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JOURNAL OF PLANT PROTECTION RESEARCH Vol. 51, No. 3 (2011)

DOI: 10.2478/v10045-011-0037-5

ACTIVE SUBSTANCES USED IN PLANT PROTECTION IN POLAND AFTER THE EUROPEAN UNION ACCESSION

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Received: September 29, 2010
Accepted: May 4, 2011

Abstract: In the years 2003–2009, a significant reduction of active substances of plant protection products was observed in Poland. The amount of active substances decreased from 340 in 2003 to 279 in 2009. The real difference proved to be much higher because some substances were being withdrawn, and at the same time, new ones were being introduced on the market. The reductions were observed in all groups of plant protection products. The biggest decrease took place in the case of insecticides, which also had a smaller than average number of registered formulations compared to herbicides and fungicides. Herbicides had the highest number of registered formulations per active substance, while fungicides were the only group where the average number of registered formulations per active substance had increased in the analyzed period.
The main reason for the described changes was the European Union's review of active substances. Substances which could pose a risk for humans or the environment were withdrawn. This positively influenced overall safety. The changes, however, also gave rise to some problems which are noted. Particularly pressing in Poland, is the problem of minor crops protection.

Key words: registration, plant protection, active substance, availability, changes, Poland, European Union accession

INTRODUCTION

Plant protection products are widely used in agriculture to control different kinds of pests. Although they do not influence direct yield increase (with the exception of some plant growth regulators), they contribute to the increase in quantity, as well as to the quality of agricultural production. The use of plant protection products improves food availability by preventing losses in the field and during storage. In both developed and developing countries, crop loss caused by pests is considerable. Such losses amount to between 10 and 75% depending on a given crop, climate, agricultural practices and other factors (WHO 1990).

From the chemical point of view, plant protection products are mixtures of a number of compounds. The formulation which is marketed and consequently used, usually contains solvents, adjuvants, safeners, synergetics, and other compounds. Several aims of these ingredients are: to enable or facilitate proper use, increase effectiveness, decrease the spray-drift or ensure safety. The most important part of the formulation is, however, the active substance, which is the component (or components) responsible for the control of the pest; very often by killing it. The active substance can also influence non-target organisms, and harm the environment and humans. At the beginning of chemical plant protection (in the first half of the 20th century), non selective and toxic-active substances were also used over large areas (Carlson 1962). Gradually, the rules regarding the placing of plant protection products on the market became much more strict, to comply with public demand, and the desire to improve living standards.

In 1991, the European Union (EU) issued Directive 91/414 (1991) concerning placing plant protection products on the market. This directive contains the important statement "Provisions governing authorization must ensure a high standard of protection, which, in particular, must prevent the authorization of plant protection products whose risks to health, groundwater and the environment and human and animal health should take priority over the objective of improving plant production". To enforce this statement, in 1993, the European Commission launched a work programme for the Community-wide review of all active substances used in plant protection products within the EU. In this review process, each substance had to be evaluated as to whether it could be used safely with respect to human health and the environment, in particular groundwater and non-target organisms. The programme was finalised in March 2009 when the last decisions were taken (Europa 2010).

The review had a positive impact on consumer and environmental safety, and it reduced the diversity of plant protection products in member states. This paper presents the analysis of active substances used in Poland before and several years after the date of EU accession (01.05.2004).

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MATERIALS AND METHODS

For the purpose of the analysis, data from two different years were compared:

1. The year 2003 was the last full year before accession. In this year some legal acts implementing the EU requirements were already issued (among others, the Plant Protection Act of 18th December 2003 implementing requirements of the Directive 91/414 into the Polish legal system). But because of vacatio legis of these new legal acts, the results of the EU review of active substances had no direct impact on the registration of plant protection products in Poland.
2. The year 2009 was the year the EU review of active substances was finalized. It should be noted, however, that a small portion of PPP containing not-yet-withdrawn substances were still on the market in 2009.

The material which comprised the analysis of the year 2003 was compiled from the internal data of the Department of Assessments and Opinions about Plant Protection Products (former Office of Plant Protection Products Registration). This department was responsible for placing plant protection products on the Polish market before EU accession.

In 2009, the analysis data was compiled on the basis of the register of plant protection products placed on the Polish market, and published on the website of the Polish Ministry of Agriculture and Rural Development (Register 2010).

The active substances were divided into four groups: herbicides, fungicides (with bactericides), insecticides (with acaricides and fumigants) and others (plant growth regulators, atractants, repellents, rodenticides and molluscocides). The data regarding availability were compared for each group separately. For each active substance, the number of registered formulations were calculated. In a few cases, the active substance was used in two groups of plant protection products (for example as a herbicide and plant growth regulator, or as an insecticide and fungicide). These active substances were listed in both of the groups they belonged to.

In many cases, plant protection products contain more than one (sometimes up to four) active substances. In effect, this means that calculating the number of registered formulations for all active substances would give a result much higher than the real number of plant protection products placed on the market.

Also to be considered were the fact that there are several ways of spelling the names of active substances. In this paper, the names of active substances were spelt according to the EU Pesticides database. In the case where the substance was not listed in the database, the source of spelling was "The Pesticide Manual" (Tomlin 2009).

Before the EU accession, all adjuvants were registered in Poland as plant protection products. In the year 2009, the registration of adjuvants was no longer continued, however a portion of adjuvants, which were registered on the basis of the old regulations, had been assigned registration numbers and were listed in the register of plant protection products. They will be listed there up to the end of their registration period. It should be noted, that this analysis does not include adjuvants in spite of their presence in the register of plant protection products placed on the Polish market, both in 2003 and 2009.

RESULTS

The data presented in table 1 clearly show that in the analyzed period, there is a decrease of active substances registered in Poland for all the groups of plant protection products. Herbicides are sold in higher amounts than all the other groups of plant protection products, both in terms of tonnes of PPP, as well as in tonnes of active substance (Figs. 1 and 2). Despite the large amount sold, the number of active substances registered was not the highest for herbicides, but for fungicides, both in the year 2003 and 2009. The percentage decrease of available active substances amounted to (depending on the group) 10 to 33%, and was the highest for insecticides.

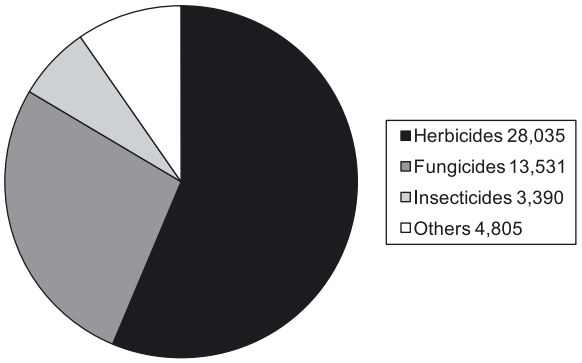

Fig. 1. Sales of plant protection products in Poland in the year 2009 (tones of plan protection product)
Source: data of Ministry of Agriculture and Rural Development. Sales and reserve of plant protection products. Data of producers and importers
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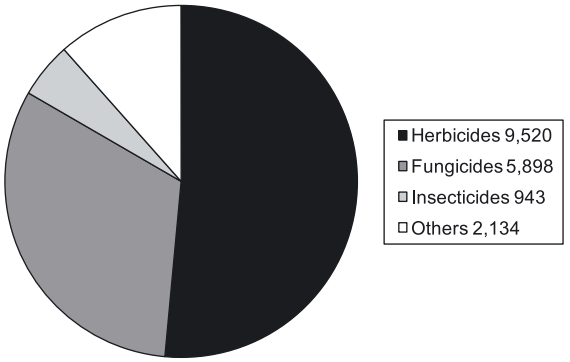

Fig. 2. Sales of plant protection products in Poland in the year 2009 (tones of active substance)
Source: data of Ministry of Agriculture and Rural Development. Sales and reserve of plant protection products. Data of producers and importers
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Table 1. Number of active substances of plant protection products placed on the Polish market in the year 2003 and 2009

Year	Herbicides	Fungicides and Bactericides	Insecticides and Acaricides	Others	Total
2003	103	106	89	42	340
2009	89	92	60	38	279

Source: author's research

Herbicides

There were 103 active substances of herbicides registered in the year 2003, and 89 in the year 2009. It is therefore obvious that in 2009, in numerical terms there was a decrease in use of 14 active substances in comparison to 2003. When this is considered from the substantive point of view, however, the difference is more significant: 31 herbicidal active substances were withdrawn from use in Poland in the period 2003–2009 and 17 new active substances were registered.

The active substances withdrawn were as follows (number of formulations registered in 2003 given in brackets):
– atrazine (27),
– trifluralin (10),
– alachlor and prometryn (6),
– clethodim, cycloate, dichlobenil, dichlorprop, diclofop, diuron, fluorglycofen, haloksyfop-R, imezathapyr, sethoxidim, S-metolachlor, symazine, terbutryn (2),
– alloxidim, aziprotyne, benazolin, carbetamide, cyanazine, flupyrsulfuron-methyl, imazamethabenz, imazapyr, naptalam, nicosulfuron, paraquat, pyraflufen-ethyl, pyridate, terbacil (1).

The herbicidal active substances registered were as follows (number of formulations registered in 2009 given in brackets):
– mesotrione (3),
– bifenox, chlorpropham, clethodim, dazomet (2),
– aminopyralid, capric acid, dimethenamid-P, fluazifop-P, flurtamone, lauric acid, methyl bromide, pethoxamid, pinoxaden, prosulfocarb, tembotrione, triflursulfuron (1).

On analyzing the active substances given above, along with the number of registered formulations, we can state that the decrease in the number of herbicidal active substances available for Polish farmers in the analyzed period was accompanied by a decrease in the number of registered formulations. Figure 3 illustrates the average number of registered formulations for all active substances of herbicides used in the year 2003 and 2009. In both years, 34 active substances were registered in 1 herbicide only. Also, in both years, for most active substances of herbicides there existed more than one registered formulation. In 2003 however, the average number of registered formulations was higher. It is worth mentioning the most frequently registered herbicidal active substances, as it may be assumed that the more registered the formulations, the more important a role the active substance plays in the protection against weeds. In the year 2003, the five most important herbicides were (in brackets the number of registered formulations): phenmedipham (48), glyphosate (40), isoproturon (37), ethofumesate (34) and MCPA (30). All these substances were on the market in 2009, but all without exception had a decreased number of registered formulations. In 2009, the five most widely used herbicides were: 2,4-D (29), glyphosate (28), ethofumesate (24), phenmedipham (23) and metamitron (21). Metamitron and 2,4-D were on the market in 2003, and during the analyzed period the number of registered formulations containing these active substances had increased.

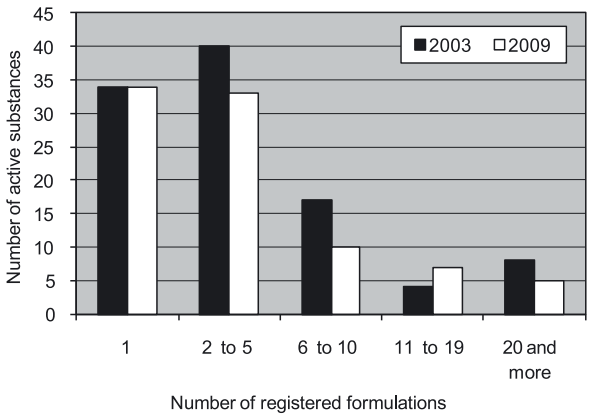

Fig. 3. Number of registered formulations of herbicidal active substances in the years 2003 and 2009
Source: author's research

The withdrawn herbicidal active substance with the most registered formulations (27) in 2003 (and therefore probably most missed by farmers) is atrazine. Atrazine ensured cheap control of weeds, but it was not safe enough. There are, of course, efficient products available which can substitute for atrazine. It should be stressed, however, that the cost of some alternative weed control products is higher by several hundred percent (!) when compared to the cost of the herbicides with atrazine.

Fungicides

After herbicides, fungicides are the second most widely used group of plant protection products in Poland. The number of fungicidal active substances, however, were higher than herbicides in both of the analyzed years. The number of fungicidal active substances registered in Poland in the analyzed years decreased by 14, but as with herbicides, the real difference was more significant. There were 34 active substances withdrawn and 20 active substances newly registered.

The active substances withdrawn were (number of formulations registered in 2003 given in brackets):

– benomyl (9),
– triadimenol (7),
– azaconazole (6),
– oxine-copper (5),
– tolyfluanid, triadimefon (4),
– furathiocarb, guazatine, tridemorph, vinclozolin (3),
– *Agrobacterium radiobacter K 84*, fentin acetate, iprovalicarb, (2),
– aldimorph, anilazine, biohumus, chlorine, dinocap, ethirimol, fenarimol, fentin hydroxide, flurtamone, furalaxyl, lecithin, maneb, ofurace, oxadixyl, procymidone, propolis, qaternary ammonium compounds, streptomycin, trazamate, triflumizole, triforine (1).

The following fungicidal active substances were registered (number of formulations registered in 2009 given in brackets):
– prothioconazole (9),
– *Phlebiopsis gigantea* (5),
– grapefriut extract, metrafenon, pyraclostrobin (3),
– cyazofamid, dymoxistrobine, fluoxastrobin, picoxystrobin (2),
– benalaxyl-M, benthiavalicarb, benzoic acid, *Coniothyrium minitrans*, fenbuconazole, fluopicolide, garlic pulp, mandipropamid, proquinazid, *Pseudomonas chlororaphis*, *Pythium oligandrum* (1).

Figure 4 illustrates the average number of registered formulations for all active substances of fungicides used in the years 2003 and 2009.

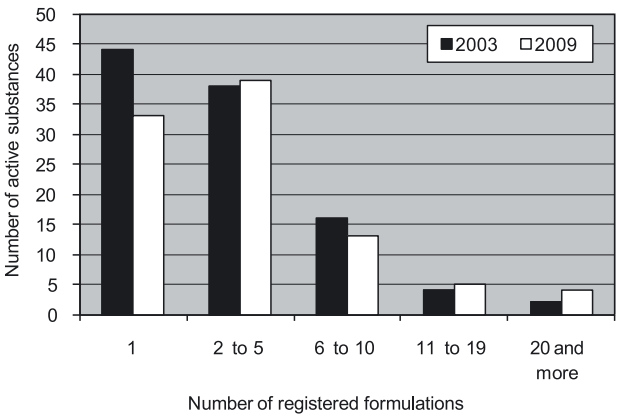

Fig. 4. Number of registered formulations of fungicidal active substances in the years 2003 and 2009
Source: author's research

The data regarding fungicides is similar to herbicides in that, for both years, more than one registered formulation existed for most active substances. However, there was not a clear tendency for a reduction in the number of registered formulations. In fact, quite the opposite happened; the number of fungicides with only one registered formulation decreased from 44 in 2003 to 33 in 2009. On the other hand, the number of fungicidal active substances with more than one registered formulation slightly increased. An exception was with substances registered in 6–10 formulations, in which the number decreased from 16 to 13. For the average fungicidal active substance, there were fewer formulations registered in comparison with herbicides. The five most often registered fungicidal active substances in 2003 were: mancozeb (35), carbendazim (33), thiram (23), copper compounds (21) and tebuconazole (16). All these active substances were also available to farmers in 2009. In 2009, the most widely used active substances were: tebuconazole (39), mancozeb (26), carbendazim (17) prochloraz (16) and thiram (15). It is worth noting, that the number of registered formulations for tebuconazole was over two times higher in 2009 than in 2003. The withdrawn fungicidal active substance with the most registered formulations in 2003, was benomyl. Another frequently used substance – carbendazim – was allowed to remain on the market, but the scope of its use was strongly reduced on the basis of the European Commission decision (Directive 2006).

Insecticides

Insecticides are the least used group of plant protection products in Poland. In this group the most significant decrease in available active substances took place in the analyzed period (from 89 in 2003 to 60 in 2009). The result of simple subtraction puts the decrease at 29. As in the case of the other groups, the real difference was higher than 29. The number of the insecticidal active substances withdrawn was 44 while 15 substances were newly registered.

The active substances withdrawn were (number of formulations registered in 2003 given in brackets):
– bensultap, diazinon (8),
– aldrin, carbofuran (5),
– carbosulfan, dichlorvos, fenitrothion (4),
– *Bacillus thuringiensis subsp. Tenebrionis*, chlorfenvinphos, fenpropathrin, malathion (3),
– acephate, amitraz, azinphos-methyl, befuracarb, cyhexatin, endosulfan, heptenophos, methomyl, oxydemeton-methyl (2),
– 2-mercaptobenzothiazole, acrinathrin, aldicarb, azocyclotin, *Baculovirus GV*, cumylphenol, fenbutatin oxide, fenoxycarb, fenthion, fipronil, flucycloxuron, flufenoxuron, hexaflumuron, isofenphos, lufenuron, methamidophos, parathion-methyl, phosalone, propoxur, tebufenozide, tetradifon, tetramethrin, thiodicarb, trichlorfon (1).

The insecticidal active substances registered were (number of formulations registered in 2009 given in brackets):
– clothianidin (3),
– *Cydia pomonella granulosis virus*, dazomet (2),
– (E,E)-8,10-dodecadien-1-ol (codlemone), cyfluthrin, flonicamid, gamma-cyhalotrin, metaflumizone, methiocarb, mineral oils, oleic acid, paecilomyces fumosoroseus, soap, spiridoclofen, tau-fluvanilate (1).

Figure 5 illustrates the average number of registered formulations for all active substances of insecticides used in the years 2003 and 2009.

On analysing figure 5, we may observe that insecticides have a smaller average number of formulations registered for the active substance than fungicides and herbi-

cides. In 2009, 30 insecticidal active substances (from an available 60) were registered in only one formulation, and only one (imidacloprid) in more than 20 formulations. The five most often registered active substances for insecticides in 2003 were: deltamethrin (24), alpha-cypermethrin (16), imidacloprid (13), piperonyl butoxide (11) and pyrethrins (10). In 2009, the three active substances with the highest number of registered formulations were: imidacloprid (23), paraffin oil (7) and deltamethrin (7). Six (6) formulations were registered for aluminium phosphide, beta-cyfluthrin, piperonyl butoxide and pyrethrins. The active substances withdrawn with the most registered formulations (8) in 2003, were bensultap and diazinon.

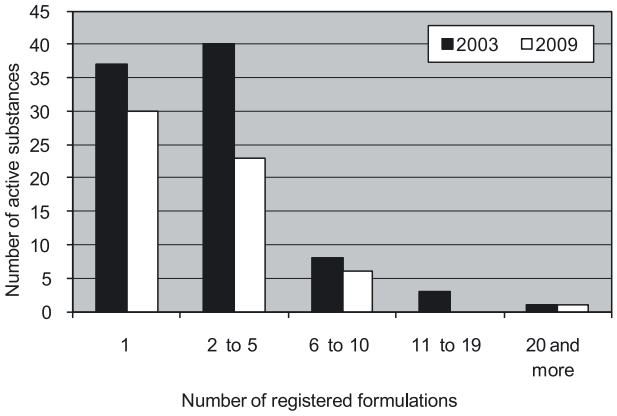

Fig. 5. Number of registered formulations of insecticidal active substances in the years 2003 and 2009
Source: author's research

The insecticide *Bacillus thuringiensis* subsp. *Tenebrionis* was not withdrawn from use in Europe. Its withdrawal from the Polish market took place due to low demand and because the registration period had ended. The diminishing number of available insecticides, and the development of organic farming (Inspekcja 2009) were probably the main factors influencing the change of the producers' decision. Since 2010, *B. thuringiensis* subsp. *Tenebrionis* has become available again in Poland.

Other plant protection products

The smallest number of active substances belonged to this group – 42 in 2003 and 38 in 2009. In spite of this fact, this group is the most complex, because the active substances are used to control a diversified number of harmful organisms. Not all compounds belonging to this group can be classified as pesticides because their aim is not to kill, but either to repel harmful organisms (repellents), or to attract them (atractants). Plant growth regulators also belong to this group and are not intended to have an influence on harmful organisms, but rather to have an effect on the crop. For example, such compounds can stimulate resistance.

The group "other plant protection products" includes six subgroups: plant growth regulators (PG), attractants (AT), repellents (RE), rodenticides (RO), molluscocides (MO) and nematocides (NE). Graph 6 presents the number of active substances belonging to each group in 2003 and 2009. The biggest of them was the group of plant growth regulators with 21 active substances in 2003 and 19 in 2009. Rodenticides followed with 10 active substances in 2003 and 5 in 2009. It should be noted, that for the three groups – atractants, moluscocides and nematocides – the number of active substances available on the market in 2009 was higher than in 2003. Since there were only a few active substances in each of these groups, and most of them had only 1 to 3 registered formulations, deeper analysis of registered formulations seems unnecessary. The active substances in plant growth regulators had the most registered formulations.

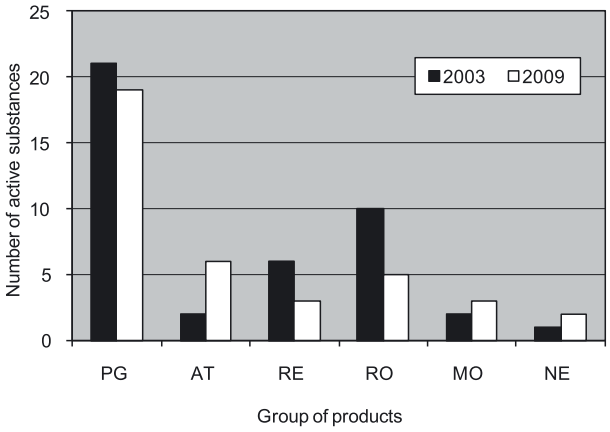

Fig. 6. Number of active substances used in Poland belonging to each of the six groups of "other plant protection products" in the years 2003 and 2009
Source: author's research
PG – plant growth regulators; AT – atractants
RE – repellents; RO – rodenticides; MO – molluscocides
NE – nematocides

From the whole group labeled "other plant protection products", a relatively low decrease in the number of active substances was observed. The substances decreased by four, with 16 substances withdrawn and 12 new ones registered. The withdrawn substances are below (number of formulations registered in 2003 is given in brackets). The name is followed by the group:

– anthraquinone RE (3),
– chlorophacinone RO, cholin chloride RO (2),
– 3-phenyl-2-propenal AT, aliphatic alcohols PG, calcium oxide RE, carbon oxide RO, daminozide PG, dimethipin PG, lineatin AT, naphtylaceticacid hydrazide PG, phosphane RO, polyvinyl acetate RE, propham PG, thiourea RO, urea PG (1).

The active substances registered in 2009 were (number of formulations registered given in brackets). The name is followed by the group:

– ipsdienol AT (2),
– (9Z,12E)-tetradecadien-1-yl acetate AT (1), (E,E)-8,10-dodecadieno-1-ol AT, 1-decanol PG, 1-methyl-cycloprophene PG, 2-methyl-3-buten-2-ol AT, methiocarb MO, myrcenol AT, oxamyl NE, paclobutrazol PG, S-(cis)-verbenol AT, sea algae extract PG (1).

No one active substance from this group had a significantly high number of registered formulations (20 or over) in 2003 or 2009. In 2003, 21 (out of 42) active substances were registered in only one formulation; while in 2009, there were only 17 (out of 38). The five active substances with the highest number of formulations registered in 2003 were plant growth regulators: 1-naphtylacetic acid (15), chlormequat (15), gibberelic acid (8), rodenticide aluminium phosphide (7) and the plant growth regulator etephon (7). All the substances were also on the market in 2009, but all were registered in a lower number of formulations. In spite of the lower number of formulations, 4 of them were numbered amongst the most frequently registered formulations (also in 2009) : chlormequat (11), 1-naphtylacetic acid (7), aluminium phosphide (6) and etephon (6). The fifth one was the plant growth regulator indolybutyric acid (6). The number of registered formulations increased only for two active substances registered in 2003: indolybutyric acid (from 4 to 6) and denathonium benzoate (from 2 to 3). The withdrawn active substance which had the most registered formulations (3) in 2003 was the repellent anthraquinone.

DISCUSSION

Poland's accession to the EU affected the availability of plant protection products and their active substances in Poland. The data presented above show that the total number of active substances used in plant protection in Poland decreased from 340 in 2003 to 279 in 2009. In numerical terms, this amounts to a decrease of approximately 18% of active substances. In fact the changes were much more significant, with 125 substances withdrawn after accession (more than a third of active substances was withdrawn) and 64 new ones registered. On the Polish market, the introduction of such a significant number of new, more environmentally friendly active substances was an asset for agriculture. Changes in the availability of active substances were accompanied by a reduction in the number of registered formulations per active substance in all groups of plant protection products, with the exception of fungicides.

Few active substances were withdrawn from the Polish market because of the market decisions of their producers. The main reason for the above described changes was the EU review of active substances. Following the aim of the review, the substances which pose a risk for humans and/or the environment were withdrawn. Undoubtedly, this positively influenced consumer and environmental safety, which was a great benefit.

However, not all results can be considered as changes for the better. The review also gave rise to some difficulties which should be noted:

1. Not all the withdrawn active substances were harmful to the environment. Some were withdrawn simply because they did not generate enough income. In these cases, it was doubtful if the expenditure on the review (which was covered by the producer) would be recovered.
2. The reduction of available active substances obviously diminishes the possibilities of their rotation and increases the probability of resistance development [Węgorek, 2007]. Harmful organisms can become resistant to plant protection products. Resistance has been a central issue in agriculture for some time [Heimbach et al 2002].
3. The direct effect of the review was a decrease in the number of registered formulations. This show of a decrease was because only the producer (or producers) covering the costs of the review are entitled to sell the plant protection products containing a given active substance. These producers, can also (for a fee) allow another company to use the active substance, but in practice this rarely happens. Some producers therefore, were obliged to withdraw their products from the market.
4. The decrease in number of registered formulations resulted in a reduction of registered uses, especially for minor crops. Some of the formulations withdrawn were registered for minor uses. The producers of formulations remaining on the market are usually not very eager to widen the scope of registration just for minor uses, for financial reasons. Minor-use registration would require investing in studies, and paying registration costs which are not very likely to pay off.
5. Withdrawals of active substances and some formulations are accompanied by a reduction in the number of registered uses on the labels of products which remain on the market. This leads to problems with the protection of minor crops. Due to an increase in demands regarding documentation and the relatively high cost of studies, many minor uses are withdrawn from the labels during the re-registration of plant protection products. In Poland from 2004–2007, the number of registered uses was reduced in case of more than 70% of plant protection products with registration renewal (Matyjaszczyk 2008).
6. The expenditures for the review are considered when calculating the prices of plant protection products. A smaller number of registered formulations on the other hand, reduces competition on the market. These two factors combine to contribute to an increase in the price of existing plant protection products. New plant protection products, containing new active substances are usually more expensive than the old ones. Studies and the development of new active substances as well as their registration are costly. This contributes to a constant increase in the agricultural crop protection costs.
7. The numerous changes in the registration of plant protection products cause confusion and problems for farmers. In many cases, farmers were very familiar with the Polish products withdrawn, which had a long history on the Polish market. In light of the withdrawals, farmers need advice on what available substitutes can be used as replacements.

The difficulties described above are common for all EU member states to a greater or lesser degree. Their influence on the agriculture of the member states depends among other things, on the climatic conditions and the crops grown in a given country. The reductions of the

availability of insecticides for example are the greatest difficulty for Mediterranean member states. The problem with a lack of plant protection products for minor crops protection however, is particularly pressing in Poland. Problems are intensified because: Polish agriculture has a high number of small farms, numerous minor crops, weak farmer organizations and a Farmer Advisory which needs improvement (Chlebicka *et al*. 2008). Minor crops are an important source of income, especially for smaller farms. Therefore, the lack of protection may also cause some social problems.

The following example illustrates the fact that the availability of chemical protection depends strongly on the economic importance of the crop and the amount of plant protection products used: after the Polish EU accession, in spite of the significant decrease in the number of formulations, the number of plant protection products available for protection of winter wheat (the most important Polish crop grown on an area over 1,7 million hectares) against diseases had increased. The number of herbicides and insecticides registered for winter wheat protection have decreased, but they are still sufficient. At the same time, the number of plant protection products registered for carrot protection (a minor crop in Poland grown on an area of less than 33 thousand hectares) significantly decreased and is not sufficient from the point of view of the resistance preventing strategy. While mint (a very minor crop grown in Poland on the area of about 1 thousand hectares) was left almost entirely without protection. (Matyjaszczyk 2009)

CONCLUSION

In the years 2003–2009, a significant reduction of active substances used in agriculture was observed in Poland. In numerical terms, the amount of active substances decreased by 18%, but the real difference was much higher. There was a discrepancy because some substances were withdrawn at the same time that new ones were introduced on the market. The reductions were observed in all groups of plant protection products. The biggest decrease took place in the case of insecticides, which also had a smaller than average number of registered formulations when compared to herbicides and fungicides. Herbicides had the highest number of registered formulations per active substance, while fungicides were the only group where the average number of registered formulations per an active substance had increased in the analyzed period.

The withdrawals caused some complications, which were described in this paper. Particularly pressing in Poland, however, is the problem minor crop protection. The reason for this is related to the large number of small farms and numerous minor crops which characterize Polish agriculture.

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POLISH SUMMARY

SUBSTANCJE AKTYWNE STOSOWANE W OCHRONIE ROŚLIN W POLSCE PO PRZYSTĄPIENIU DO UNII EUROPEJSKIEJ

W latach 2003–2009 znacznie zredukowano liczbę substancji aktywnych stosowanych w ochronie roślin w Polsce. Zmniejszyła się z 340 w 2003 roku do 279 w roku 2009, ale rzeczywista różnica była znacznie większa, ponieważ wycofywaniu niektórych substancji towarzyszyło wprowadzanie do obrotu innych. Redukcje w dostępności wystąpiły we wszystkich grupach środków ochrony roślin. Największy spadek dotyczył insektycydów, które jednocześnie miały mniejszą niż przeciętna liczbę zarejestrowanych formulacji. Herbicydy miały najwyższą liczbę zarejestrowanych formulacji na substancję aktywną. Fungicydy były jedyną grupą, w której przeciętna liczba zarejestrowanych formulacji na substancję aktywną w analizowanym okresie wzrosła.

Główną przyczyną opisanych zmian był prowadzony w Unii Europejskiej przegląd substancji aktywnych. Zostały wycofane substancje mogące stanowić zagrożenie dla ludzi lub środowiska naturalnego. Wpłynęło to pozytywnie na bezpieczeństwo, jednocześnie jednak spowodowało trudności przedstawione w artykule. W warunkach polskich szczególnie istotny jest problem z ochroną upraw małoobszarowych.