ORIGINAL ARTICLE

HYGIENIC SUBSTANTIATION OF NECESSITY FOR MONITORING IN THE ENVIRONMENTAL OBJECTS OF SDHI FUNGICIDES CONSIDERING THEIR POSSIBLE IMPACT ON THE THYROID GLAND

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Anna M. Antonenko[1], Bohdan I. Shpak[2], Olena P. Vavrinevych[1], Sergii T. Omelchuk[1], Tetiana I. Zinchenko[1]
[1]BOGOMOLETS NATIONAL MEDICAL UNIVERSITY, KYIV, UKRAINE
[2]DEPARTMENT OF REGISTRATION AND REGULATION OF «SYNGENTA» LLC, KYIV, UKRAINE

ABSTRACT

The aim: Was hygienic substantiation of necessity for monitoring in the environmental objects of SDHI fungicides considering their possible impact on the thyroid gland.

Materials and methods: To test the proposed selection criteria for hygienic monitoring of pesticides that affect the thyroid gland, we evaluated 4 new SDHI fungicides from the chemical class of pyrazolecarboxamides (isopyrazam, pentiopyrad, sedaxan, fluxapyroxad).

Results: Based on the results obtained, all studied compounds are assigned to the second pesticide group, hygienic monitoring of which is desirable but not required. This is due, on the one hand, to their low toxicity, to the other, to low environmental sustainability.

Conclusions: It was shown, that compared to other classes of pesticides, the studied are much less dangerous in terms of groundwater contamination.

KEY WORDS: fungicides, selection criteria, hazard class, thyroid gland, monitoring

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INTRODUCTION

Despite their popularity and widespread use, pesticides pose a serious risk to human health not only when mixing and applying pesticides or working in cultivated fields, but in the consumption of food and water containing pesticide residues [1, 2]. The risk assessment for the population when consuming food containing pesticide residues is mandatory in the US and European countries [3, 4]. In Ukraine, when conducting state tests of new pesticide formulations, a risk assessment is carried out only for agricultural workers and taking into account just possible inhalation and skin contact with pesticide compounds.

In the countries of the European Union and the USA, risk assessment techniques for non-professional contingents have long been tried and actively used [3-7]. Recommendations for such monitoring have also been developed in Ukraine in recent years [8]. The vast majority of such monitoring models existing in Ukraine and in the world do not include assessment of specific indicators for pesticides that may affect the thyroid gland.

Given the level of endocrine pathology in the world, and in particular the prevalence of thyroid disease [8-11], the introduction of such techniques is relevant, timely and necessary.

THE AIM

The purpose was hygienic substantiation of necessity for monitoring in the environmental objects of fungicides – succinate-dehydrogenase inhibitors (SDHI), considering their possible impact on the thyroid gland.

MATERIALS AND METHODS

Before, we have improved the pesticide monitoring system [8], considering their possible effect on the functioning of the thyroid gland [12], namely:

1. A point evaluation of the selection criteria for monitoring studies was proposed;
2. Additional (groundwater and surface water contamination index (LEACH), integral pesticide contaminated water consumption hazard index (IPCWCI), integral pesticide contaminated food consumption hazard index (IPCFCI) were proposed;
3. Specific criteria (influence on thyroid gland as target organ, severity of pesticide induced tyrosinemia (plasma tyrosine level, nmol / ml)).

After adding all points received, the need for monitoring is evaluated as follows: for a total of 11-16 points – monitoring is not required; 17-27 points – monitoring is desirable; 28-38 – mandatory monitoring; 39-44 – pesticide application should be prohibited [12].

To test the proposed selection criteria for hygienic monitoring of pesticides that affect the thyroid gland, we evaluated 4 new SDHI fungicides from the chemical class of pyrazolecarboxamides (isopyrazam, pentiopyrad, sedaxan, fluxapyroxad).

RESULTS AND DISCUSSION

Environmental monitoring models that exist in Ukraine today [8, 13] provide for observations of the state of the

Table I. Selection of investigated fungicides for hygienic monitoring

Criteria	Index value (score in points)			
	isopyrazam	**pentiopyrad**	**sedaxan**	**fluxapyroxad**
Allowable daily dose (ADD), mg/kg	0,01 (2)	0,1 (1)	0,1 (1)	0,02 (2)
Class of hazard according to State Standards 8.8.1.002-98	2 (3)	3 (2)	3 (2)	3 (2)
Impact on the thyroid gland as a target organ	weak effect in animal experiments (2)	weak effect in animal experiments (2)	weak effect in animal experiments (2)	weak effect in animal experiments (2)
The severity of pesticide-induced tyrosinemia (plasma tyrosine levels, nmol/ml)	<300 (1)	<300 (1)	<300 (1)	<300 (1)
Half-life period (DT_{50}) in soil, day	12,5 (2)	3,0 (1)	12,5 (2)	11,3 (2)
Half-life period (DT_{50}) in water, day	2,3 (1)	9,9 (2)	14,0 (3)	4,4 (1)
Half-life period (DT_{50}) in plants, day	3,6 (1)	2,5 (1)	2,8 (1)	3,8 (1)
the Groundwater and Surface Water Pollution Index (LEACH), units	0,0028 (1)	0,0214 (2)	0,0342 (2)	0,0534 (3)
Screening of maximum pesticide concentration in groundwater (SCI-GROW), μg/l	$5,5\times10^{-3}$ (2)	$5,4\times10^{-3}$ (2)	$3,4\times10^{-2}$ (2)	$2,6\times10^{-3}$ (2)
Integral index of contaminated water consumption hazard (IICWCH), points	4 (1)	5 (2)	6 (2)	5 (2)
Integral index of contaminated food consumption hazard (IICFCH), points	7 (3)	6 (2)	8 (3)	8 (3)
Total score	19	18	22	21

environment (air, land waters, coastal waters, soil), and the level of pollution. The implementation of these functions is entrusted to the Ministry of Energy and Environmental Protection and other central executive organizations, which are the subjects of the state environmental monitoring system, as well as to the enterprises, institutions and organizations whose activities lead to or may worsen the environment [13].

Our monitoring system model proposes a risk assessment for non-professional contingents whose organisms can be exposed with pesticides mainly by oral intake with drinking water and food. In addition, it lays down specific criteria for pesticide monitoring that affect the thyroid gland, which is extremely relevant today for many countries in the world [10-11].

Such hygienic monitoring of pesticides that affect the thyroid gland requires, first of all, areas with intensive agriculture. In Ukraine, for example, such regions as Vinnytsia, Cherkasy, Poltava, Kherson, Odessa, Mykolaiv. However, in other areas such monitoring is desirable, as chemical plant protection products are being actively introduced into world agriculture, including privately owned farms that are mostly uncontrolled, which complicates the determination of pesticide application volumes in them.

According to the toxicological criteria, all tested compounds are low- and moderately toxic: relatively high allowable daily doses, 2-3 hazard class.

In soil and climatic conditions of Eastern, Southern and partly Central Europe, including Ukraine, the investigated fungicides are unstable in environmental objects and agricultural raw materials [14, 15].

It was established that in soil-climatic conditions of Ukraine the risk of groundwater contamination by all investigated fungicides (isopyrazam, pentiopyrad, sedaxan, fluxapyroxad) is low, and their maximum possible concentrations in groundwater are insignificant and much lower than allowable. This is due to the low percentage of active ingredients in the fungicide formulations and indicates the relative safety for human health of drinking of water in which the test compounds may be present [14].

Given that, isopyrazam, pentiopyrad, sedaxan, fluxapyroxad based formulations are used predominantly for the treatment of cereals (consumed after purification and heat treatment), the risk to humans of consuming contaminated products is also relatively low [16].

Each of proposed criteria was evaluated according to the proposed scale in points and their sum was calculated (Table I).

Given that, isopyrazam, pentiopyrad, sedaxan, fluxapyroxad based formulations are used predominantly for the treatment of cereals (consumed after purification and heat treatment), the risk to humans of consuming contaminated products is also relatively low [16].

Compared to other classes of pesticides, the studied are much less dangerous in terms of groundwater contamination. For example, herbicides that have been successfully used in Ukrainian and world agriculture for many years, benzoic acid derivative – dicamba, sulphonyl urea – nicosulfuron, and strobilurin class fungicide – azoxystrobin are characterized by high risk of groundwater contamination [17, 18]. Similarly, pymetrozine is a fungicide that belongs to a relatively new chemical class of fungicides, namely pyridine azomethrines [17].

There may be several reasons. For example, low toxicity, low environmental stabilityю Fungicides from the studied classes do not lead to the development of tyrosinemia. This effect is observed in the herbicides of 4-hydroxyphenylpyruvate dioxygenase inhibitors and the tetramic and tetronic acid-like insecticides [19, 20].

CONCLUSIONS

Based on the results obtained, all studied compounds are assigned to the second pesticide group, hygienic monitoring of which is desirable but not required. This is due, on the one hand, to their low toxicity, to the other, to low environmental sustainability.

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ORCID and contributionship:

Anna M. Antonenko: 0000-0001-9665-0646 [A, D]
Bohdan I. Shpak: 0000-0001-9273-8544 [B]
Olena P. Vavrinevych: 0000-0002-4871-0840 [E]
Sergii S. Omelchuk: 0000-0003-3678-4241 [F]
Tetiana I. Zinchenko: 0000-0002-3541-9480 [C]

Conflict of interest:

The Authors declare no conflict of interest.

CORRESPONDING AUTHOR
Anna M. Antonenko
Bogomolets National Medical University
13 Tarasa Shevchenko st., 01601Kyiv, Ukraine
tel:+380991466331
e-mail: antonenko1985@ukr.net

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