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CHEMICAL THREATS IN AGRICULTURE

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Abstract. Farm work is highly diverse and can be intense during growing seasons. It involves machinery and tools, close contact with animals and changing environmental conditions. Farmers face many dangers as part of their everyday duties, among them being chemical hazards such as pesticides, fuels and lubricants, mineral fertilizers and disinfectants. This risk is followed by dust generated when growing plants, feeding animals and cleaning the farm. Mineral fertilizers should be applied in a way that is safe for the health of humans, animals and the environment. Work related to the application of fertilizers may be performed only by healthy adults after appropriate training: any sick workers require medical certification before working with mineral fertilizers. In all cases, direct contact with the skin and eyes should be avoided, and mineral fertilizers, especially dusty ones, should only be spread on windless days. Pesticides are among the most harmful compounds to which farmers are exposed. The user is at risk during their use, as well as while they are stored in a warehouse when disposing of residues and empty packaging. A thorough knowledge of risk factors significantly increases work safety in agriculture.

Key words: agriculture, chemical hazards, disinfectants, fuels and lubricants, mineral fertilizers, plant protection products.

INTRODUCTION

Working on a farm encompasses a range of jobs and production processes. These typically involve the use of machinery and tools, close contact with animals and exposure to potential environmental hazards. Such a complex work environment increases the risk of accidents or occupational illness; indeed, farm work is characterised with a higher accident rate than industry (Maciołek and Zielińska 2012). According to the Agricultural Social Insurance Fund, 10 974 accidents were recorded in 2020 (KRUS 2021). This figure is 19.6% less than in 2019, with the number of insurance policy holders decreasing by 2.3%.

The key threats noted in farms are:

- chemical and dust hazards,
- mechanical hazards,
- biological hazards,

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– physical hazards (e.g. noise, falls from heights, impact by objects, crushing, slipping, stumbles and falls at the same level),
– animal hazards.

Of these, the greatest risks are posed by chemical hazards such as plant protection products, fuels and lubricants, mineral fertilizers and disinfectants (Fig. 1). This risk is followed by dust generated when growing plants, feeding animals and cleaning the farm.

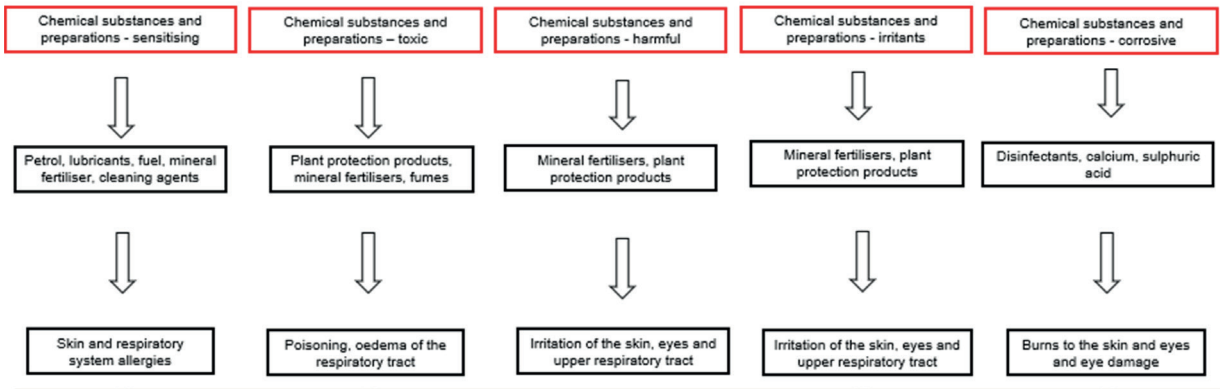

Fig. 1. Classification of chemical hazards in agriculture (own elaboration)

MINERAL FERTILIZERS

At the end of the 19th century, mineral fertilizers were developed; however, although they have increased crop yields, they also represent a threat to the health of their users. Mineral fertilizers are industrially prepared chemical compounds or mixtures used to provide nutrition for cultivated and horticultural plants. Although mineral fertilizer use is currently increasing in Poland due to the decline in farm animal numbers (Piwowar 2011), their price has recently increased by 300%, and hence, their use is expected to fall.

Mineral fertilizers should be applied in a way that is safe for the health of humans, animals and the environment (Hartley et al. 2013). Excessive, and ineffective, mineral fertilizer application results in contamination of drinking water and water eutrophication, among others. The long-term effects of mineral fertilizer use are difficult to define (Xu et al. 2012; Hartley et al. 2013). Therefore, when using them, care must be taken to minimise their impact on humans and the environment. Mineral fertilizers can also be a source of soil contamination with heavy metals (e.g. Pb and Cd), which can cause atherosclerosis and mutagenic neoplasms in humans (Dutkiewicz and Świątczak 1993). Both lead (Pb) and cadmium (Cd) are highly toxic and non-biodegradable (Patra et al. 2005), and Krzywy et al. (2010) notes that lead also tends to accumulate in the tissues of organisms. Both metals are taken up by humans, with the rate of uptake being determined by their abundance in the environment. Lead is absorbed through the alimentary canal and respiratory tract, with some bioaccumulating in the bones and soft tissues, and the rest being excreted. Around 10% of Pb is absorbed from the gastrointestinal tract, with as much as 50% absorbed in children (Jakubowski et al. 1997; Kabata-Pendias and Pendias 1999; Krzywy et al. 2010). Lead weakens the immune system and is known to damage the nervous and hematopoietic systems (Hsu and Guo 2002).

In addition to the heavy metal content, contamination with mineral fertilizers, especially nitrogen fertilizers, entails further risks for infants and young children, as it lowers the level of haemoglobin in the blood. Furthermore, the nitrates in the fertiliser, and the resulting nitrites, react with amines to form nitrosamines, which can have carcinogenic effects (Kabata-Pendias and Pendias 1999).

Work related to the application of fertilizers may be performed only by healthy adults after appropriate training: any sick workers require medical certification before working with mineral fertilizers.

All workers should be familiarised with the content of the label attached to a container of fertiliser: this contains important information about its potential hazards and associated risks. In addition, safety data sheets with detailed information on health and safety can be obtained from fertilizer distributors and on the manufacturers' websites.

In all cases, direct contact with the skin and eyes should be avoided, and mineral fertilizers, especially dusty ones, should only be spread on windless days. Furthermore, fertilizers must be stored in their original packaging, all damaged bags must be removed from the warehouse, and sufficient space must be left between the stored fertilizer piles to allow easy access by vehicles and forklifts. Fertilizers packed in big bags should not be stored in piles consisting of more than three layers, because these may be unstable. The bags should also be placed on pallets if there is a risk of fertilizer coming into contact with wet ground. All stored fertilizers, with their quantity and distributions, should be specified on a list located in a visible place.

In addition, to avoid the risk of chemical reaction or fire, different types of fertilizer, e.g. nitrogen and phosphorus, should be kept in different piles. Furthermore, under no circumstances should fertilizers be stored close to potential heat sources (e.g. fuel tanks), chemicals, pesticides or combustible materials (e.g. hay and straw).

The warehouse itself should be equipped with efficient ventilation (at least by gravity), and its equipment and electrical installations should function correctly. Smoking and the use of naked flames are strictly forbidden. Furthermore, only authorized persons may have access to the warehouse.

PLANT PROTECTION PRODUCTS

While plant protection products increase crop yields, they can also pose a potential threat to the environment, the farmers who use them and local residents. Even at low concentrations, pesticides pose a serious threat to the environment, particularly aquatic ecosystems (Agrawal et al. 2010).

Pesticides are among the most harmful compounds to which farmers are exposed. The user is at risk during their use, as well as while they are stored in a warehouse when disposing of residues and empty packaging. It is essential to ensure that stored plant protection products do not have any harmful effects on the health of agricultural workers or consumers. Inappropriate use of such products can result in cancer, genetic mutations and changes in the nervous system (Dasgupta et al. 2007; Abhilash and Singh 2008).

In many countries, including Poland, minor cases of poisoning by plant protection products involving farmers and agricultural workers are rarely reported to doctors. Furthermore, because many of the symptoms are fairly general, or similar to other common health symptoms, such as headache, dizziness or vomiting, diagnosis presents a challenge for primary care physicians. The World Health Organization (WHO 2005) and the United Nations Environment Program (UNEP 1998) estimate that for every reported and registered case of pesticide poisoning in agriculture, there have been 50 unregistered or unreported cases. Incorrect use of pesticides causes hormonal changes, DNA damage, foetal death, birth defects, problems with spermatogenesis, lung cancer, damage to the renal tubules, leukaemia and anaemia (Zahm et al. 1997).

The rules regarding the introduction of plant protection products to the market and their use are governed by the Act of March 8, 2013. These regulations also specify the procedures used for confirming the technical efficiency of the associated equipment, the required training and collection of information about poisoning.

Any worker operating a pesticide sprayer must have an appropriate certificate, indicating completion of training in the use of plant protection products. Most importantly, plant protection products must be stored as instructed.

Some of the chemical agents contained in plant protection products are able to enter the body through the respiratory tract, and through the skin and mucous membranes. As it is impossible to estimate how much of each can be absorbed by the body, the employer is obliged to provide protective clothing or workwear specially designed for this type of work (i.e. made of tight fabric or waterproof material), as well as personal protective equipment. This should include non-absorbent jumpsuits or trousers, a top with cuffs at the end of the sleeves and rubber boots into which the trousers can be tucked. The worker should also be provided with comfortable rubber gloves: these must be adjusted to the size of the hands and reach beyond the wrists, and must be tucked into the sleeves of the suit. In addition, the employee should be equipped with protective glasses or a face shield with transparent glass.

The sprayer operator is most at risk when the spray liquid is being prepared, as this requires direct contact with the concentrated substances. Therefore, the operator should wear a rubber apron covering the torso and legs, half-masks with an AP2 filter, and goggles or tight glasses to protect the eyes (Doruchowski et al. 2014). All personal protective equipment should have an appropriate certificate.

Any employees working with plant protection products should be familiarised with the information contained in the accompanying leaflet. Their instructions for use should be written in a clear and understandable way for the employee. Furthermore, the products should be stored in their original packaging and grouped according to their purpose and toxicity, and should only be used with correctly-functioning equipment. When spraying, the wind speed must not exceed 4 m/s. A distance of not less than 5 m should be maintained from public roads, and not less than 20 m from buildings, apiaries and the intermediate zone of water and surface water intakes. Plants that are covered with honeydew must not be sprayed.

The Regulation of the Minister of Agriculture and Rural Development of 18 April 2013 on the requirements of integrated pest management specifies that a professional user performing treatments with plant protection products is obliged to keep appropriate documentation, specifying the following: the date of the treatment , the name of the chemical agent used for the treatment, the area of the protected field, the type of crop being protected, the amount of the preparation used per unit area, the reason for application of the plant protection product. This should be accompanied by any other comments such as conditions during the treatment and the effectiveness of the preparation. Such documentation should be kept for a period of three years.

Plant protection products should be stored in dry storage rooms and the base should be protected against moisture. Unauthorized persons should not have access to plant protection products; therefore, the entrance door should be kept locked (e.g. with a padlock) and the windows should have bars to prevent unauthorized access. Instructions for the safe handling of plant protection products should be posted on the entrance to the warehouse, together with a list of emergency telephone numbers. Inside, a description of the warning signs, symbols and pictograms placed on the packaging of chemical agents should be placed in a visible place. The warehouse should be equipped with efficient ventilation (at least by gravity) to prevent the accumulation of harmful gases, and should include measures and accessories to neutralize leaks (e.g. absorbent).

FUELS AND LUBRICANTS

Agricultural equipment and tractors not only pollute the environment with exhaust gases, their operation also entails other risks, such as poisoning due to contact with harmful exhaust fumes,

burns by corrosive substances (e.g. from batteries, brake systems) or hot vehicle parts (e.g. engine), together with a risk of fire or explosion due to the presence of fuel vapour.

Exhaust gases also contain a number of poisonous chemicals that can also enter the body through the skin, respiratory tract or digestive system. Such chemicals include carbon monoxide, carbon dioxide and nitrogen oxides, as well as unburned hydrocarbons, and lead and sulphur compounds (Šimatonis and Tiškevičius 1994). A particular threat is posed by carbon monoxide: upon inhalation, it combines with blood haemoglobin, where it is transformed into carboxyhaemoglobin, resulting in oxygen deprivation (hypoxia) as noted by Seńczuk (1994). Higher levels of blood carboxyhaemoglobin result in a greater risk to human health and life. In addition, all factors also negatively influence the ecological balance, which can also have a negative impact on human health.

Machine and tractor repair also entails contact with solvents and lubricants such as benzene and its derivatives (toluene, xylene). Among these, the more volatile substances pose a greater threat to the respiratory tract. According to the safety data sheet prepared in accordance with Regulation (EC) No. 1907/2006, as amended, acute human poisoning with petroleum distillation products result in paralysis of the central nervous system, headaches, loss of consciousness, convulsions, chronic poisoning and loss of consciousness, as well as respiratory disorders. In addition, brake fluids, lubricants, fuels and solvents contain heavy metals such as cadmium and lead; long-term contact presents a risk of chronic poisoning resulting in headaches, shortness of breath, heart disorders and respiratory disorders (Feliksik 2016).

SUBSTANCES FOR DISINFECTING LIVESTOCK PREMISES

Disinfection is most commonly performed using quaternary ammonium salts, acids and bases, phenolic compounds, alcohols (e.g. ethyl, isopropyl), aldehydes (e.g. formaldehyde), heavy metal compounds (e.g. silver, copper), oxidants (peroxides) and chlorine compounds (Kampf and Löffler 2007; Balwierz et al. 2018). While the responsibility associated with the selection of preparations and the disinfection process itself rests with the farmer in the case of small premises, in larger farms, the management is responsible. When selecting a preparation, attention should be paid to the range of biocidal activity, speed of action and efficiency of the preparation and the concentration that is safe for the environment; in addition, the selected disinfectant must allow for effective treatment. In all cases, before starting work, it is important to read the product safety data sheet.

An integral part of the REACH system (registration, evaluation, authorization and restriction of chemicals) used in European Union countries is the safety data sheet (SDS), whose aim is to provide recipients and users with information about preparations, i.e. the health hazards and precautions. The SDS must be available when using and storing the disinfectant. It must be presented in such a way that the person who has contact with the preparation can easily recognise the hazards described in the card.

It is also very important that the employees are adequately prepared for performing disinfection work; they should receive initial training in this field, and this training should be repeated periodically as part of the job. It must be emphasised that disinfectants are dangerous preparations that irritate the eyes and skin, and their use is associated with a relatively high risk of side effects (Kampf and Löffler 2007; Balwierz et al. 2018). Quaternary ammonium compounds, chlorhexidines, ortho-phthalic and glutaraldehydes are irritants and can elicit skin sensitivity (Bocian and Tyski 2010; Kieć-Świerczyńska et al. 2010). Therefore, when diluting the preparation and carrying out the disinfection itself, appropriate protective clothing, such as rubber boots, coveralls and gloves, protective glasses and a protective mask must be worn. In addition, when disinfecting equipment from livestock housing outdoors, the operator must consider the direction and strength of the wind.

CONCLUSION

A thorough knowledge of risk factors significantly increases work safety in agriculture. The use of appropriate technical solutions and following procedures compliant with regulations helps protect the health of farmers and other agricultural workers. Therefore, these groups should be familiarised with safety procedures, and appropriate habits to ensure occupational safety.

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ZAGROŻENIA CHEMICZNE W ROLNICTWIE

Streszczenie. Praca w gospodarstwie rolnym charakteryzuje się sezonowym nasileniem oraz dużym zróżnicowaniem. Rolnik podczas pracy używa maszyn oraz narzędzi, ma kontakt ze zwierzętami oraz jest narażony na zmieniające się warunki środowiskowe. Do jednych z najbardziej niebezpiecznych należą zagrożenia chemiczne, na które rolnik jest narażony podczas pracy ze środkami ochrony roślin, paliwami i smarami oraz nawozami mineralnymi i środkami do dezynfekcji. Drugą niebezpieczną grupę stanowią pyły, które powstają podczas uprawy roślin, zadawania karmy zwierzętom oraz przy pracach porządkowych w gospodarstwie. Nawozy mineralne powinno się stosować w sposób, który jest bezpieczny dla zdrowia ludzi i zwierząt oraz środowiska. Prace związane ze stosowaniem nawozów mogą być wykonywane tylko przez pełnoletnie i zdrowe osoby po przeprowadzeniu odpowiedniego szkolenia. Pracownicy ze schorzeniami mogą pracować z nawozami mineralnymi tylko za zgodą lekarza. Pamiętać należy także, aby nawozy mineralne (szczególnie pyliste) wysiewać w dni bezwietrzne. Należy unikać bezpośredniego kontaktu ze skórą i oczami. Nawozy mineralne muszą być przechowywane w oryginalnych opakowaniach. Stosowane w rolnictwie środki ochrony roślin (pestycydy) należą do grupy najbardziej szkodliwych związków, na które narażeni są rolnicy. Zagrożenie dla rolnika jest nie tylko podczas ich stosowania, ale również podczas przechowywania w magazynie, jak i utylizacji pozostałości oraz pustych opakowań. Znajomość czynników, które są niebezpieczne, oraz dróg ich szerzenia w znaczący sposób zwiększa bezpieczeństwo pracy w rolnictwie.

Słowa kluczowe: rolnictwo, zagrożenia chemiczne, środki do dezynfekcji, paliwa i smary, nawozy mineralne, środki ochrony roślin.