PESTICIDE RESIDUES IN FRUITS AND VEGETABLES PRODUCED IN ORGANIC, INTEGRATED AND CONVENTIONAL SYSTEMS

POZOSTAŁOŚCI PESTYCYDÓW W OWOCACH I WARZYWACH WYPRODUKOWANYCH W SYSTEMACH EKOLOGICZNYM, INTEGROWANYM I KONWENCJONALNYM

Abstract: Presented research concerns the evaluation of residues of synthetic pesticides in crops, depending on the system of production: conventional, integrated and organic. The study was conducted in 2005–2009 on 1134 samples of plant material derived from the four provinces: Lubelskie, Podlaskie, Warmińsko-Mazurskie and Mazowieckie. The 123 active substances of pesticides were searched in the plant material.

This research has been shown that in the samples of fruit produced in the integrated system percentage of samples with residues below the maximum residue levels (MRL) is larger (55 %) than in the samples from conventional production (28 %), and less with above MRL (3 %). The pesticide residues were also detected in 8 % in samples of fruits and vegetables from organic production.

Keywords: pesticide residues, fruits, vegetables, conventional, integrated, organic production

Pesticide residues in crops are primarily the result of application of synthetic pesticides for the purpose of protection of crops against undesirable pests or the result of persistence in the environment. These residues must be present in an amount that is as small as possible and are usually detected in very low concentrations (mg · kg⁻¹, µg · kg⁻¹). A maximum residue level (MRL) is defined for every pesticide used in the production of food [1, 2].

Crops in Poland are mainly produced in the conventional system (CC), and also in integrated system (IC) and organic system (EC). The nature of each of these systems is defined by the scope of applied pesticides, the degree of interference in the natural environment, as well as by expectations concerning the quality and quantity of obtained
crop yield. The goal of integrated production is to achieve high crop yield of good quality, free from substances that are unfavorable for human health, as well as protection of the natural environment. Chemical protection of plants against diseases, pests or weeds should be replaced by alternative methods whenever possible, such as: biological, physical, and agrotechnical methods. Conventional farming is a farming method directed towards maximization of profit, which is achieved thanks to high crop yield obtained in specialized farms that apply production technology based on high consumption of pesticides and very low costs of labor, which also create a series of negative consequences. The philosophy of organic farming is based on the prohibition of using chemical agents, including mineral fertilizers and synthetic pesticides [3]. The goal of this method of production is to obtain products of a high biological value that are free from chemical residues.

The goal of the study was to evaluate the presence of pesticide residues in crops from northeastern Poland depending on the system of their production.

Materials and methods

Crops samples (1134) were obtained within the framework of an official inspection of pesticide residues conducted in the years 2005–2009 on the order of the Ministry of Agriculture and Rural Development, realized in cooperation with the State Plant Health and Seed Inspection Service (PIORiN). Crops originated from three farming systems: integrated (265 samples), conventional (774), and organic (95). 123 active substances of pesticides were sought for in the plant material. A procedure developed by the authors, based on sample dispersion in a solid phase MSPD (Matrix Solid Phase Dispersion) [4, 5], was used to determine these substances. Extraction with a simultaneous purification step was carried out with the application of adsorption column chromatography. Instrumental determinations where carried out using gas chromatographs with simultaneous EC and NP detection. The applied method fulfills the validation criteria required for analysis of pesticide residues [6] and is accredited by the Polish Centre for Accreditation (AB 839), and the laboratory regularly participates in proficiency tests to confirm its competencies. Evaluation of pesticide residues was carried out based on maximum residue levels (MRL) according to applicable legal provisions.

Results

The distribution of pesticide residues in crops originating from organic, integrated, and conventional production is presented in Fig. 1.

The most numerous group of tested samples contained crops produced in the conventional system (68.25 % of all samples), among which 69 % did not contain pesticide residues and 3 % were stated to have violated MRLs. In the group of crops originating from integrated production, which constituted 23.37 % of all samples, no residues were stated in 42 % of samples, and MRL violations were noted in 3 % of samples. The least numerous group was represented by plant material originating from
organic farms, comprising 8.38% of all plant material. Pesticide residues were noted in 8% of samples, which is considered to be an MRL violation in organic products.

The distribution of pesticide residues in fruits and vegetables originating from organic, integrated, and conventional production is presented in Fig. 2.

Vegetable samples from organic, integrated, and conventional production were laden with pesticide residues in a lesser degree (22%, 17%, 14%, respectively) than fruits (7%, 66%, 56%, respectively). The smallest share of samples without residues was noted for organic fruits (93%), and the highest percentage of MRL violations was noted for vegetables from this system of production (22%). The highest percentage of
samples with pesticide residues and MRL violations was noted for fruits (66 %) originating from integrated production and vegetables (22 %) originating from organic production.

**Discussion**

Integrated farming in Poland is mainly oriented towards growing fruits and vegetables. Pesticides were intensively used in this production, which led to a larger amount of samples in which residues were determined. The results of these studies, which were conducted in the years 2005–2009, indicate that among crop samples originating from integrated production pesticide residues were stated below acceptable limits in 55 % of samples, and MRL violations were noted in 3 % of samples.

According to Lozowicka [7], 48 % of Polish samples originating from integrated production in 2006 contained residues. MRL violations were stated in 2.6 % of these samples.

In the presented studies, 28 % of the crop samples from the conventional system contained residues below MRLs. MRL violations were noted in 3 % of these samples. In 2006, the presence of pesticides was stated in 21 % of such samples, and a level of these substances that was higher than the acceptable level was noted in 3.2 % of samples.

It should be noted that the share of samples from the conventional system of production in which pesticides were detected (31 %) is smaller than for the integrated system (58 %). In samples originating from IC, pesticide residues were detected in over half of the analyzed material, and the number of cases in which MRLs were violated is only smaller by 0.2 %. It is commonly recognized that conventional production should be distinguished by greater pesticide consumption, and thus, by a greater amount of residues in tested products. Both the economic aspects of applying pesticides and the structure of cropland in individual types of production, including the type of plant grown and its qualities (susceptibility to pests, and thus the necessity of applying chemical plant protection) could have influenced this different state of affairs. The lack of strict and systematic inspection combined with incorrect treatment techniques and failure to observe guidelines for use of preparations could have contributed to the detection of pesticide residues in crops from both of these systems.

The contents of pesticide residues in crops from northeastern Poland shown in this study are similar to the distribution for the whole of Poland [8–11]. Date from the literature shows that integrated farming produces food that is visibly less contaminated in comparison to that from conventional farming [12]. For example, Tsakiris [13] indicates that peaches produced in the conventional system in Greek contained pesticides in concentrations that were three times greater than in peaches from the integrated system. This study prove that in Greece, IC offers fruits of the highest quality, is safe for the environment, and integrated farming methods have been implemented successfully. The situation in northeastern Poland is different than in the entire country [14]. As a result of conducted studies, it can be concluded that, in fruit samples from integrated production, a greater percentage of samples contains residues...
below MRLs in comparison with conventional production, and a smaller percentage of samples violate MRLs. However, a smaller percentage with residues above MRLs was demonstrated for vegetables from conventional production.

According to data from the literature, the number of samples from organic production with pesticide residues, e.g. in the Austria, is equal to 8.2 % [15], in the Czech Republic 14 % [16], and in Belgium 8 % [16]. In years 2007–2010, the presence of pesticides was noted in 4.4 % of Polish crop samples [18, 19]. In northeastern Poland, these agents were present in 8 % of samples, of which 22 % were vegetable samples and 7 % were fruit samples.

The presented data attests to the fact that synthetic pesticide residues are generally detected in organic products from around the world, which may indicate their use, and this is inconsistent with the assumptions of organic farming [20, 21]. The presented results indicate a need for continuing inspections of pesticide residues.

Conclusions

1. In the studied region, tested conventional products are characterized by a lower content of pesticide residues in comparison with integrated production. Both the economic aspects of pesticide application and the crop structure in individual types of production, as well as the type of tested samples have an influence on this state of affairs.

2. The conducted studies show that a greater percentage of fruit samples from integrated production contain residues below MRLs as compared with conventional samples, and a smaller percentage of samples violate MRLs. The situation is reversed in the case of vegetables.

3. The unfavorable trends of pesticide detectability in crops produced in the organic system shown in this work require rectification through the application of economical mechanisms and modernization of techniques and programs of plant protection, as well as through the education of farmers and fruit-growers.

4. Systematic testing of pesticide residues made it possible to demonstrate tendencies of changes of food of plant origin contamination with these residues at the stage of primary production in northeastern Poland, depending the method of production.

5. The burdening of crops with pesticides in the region of northeastern Poland is comparable with tendencies for the whole of Poland, but it is still present in a degree that is clearly lesser than in highly developed countries. This fact should be used to promote these crops both on the domestic market and in exporting. A necessary condition for such promotion is the continuation of systematic and representative laboratory tests according to internationally recognized standards of analytical procedures, as have been presented in this paper.

References

[1] Regulation of the Minister of Heath of 16 May 2007 on the maximum residue levels of chemical pesticides, which may be presented in plant foods or on their surface. J of Laws 2007;119(817), with later amendments.


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Abstrakt: Przedstawione badania dotyczą oceny pozostałości środków ochrony roślin wплодach rolnych wyprodukowanych w systemie konwencjonalnym, integrowanym i ekologicznym. W latach 2005–2009 przeprowadzono analizy 1134 próbek materiału rolnego, pochodzących z czterech województw: lubelskiego, podlaskiego, warmińsko-mazurskiego i mazowieckiego. W materiale roślinnym poszukiwano 123 substancji aktywnych pestycydów. W badaniach wykazano, że w próbkach owoców produkowanych w systemie integrowanym próbkii z pozostałościami poniżej najwyższego dopuszczalnego poziomu mają większy udział (55 %) niż w próbkach z produkcji konwencjonalnej (28 %), a nieznacznie mniejszy z przekroczeniami NDP (3 %). Pozostałości pestycydów wykryto również w 8 % próbek owoców i warzyw z produkcji ekologicznej.

Słowa kluczowe: pozostałości pestycydów, owoce, warzywa, produkcja konwencjonalna, integrowana, ekologiczna