
τ_{95} – the period of 95% of the substance initial amount decomposition;
τ_{99} – the period of 99% of the substance initial amount decomposition;
** – according to the literature [14].*

Table 2

Risk assessment for humans when consuming pesticide-contaminated food products (taking into account the toxicity indicators of the compound)

ADD, mg/kg		τ_{50} in plants, days		C, g/day		Total score
value	score	value	score	value	score	
0.02	2	11.3±1.5	2	100-150	2	6

Notes: ADD – allowable daily dose;
τ_{50} – the period of 50% of the substance initial amount decomposition in plant;
C – general norm of corn consumption.

Therefore, the next stage was the calculation of τ_{50}, τ_{95} and τ_{99} and statistical processing of the obtained data for the reliability of their differences in the studied agroclimatic zones (table 1). It was established that when applying the Brigade 3Rive 3D, SC formulation using 3Rive 3D technology, bifenthrin τ_{50} in corn was 11.3 days, τ_{95} – 48.8 days and τ_{99} – 75.0 days, the destruction rate constant was equal to 0.06, which correlates with the average values obtained in other studies [12, 13].

In accordance with State standard 8.8.1.002-98 [10], based on persistency indices in growing agricultural crops and agricultural raw materials, bifenthrin can be classified as a moderately hazardous compound (hazard class 3).

The next stage of this study was to assess the risk to human health when consuming products from corn grown with the application of bifenthrin using the innovative 3RIVE 3D pesticide application technology.

Three main indices were evaluated on a 4-point scale:

- ❑ the allowable daily dose (ADD) of bifenthrin is approved in Ukraine at the level of 0.02 mg/kg [24], which according to [18] gives 2 points;
- ❑ τ_{50} of bifenthrin in a corn plant when applying 3RIVE 3D is (11.3±1.5) days, that is, it is estimated at 2 points;
- ❑ the general norm of corn consumption in Ukraine (C) per person in grams does not exist as such. However, according to WHO recommen-

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Research results and their discussion. *When studying the dynamics of bifenthrin residual amounts in corn grown with the Brigade 3Rive 3D, SC formulation application using 3Rive 3D technology, it was established that during the growing season the content of bifenthrin in corn gradually decreased and after 50 days in the ears of corn it was below the limit of quantitative determination of the method.*
The integral index of hazard when consuming pesticides contaminated food products (IIHCPCF) = ADD+C+τ_{50} = 2+2+2 = 6 points (table 2). That is, according to this index, bifenthrin can be attributed to compounds of the 3-rd class of hazard (moderately hazardous compounds), since its moderate toxicity (ADD value) is combined with its moderate resistance in agricultural crops and the relative low corn amount in the diet of Ukrainians.
Conclusions*: It was established that according to State Standard 8.8.1.002-98 bifenthrin belongs to the 3-rd class of hazard – moderately stable compounds. According to the value of integral index of hazard when consuming pesticides contaminated food products bifenthrin can be assigned to the 3-rd class of hazard (moderately hazardous compounds). As the application of the Brigade 3Rive 3D, SC formulation using 3Rive 3D technology for the protection of corn does not carry the risk of crops pollution and consumption of corn by the population, deterioration of the ecological situation, as well as it has significant agro-economic and population safety advantages, the application of pesticides using 3Rive 3D technology is very promising and will be actively and widely implemented in the agricultural practice of Ukraine in the future.*

Keywords: pesticide, bifenthrin, food products, consumption risk, half-life period.

dations [16], the level of consumption of vegetables and fruits, including corn, is at least 400 grams per day. Taking into account the content of corn in this amount, it is about 100-150 grams per day – 2 points.

Therefore, the integral index of hazard when consuming pesticides contaminated food products (IIHCPCF) = ADD+C+τ_{50}= 2+2+2 = 6 points (table 2). That is, according to this index, bifenthrin can be attributed to compounds of the 3-rd class of hazard (moderately hazardous compounds), since its moderate toxicity (ADD value) is combined with its moderate resistance in agricultural crops and the relative low corn amount in the diet of Ukrainians. In addition, corn is subjected to mechanical and often heat treatment before use, which leads to even greater destruction of bifenthrin in it after treatment.

Conclusions

1. It was established that according to State Standard 8.8.1.002-98 bifenthrin belongs to the 3-rd class of hazard – moderately stable compounds.

2. According to the value of integral index of hazard when consuming pesticides contaminated food products bifenthrin can be assigned to the 3-rd class of hazard (moderately hazardous compounds).

3. As the application of the Brigade 3Rive 3D, SC formulation using 3Rive 3D technology for the protection of corn does not carry the risk of crops pollution and consumption of corn by the population, deterioration of the ecological situation, as well as it has significant agro-economic and population safety advantages, the application of pesticides using 3Rive 3D technology is very promising and will be actively and widely implemented in the agricultural practice of Ukraine in the future.

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