RISK ASSESSMENT OF THE PERFORMANCE OF PLANT PROTECTION

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Summary. Risk assessment of the plant protection treatment in relation to changeable natural and operational factors and the constant technical and technological factor was performed. The paper made use of the method of assessing environmental dangers while applying pesticides, according to Spungoli and Vieri [1998]. It was shown that having a technically efficient sprayer alone does not ensure high quality of treatment or low risk of dangers to the environment. The importance of education of agricultural producers was emphasized in the sphere of pesticide application.

Key words: risk of pesticide application, risk factors, ecological education.

INTRODUCTION

Pesticide application in agricultural production still remains an important treatment enabling high yields. Pesticides as poisons and their application aiming at controlling the organisms that are agriculturally undesirable (agrophagous species) can cause a number of hazards, including danger to the sprayer operator, to outsiders and to other elements of the environment.

Besides, the level of these threats is conditioned both by qualifications and experience of the operator and by technical state of the equipment (mostly sprayers) as well as by field and atmospheric conditions. At the same time, pesticides show a high biological activity followed by diverse effects, for example on man's health, the formation of the biological activity of the soil and water environment and a danger to the air purity, which makes them a high risk factor of agricultural production [Schampheleire, 2007; Maroni and Fait, 1993].

The undertaken attempts to reduce the risk of using pesticides in plant protection concern such activities as improving the chemical composition and forms of pesticide application, improving the construction of the equipment and training its operators as well as preparing quality standards, requirements of the norms and legal regulations. In this respect, the governments of certain countries undertook a number of activities, including compulsory trainings for operators and testing the technical state of sprayers [Huyghebaert et al., 2004].

However, the problem that remains refers to the effective and complex assessment made by the producers of technical, technological and environmental conditions that constitute risk factors in performing the plant protection treatment. These constraints may result from the fact of trying to keep the dates of agricultural treatments, but at the same time they can result in neglect of the above-mentioned risk factors. It is for these reasons that attempts are made to work out the methods of risk assessment in the performance of plant protection treatments, including technical as well as exploitation or environmental factors.

AIM AND SCOPE

The aim of the paper is to assess the degree of risk in performing a plant protection treatment in the case when a technically efficient agricultural sprayer is used in two different kinds of conditions. An environmental impact analysis presented by Spugnoli P. and Vieri M. [Spugnoli and Vieri, 1998] was used to make the assessment. The method distinguishes and assesses risk factors (natural, technical and technological, exploitation ones) and such risk objects as operator, people and animals in the area of the treatment, air, water reservoirs, neighbouring cultivations, spraying quality.

Risk factors and their components were assessed in a three-grade scale, considering the ways in which they affect the objects of risk such as: direct (A), indirect (B) and marginal (C) ones. Particular components (Table 1) are assigned the proper scores. Besides, the character of the effect (A, B, or C) of the risk components on the risk object made the basis for the team of experts to establish the risk coefficient for each of the considered elements. In the applied methods, the assigned number of points for each risk component, multiplied by the proper risk coefficient, determines the level of risk for a given component. On the other hand, the sum of those risk levels makes it possible to determine the risk level for particular components, and next the total level of risk.

Table 1. Risk factors and their components together with risk coefficient and justification for the assessment in scores[1)]

Risk factors and their components	Scope of assessments of risk components	Scope of assessments of risk components	Risk coefficients
Natural:			
- wind	1 ÷ 15	Off-target airborne drift	13.1
- temperature and humidity	1 ÷ 15	Losses due to vapour drift	9.3
- closeness of the subject at risk to the treatment area	1 ÷ 15	Hazard for human and animal beings and other crops or water reservoirs	10.4
- target complexity	1 ÷ 10	Off-target airborne drift and run-off from target surface	9.1
Technological:			
- set up devices (regulations)	1 ÷ 10	Ease and reliability with which the delivered dose and regulation can be set	8.3

- devices to enhance spray accuracy	1 ÷ 10	Improvement of spraying precision	8.9
- mix preparation quality	1 ÷ 10	Reduction of outflow during the filling	6.2
- material and manufacture quality	1 ÷ 10	Reliability of team work, material quality, good labour coefficients (preparation, work, finishing the work)	9.6
Operational:			
- constraints on pesticides	1 ÷ 10	Habitat and operator safety (e.g. sprayer type and easy of exchanging it, toxicity of the chemical)	12.2
- constraints on operational methods	1 ÷ 10	Estimation of the treatment and its effect on operator and habitat	13.4
- constraints on periodic checks	1 ÷ 10	Up-to-date checks, repairs and tests	11.0
- disposal of residuals, cleaning the sprayer	1 ÷ 10	Ways and places of cleaning the sprayer (biobed) and utilization of residuals and wrappings	8.7

1) according to [Spugnoli i Vieri, 1998].

RESULTS

Increased use of pesticides in agriculture improves the effectiveness of production, but it is connected with the necessity of adjusting these treatments to legal regulations as well as the introduced system solutions, for example the Code of Good Plant Protection Practice [KDPR, 2002]. Particular legal regulations include the obligation of making technical checks of sprayers and conducting trainings for operators and producers in the field of the technology of plant protection.

The reason for these activities is the fact that an improvement of the sprayer construction is not connected with an increased awareness in the sphere of principles of using plant protection means and prevention of the resulting dangers. This is reflected in the number of sprayers checked in Poland: in the period 1999-2007, 315,888 sprayers (out of the total number of 331,313) were tested, which – considering the duty to repeat these checks in the period of 3 years – enables to estimate the effectiveness of these checks at about 30% [Kołodziejczyk, 2007]. Besides, the agricultural practice does not use the so-called protection (buffer) zones near the open water reservoirs. Moreover, it is common to equip the newly purchased sprayed with one type of nozzles (most often with the outflow intensity of 1.5 $dm^{3 \cdot}$ min^{-1}). It should also be taken into consideration that short agrotechnical periods for the performance of plant protection treatments and the changeable atmospheric conditions can induce producers to perform the treatments against the principles, in this way increasing the risk for the operator, the people around and the environment.

Considering the conditions mentioned in the paper (in accordance with the research method), the factors that determine the risk level while applying pesticides were estimated. It was assumed that the assessment of the risk level would be made for the same sprayer (Table 2) whose technical state does not arouse any doubts since it fulfils all research criteria that should be observed at the Sprayer Diagnostic Stations (SKO).

Table 2. Technical characterization of the sprayer considered in the assessment of the risk level of plant protection treatment

Specification	**Measurement units**		**Specification**	**Measurement units**
Tank capacity	dm^3	400	Type of steering valve	ARAG
Working width	m	12	Nozzle type	Slotted
Scale of regulation of the field beam	m	0.3-2	Pesticide mix preparation	equipped
Number of a field beam sections	pieces	3	Clean water tank	Equipped
Spacing of nozzles	m	0.5	Tank for rinsing water	Equipped
Maximum working pressure	MPa	0.4	Pesticide mix preparation	Equipped
Intensity of liquid outflow per minute	dm^3	107	Working liquid mixer	hydraulic
Type of sprayer pump	COMET BT 105		Sprayer fulfils the requirements binding at the diagnostic stations	

Two variants were considered for other conditions of performing the treatment: variant I refers to better (lower), and variant II refers to worse (higher) risk factors, which is reflected in correspondingly better and worse conditions of performing the treatment. The assessment (Table 3) considered three risk factors and the risk elements connected with them, including:

Variant I (positive)

natural risk factors – related to the wind speed (reducing the drift of a sprayer drop), air temperature and humidity adequate to the recommendations given by the producer of the pesticide, execution of the treatment on the area of the fields with marked buffer zones, the spectrum of spraying drops adjusted to the requirements (the use of adjuvant) and reducing the run-off of a drop from the protected surface.

technical and technological risk factors – connected with the sprayer construction (Table 2) expressed in low risk indexes, which follows from the fact that it is a medium class sprayer, fulfilling the requirements of the norms but not having, for instance, the air sleeve or the self-adjusting field beam.

operational risk factors – connected with such elements as the proper nozzle type, low toxicity of the pesticide, a systematically trained operator, up-to-date repairs and checks of the sprayer, proper management of the residue of the sprayer liquid, access to the stand 'biobed' and the storeroom for plant protection means.

Table 3. Assessment of overall risk for the conditions of treatment with a sprayer of technical parameters given in table 2 and estimation of the minimum (Min.) and maximum (Max.) risk level

Risk factors and their components	Scope of scores of risk components		Theoretical risk level		Calculated risk level (variant)			
					Good conditions (I)		Worse conditions (II)	
	Assessment of risk components	Risk coefficients	Min.	Max.	scores	Risk level	scores	Risk level
Natural:								
- wind	1 ÷ 15	13.1	13.1	196.5	5	65.5	10	134.0
- temperature and humidity	1 ÷ 15	9.3	9.3	139.5	5	46.5	10	93.0
- closeness of the subject at risk to the treatment area	1 ÷ 15	10.4	10.4	156.0	5	52.0	10	104.0
- target complexity	1 ÷ 10	9.1	9.1	91.0	3	27.3	7	63.7
Sum	**x**	**X**	**41.9**	**583.0**	**x**	**191.3**	**x**	**391.7**
Technological:								
- set up devices (regulations) (regulations)	1 ÷ 10	8.3	8.3	83.0	4	33.2	4	33.2
- devices to enhance spray accuracy	1 ÷ 10	8.9	8.9	89.0	5	44.5	5	44.5
- mix preparation quality	1 ÷ 10	6.2	6.2	62.0	4	24.8	4	24.8
- material and manufacture quality	1 ÷ 10	9.6	9.6	96.0	4	38.4	4	38.4

Sum	**x**	**X**	**33.0**	**330.0**	**x**	**140.9**	**x**	**140.9**
Operational:								
- constraints on pesticides	1 ÷ 10	12.2	12.2	122.0	4	48.8	7	85.4
-constraints on operational methods	1 ÷ 10	13.4	13.4	134.0	4	53.6	7	93.8
- constraints – e.g. periodic checks of sprayers	1 ÷ 10	11.0	11.0	110.0	1	11.0	8	88.0
- disposal of residuals and wrappings, cleaning the sprayer	1 ÷ 10	8.7	8.7	87.0	2	17.4	7	60.9
Sum	**x**	**X**	**45.3**	**453.0**	**x**	**130.8**	**x**	**328.1**
Total risk level	**x**	**X**	**120.2**	**1366.0**	**x**	**463.0**	**x**	**860.7**

1) [Spugnoli i Vieri, 1998].

Variant II (negative)

It was assumed that the technological risk factors would be the same, while the others will be less advantageous like in variant I, which is expressed in higher scores for the risk elements and which increased the index of total risk

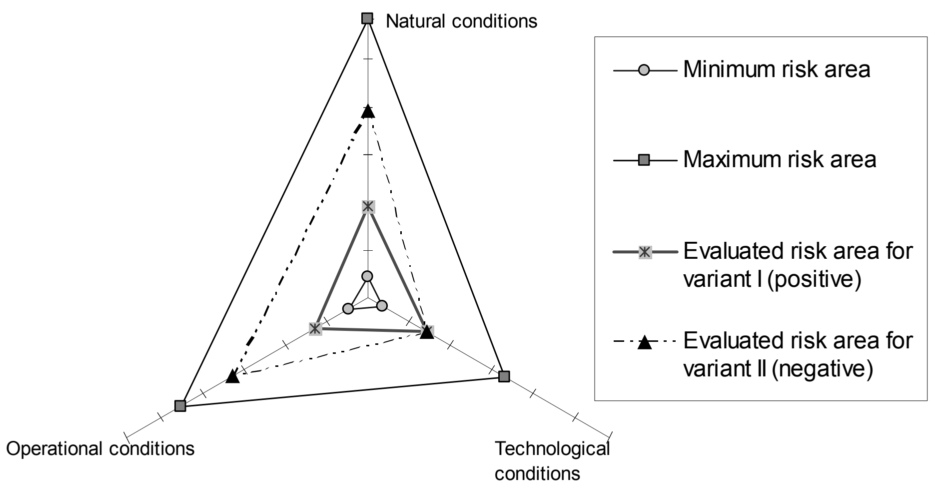

Fig. 1. Area of risk factors in different conditions of the plant protection

For a visual (Fig.1) presentation of changes in the level and risk areas for the two analyzed variants of sprayer work (of the same technical parameters), outcomes of the analysis are presented in a graphic form. It was found out that with the same parameters of the sprayer work, but with one exploited in negative natural and operational conditions, the treatment risk increases. While assessing the risk level of plant protection treatments, three areas of activity should always be distinguished, including identification of the kind of risk, determination of the risk factors character and assessment of the risk level [Maroni et al., 1999].

The risk assessment includes these areas and enables to state that the risk level is to a large extent connected with the operator's ability to adjust the technical and exploitation parameters of a machine to the currently occurring conditions of treatment performance. This means, which has been shown in the presented assessment, that just having a technically efficient sprayer at one's disposal does not ensure a high treatment quality or a low risk of environmental dangers.

CONCLUSIONS

The high risk of plant protection treatments has an economic dimension and exerts a complex influence on the process of agricultural production. This influence determines an ability of a farm to realize the process of agricultural production according to the principles established in the Code of Good Plant Protection Practice, the consequences of which can include changeable possibilities of producers taking advantage of different forms of subsidies for agriculture within the so-called agricultural-environmental programs [KDPR, 2002]. The indicated importance of each individual factor in shaping the risk level while applying pesticides, including the role of the operator's skills and responsibility, are the starting point for paying more attention to the issue of education of agricultural producers in the sphere of both theoretical and practical principles of performing plant protection treatments (ecological education).

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OCENA RYZYKA WYKONANIA ZABIEGÓW OCHRONY ROŚLIN

Streszczenie. Dokonano oceny ryzyka wykonania zabiegu ochrony roślin w odniesieniu do zmiennych czynników naturalnych i operacyjnych oraz stałego czynnika techniczno-technologicznego. W pracy wykorzystano metodę oceny zagrożeń środowiskowych przy aplikacji pestycydów wg Spugnoli i Vieri [1998]. Wykazano, że dysponowanie sprawnym technicznie opryskiwaczem nie jest równoznaczne z wysoką jakością zabiegu i niskim ryzykiem zagrożeń dla środowiska. Podkreślono znaczenie edukacji producentów rolnych w zakresie aplikacji pestycydów.

Słowa kluczowe: ryzyko aplikacji pestycydów, czynniki ryzyka, edukacja ekologiczna.