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Risk Assessment and Requirements for the Use of Personal Protective Equipment (PPE) in Agriculture

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Abstract

Many working places in agriculture and horticulture affect farmers` health by various kinds of load, such as mechanical or heat stress, or exposure to airborne contaminants which may harm or irritate skin or breathing. This can be gases and particles, which form very complex bio-aerosols depending on the kind of source. One important source of airborne contaminants are pesticides which include possible risks.

In all cases the possible risks have to be limited by reducing load or by using different types of PPE to protect the head, feet, whole body or respiration. This equipment must be tested and certified according the EU Directive 89/686 EEC and CEN standard, as far as available. In other cases, national standards or guidelines may be used, as it is done in Germany with the definition of PPE to protect users of plant protection products (PPP). Risk assessment requires consideration of exposure data and of suitable protective measures.

A particularity of the German model of risk assessment is to be seen in fixing limit values of penetration, e. g. 5 % concerning suits. A standard European testing procedure is currently under discussion in the framework of CEN work item WI 00162217. Concerning hand protection, gloves will be tested according to EN 374, which is under revision at the present time.

Keywords: risk assessment, personal protective equipment (PPE), performance requirement, test methods, plant protection products PPP (pesticides)

Zusammenfassung

Risikoabschätzung und Anforderungen für den Einsatz von persönlicher Schutzausrüstung in der Landwirtschaft

Viele Arbeitsplätze im Gartenbau, der Land- und Forstwirtschaft beinhalten Risiken für die Gesundheit und das Wohlergehen der dort Beschäftigten. Beispiele sind mechanische Belastungen, Hitzestress und die Exposition gegenüber luftgetragenen Stoffen, die sowohl respiratorisch wie auch dermal wirken können. Dies können sowohl Gase als auch Partikel sein, die aus den verschiedensten Quellen freigesetzt, z. T. sehr komplexe Bioaerosole formen. Eine weitere Quelle luftgetragener Stoffe, die ein Risikopotenzial beinhalten, sind die Pflanzenschutzmittel.

In allen Fällen sind die möglichen Risiken zu begrenzen, indem entweder die Belastung gesenkt wird oder persönliche Schutzausrüstung eingesetzt wird, die nach der Direktive 89/686.EWG geprüft und zertifiziert sein muss, soweit Standards existieren. Anderenfalls kann auf nationale Richtlinien zurückgegriffen werden, wie es am Beispiel der Pflanzenschutzmittel der Fall ist. Hier erfolgt unter Berücksichtigung der auftretenden Exposition und möglicher Schutzmaßnahmen eine Risikoabschätzung, die auch Teil des Zulassungsverfahrens für Pflanzenschutzmittel ist. Eine Besonderheit des deutschen Modells ist die Festlegung von maximal zulässigen Durchlassgraden, um das Risiko berechenbar zu machen. Für die Prüfung von Schutzanzügen im Pflanzenschutz wird derzeit beim CEN der Entwurf einer Prüfmethode diskutiert (WI 00162217, Atomizer Test). Für den Bereich Hautschutz findet die internationale Richtlinie EN 374 Verwendung, die zur Zeit überarbeitet wird.

Schlüsselwörter: Risikoabschätzung, Persönliche Schutzausrüstung, Anforderungen, Prüfmethoden, Pflanzenschutz

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1 Introduction

At their working places, farmers are affected by various kinds of load which result from ambient conditions (climate) and the work process itself, e. g., by emitting noise or airborne contaminants. These can be gases or particulates which form a risk potential for the farmers health and welfare by possibly harmful substances like pesticides. Also the biological content of aerosols - germs, bacteria, and fungi - must be taken into account. All possible loads have to be kept on low levels minimizing risk. If load can't be reduced means of protection have to be taken, at least PPE at the end of the chain of labour (worker) protection. According to the EU Directive 89/686 EEC, all PPE components on the European Market have to be labelled and certified. That means that the equipment has to be tested with standard procedures and graded by given requirements on the performance. Those requirements will be derived from the kind and situation of exposure time and level. Limit values can be given by national or international responsibilities. After a risk assessment defining necessary values of protection in agriculture and horticulture, additional questions of performance must be answered, e. g., thermal comfort, price and acceptance by the farmers and their environment. Here the situation is quite different to industrial conditions for the use of PPE, which is mostly understood as means of accident prevention. In the following, performance criteria for PPE in agriculture will be given for particular cases of load and protection. Proceeding from the example of risk assessment in pesticide (plant protection products, PPP) use, it will be shown how these requirements are set up.

2 Methodology/Application of PPE

Food and agricultural non-food production is characterised by a wide variety working places. It has to be distinguished between indoor work, e. g., in livestock-buildings or greenhouses and outdoor stationary or mobile work, that means on propelled harvesters or tractors with/without mountings. Particular stress factors results, apart from climate, from particular work, and requires specific means of protection.

Table 1 gives an overview about PPE and examples of its application in agriculture, as prescribed in Germany (accident prevention regulation, 2000).

Table 1
PPE and examples of application in agriculture

PPE protecting	Work field
Respiration	Use of pesticides, disinfectants, work in dusty atmosphere
Head	Handling of lifted goods, work on trees
Foot	Handling agric. mobiles, contact with claw and hoof animals
Eye and face	Work with saws and cutter, handling chemicals
Hearing	Work on non capsulated mobiles, with motor saw, feeding pigs
Hand	Work with saws and cutter, handling chemicals
Body	Work with motor saws, handling chemicals, pesticide application

Airborne contaminants in agriculture and horticulture, which harbour possible risks by accidents and by long-term-effects are a special case. Particulates and gases may influence farmers health by dermal or respiratory uptake. Gases are to consider during mixing manure, handling silage and during gas application for conservation, or controlling pests. Particles emitted in livestock-buildings or in field operations like harvesting primarily influence mostly respiration by their possible allergic potential (Hinz et al., 1990).

A higher risk potential will be given by the use of chemicals, such as disinfectants and especially pesticides. These are labelled according to the Hazardous Substances Ordinance (1999) if they are highly-toxic (T^+), toxic (T), caustic (C), harmful (Xn) or irritating (Xi).

Figure 1 shows the distribution of PPP used in Germany over the various hazard levels. It shows that the share of risky pesticides is much lower than it would normally expected. Only about 6 % of the pesticides are classified as T^+ or T. Most of them are rodenticides.

But the influence of those possibly hazardous substances is only one factor of load and must be seen with exposure level and time. Because of a probably remaining portion of risk for all pesticides which are meant for distributed in Germany, a special risk assessment has to be presented to the body of authorisation. Figure 2 shows the main idea of how to calculate risk including measures of protection. The total degree of operator exposure (E) in a field situation will be compared with tolerable values of exposure (tol) which are calculated by the no-observed-effect level (NOEL) divided by a safety factor, e. g., 100, depending on the specific toxicological properties of the chemical. The condition for authorisation of a PPP is $E < 1$. For $E > 1$ authorization will be kept by technical means of reduction only, e. g., by the use of PPE. This must be noted in the instructions for operator protection and be

Table 2
Main sources of airborne contaminants in agriculture and horticulture

Source	Contaminant	Effect
Manure	gas	respiratory
Silage, bio-gas	gas	respiratory
Greenhouse	aerosol / gas	respiratory / dermal
Animal house	aerosol / dust	respiratory / dermal
Field operating	dust	respiratory
Plant protection	aerosol / gas / dust	respiratory / dermal

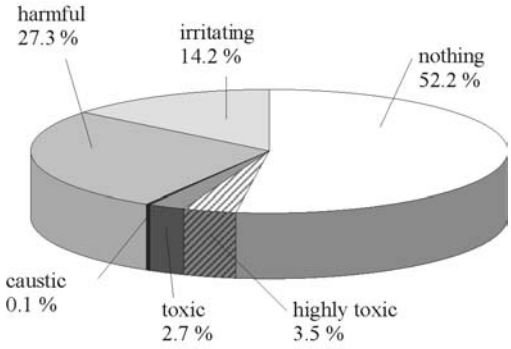

Fig. 1
Distribution of pesticides (PPP) over the various hazard levels, Germany

seen on the label of the PPP. For this purpose a risk management model has been developed which is currently being discussed as a harmonised European model (Lundehn et al., 1992).

Depart from the more simple idea of accident prevention this model shows some particularities, e. g., by the introduction of dose-effect functions instead of the break through criteria. The main idea of the model is to calculate exposure while considering all kinds of work and possible ways of uptake: undiluted pesticide while mixing and loading – short-termed, the process of application – long-termed and additional maintenance jobs in the field, before and after spraying. The oral, respiratory and dermal path of uptake must be determined. The calculated overall exposure must be compared with a relevant toxicological limit value which results from special tests and will be prescribed mostly by national authorities. In case of pesticides, this value is the acceptable operator exposure level (AOEL) which is required by EU directive 97/57/EC. In case that the ratio of calculated exposure and the AOEL is greater one, means of load reduction e.g. using other procedures of application or less harmful agents or PPE are to be fixed. One key point of the model is to fix reduction factors to maximum allowable values of penetration through the protective material.

These values are given in Table 3 with e. g. 5 % for suits and 1 % for gloves. Plant protection products are only authorised in Germany, if the exposure calculated with use of PPE is tolerablefor instance by use of PPE.

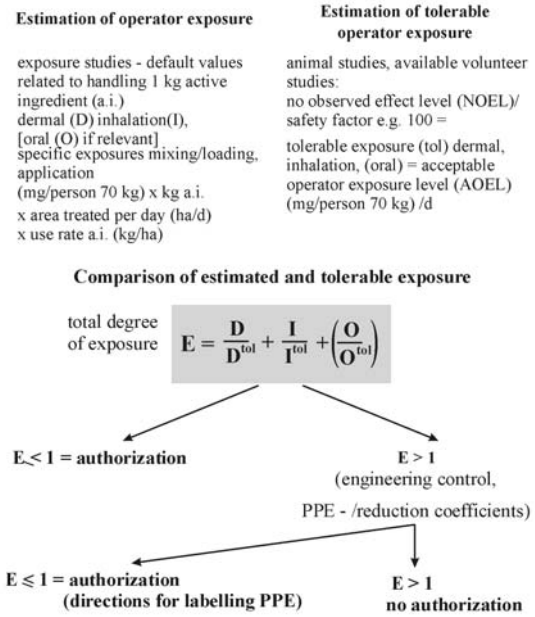

Fig. 2
Risk assessment for operator protection in Germany

Table 4 shows the numbers of authorised PPP related to prescribed protective means, Figure 3 the legal procedure and responsibility for authorisation.

Severe exposure, such as during pesticide application in greenhouses or storage's (fumigation), may require highly protective suits of type 1 chemical protective clothing.

Apart from the protective performance, PPE must also meet certain other requirements. Thermal comfort is an important factor with regard to the long time job of spraying. To ensure thermal comfort, water vapour resistance must not pass over a maximum a value, just like the mechanical properties. Design and colour of the equipment are really important for acceptance of these PPE by farmers'.

The optical impression of protective clothes is very important. Protective garment which is to be recognised as such at first sight will probably not be worn in orchard and vineyard regions which are frequented by holiday-makers and other visitors. Performance criteria of protective garment are listed in Table 5.

Table 3
Reductions coefficients of performance of PPE

Protective mean	Reduction Coefficient	
	Dermal	Inhalation
Universal protective gloves (plant protection)	0.01	
Standard protective garment (plant protection) and sturdy footwear	0.05	
Protective clothing against chemicals; type 1	0	
Broad-brimmed headgear of sturdy fabric	0.5	
Hood and visor	0.05	
Particle filtering half-mask FF2P2-SL or half-mask with particle filter P2	0.8	0.08
Half-mask with combination filter A1P2	0.8	0.02

Table 4
Number of authorised PPP (total 1160) with specific instructions for operator protection (Germany) on the basis of BBA-Guideline Part I –3/3, 1993

Means of protection	Mixing and loading pesticides		Application pesticides	
	Number	%	Number	%
Universal protective gloves (plant protection)	344	30	279	24
Standard protective suit (plant protection) and sturdy footwear	332	29	332	29
Protective clothing against chemicals; type 1	0	-	0	-
Apron	122	10.5	10	<1
Tight-fitting goggles	269	23	47	4
Particle filtering half-mask FFP2-SL or half -mask with particle filter P2	50	4	50	4
Half-mask with combination filter A1P2	0	-	27	2
Broad-brimmed headgear of sturdy fabric	0	-	77	7

Depending on the load, PPE will be worn for the different types of work in agriculture and horticulture as indicated in Table 1. According to the EU directive those means have to been tested by standard procedures of harmonised standards, as far as available. In other cases national norms or guidelines are to be used, such as the BBA guideline for PPE in plant protection (BBA, 1993, 1997) in Germany. Table 6 shows the network of existing standards of testing various parameters of PPE performance.

Table 5
Additional criteria of performance of PPE

Criterion	Measure	Limit value
Strength	Tensile strength	Longitudinal 600 N cross 400 N
	Tear resistance	25 N
Thermal comfort	Water vapour resistance	20 m^2Pa/W
Acceptance	Design, colour, prize, availability	

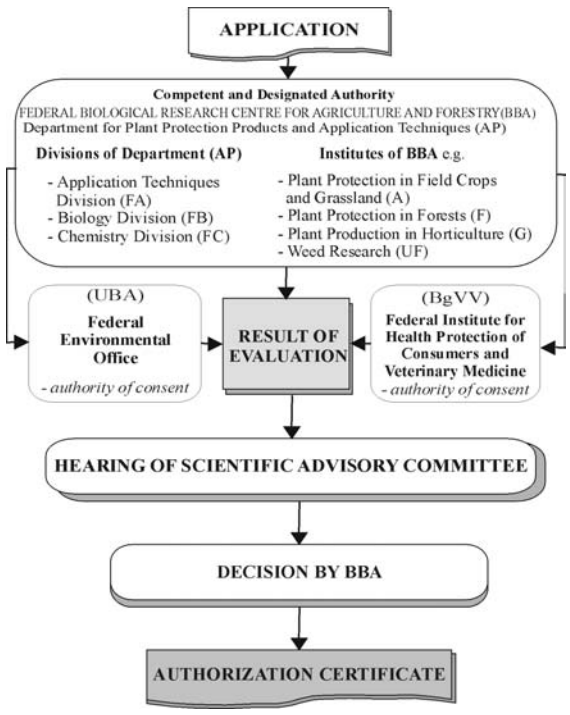

Fig. 3
German authorisation procedure for plant protection products (PPP)

Table 6
CEN standards for testing performance of PPE

Performance property	Test method standard
Respiration	EN 136, EN 140, EN 146, 147, 149
Eye/face protection	EN 166
Foot protection	EN 345
Hearing	EN 352, EN 458
Hand protection	EN 374, EN 388, EN 381 - 7
Body	EN 340, EN 465, EN 470, draft DIN 32780 - 300, prENISO 13982 - 2, EN 468, EN 463, EN 368, EN 369

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