

The importance of personal protective equipment in pesticide applications in agriculture

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Abstract

Pesticides are applied for protecting the quantity and quality of agricultural crops. Yet, these chemicals may have side effects on human health and the environment. To minimize pesticide effects on human health, farmers have to use appropriate personal protective equipment (PPE) in all stages of pesticide handling. However, empirical and research data support that farmers do not use PPE before, during, and after pesticide application. Thus, farmers can often suffer from acute and chronic poisoning by pesticides. Farmers have to be educated about the importance of PPE in pesticide use. The national authorities should provide up-to-date, accurate, and easy to understand information in the training of farmers in the use of PPE. This paper highlights the importance of PPE in pesticide applications in agriculture.

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Farmer, Agriculture, Pesticide exposure, Personal protective equipment.

Introduction

Pesticides are widely used by farmers for high quality and yield in the agricultural production. These chemicals can significantly improve quality and quantity of agricultural crops, but due to increasing sensitivity for environmental protection in recent years, different methods of crop protection are also used against diseases and pests. For example, cultural and biological methods of pest control can decrease pesticide applications. Nevertheless, in certain cases, the application of pesticides against pests and diseases is rather inevitable.

In chemical crop protection, using pesticide overdose or incorrect pesticide products may cause serious problems

on human health and the environment [1,2]. Especially, in these situations, operators' health can be seriously affected, since pesticides can cause chronic and acute effects on human health [3]. Some of these impacts are Parkinson's disease, various types of cancer, skin allergies, stomach pain, asthma, and others [4–14]. Thus, pesticides have to be applied using appropriate spraying methods to avoid negative effects on human health. Mohanty et al. [15] reported that agricultural workers should be educated regarding safe use of pesticides to prevent health and environmental hazards. Pesticide exposure in operators and workers can be minimized by using personal protective equipment (PPE), such as coveralls, headgear, gloves, protective eyewear, and footwear that can prevent pesticide exposure [16]. In this review, information is provided about the importance of PPE for people applying pesticides, with aiming to raise awareness of using PPE.

Farmers' exposure to pesticides

Farmers can be influenced by pesticides during transport of pesticides and preparation of spray solution as well as before, during or after pesticide application [17]. In particular, farmers can be affected by pesticides in three different ways during pesticide use. These mainly include oral exposure, dermal exposure, and exposure via inhalation. Especially during spraying with fog (10–30 μm) or aerosol (30–50 μm) small droplets, which are suspended in the air, farmers have to use a mask [18]. If farmers do not use mask, pesticide droplets about 1–5 μm in diameter are accumulated in the lungs and the breathing tube. Furthermore, small droplets (<1 μm) are spread in the lower part of the lungs [19].

Operator exposure is defined as the exposure of people who are primarily involved in pesticide applications [20]. About 97% of human exposure to pesticides during spraying occurs through contact with the skin [21]. Dermal exposure to pesticides is highly correlated with the manual contact with pesticide-treated plants and it is believed to be the major route of pesticide exposure during occupational use [22]. Almost 1.3 billion workers worldwide suffer from occupational injuries from the use of pesticides and are occupied in agriculture [23]. Every year, almost 17,000 workers in agriculture are under a lethal effect according to the records of ILO (International Labor Organization) [1].

Operators can be directly exposed to the pesticide during preparation of spray solution (mixing and loading pesticides), during spraying or even after pesticide

application. For these reasons, pesticide exposure can be considerably reduced by using PPE [20,24–33]. During spraying pesticides, exposure occurs in operators' head, eyes, hands, lungs, legs, and feet. For minimizing this exposure, operators should always wear PPE. Yarpuz-Bozdogan and Bozdogan [34] indicated that PPE decreased the maximum risk for workers by 32%, the intermediate risk by 44%, and increased the chances of no risk by 24%. In this study, it was concluded that PPE has to be used for minimizing pesticide exposure in workers, as it was found that PPE was important for workers in all herbicide applications. In many countries, farmers do not prefer to use PPE due to meteorological factors during pesticide applications. In particular, operators in Turkey are not using PPE due to the hot weather conditions.

PPE use and items

PPE can help operators avoid direct contact with pesticides [18,35,36]. When mixing pesticides, the operators/workers have to use gloves and eyewear. The efficiency of a working overall combined with PPE to protect operators against dermal exposure to plant protection products under field conditions was studied [37]. PPE can reduce the risk of exposure to pesticide spraying, but the use of PPE in small-scale farmers is very low [36]. Farmers should be protected against all risks with the use of PPE during spraying. Operators' exposure can be considerably reduced by using personal PPE. Nicol and Kennedy [38] reported discomfort, high expense and loss of time as farmers' reasons for not wearing PPE. Samuel et al. [39] reported that farmers in Nigeria did not use PPE during herbicide applications. Okoffo et al. [31] indicated that 20% of the farmers in Ghana did not use PPE during pesticide applications. Ribeiro et al. [40] reported that workers in greenhouses had higher risk of pesticide exposure. Consequently, workers must use PPE during pesticide application in the greenhouse. Another problem about the use of PPE by farmers is the inadequate education about pesticide application methods. Saeed et al. [41] reported that the level of knowledge of farmers about the adverse effects of pesticides on human health in Pakistan increased with education and training. It was shown that diseases such as skin allergies, stomach pain, asthma, and others can be reduced by providing training on pesticide application to the farmers and by using PPE during pesticide application [42]. To reduce the adverse effects of pesticides on human and environmental health, farmers should be educated about the proper use of pesticides and pesticide application methods [43]. PPE is categorized in five groups. These are head protection, eye and face protection, body protection, respiratory protection, as well as hand and foot protection, as described below.

Head protection

Hat

A waterproof hat should be used to protect the operators' head against pesticides. It should be easy to clean.

Eye and face protection

Face shields

Farmers should use face shields to avoid the negative effects of pesticides when preparing pesticides as well as during and after pesticide application.

Goggles

Eyes are the most sensitive part of the body. Eyes absorb pesticide quickly and to a great extent. Farmers must use goggles to be protected by spills or splashes that happen during mixing and loading the pesticides. Cargnin et al. [44] reported that 13.6% of tobacco growers used goggles in Brazil. Farmers are obliged to use gloves when pesticides are released into drug storage. The use of gloves is recommended to minimize pesticide exposure [19].

Body protection

Coveralls

It is recommended that operators use disposable or washable coveralls during pesticide preparation, mixing the tank, spraying and also during sprayer cleaning. Because of the high prices of the coveralls that are recommended for pesticide applications, different alternatives are used instead of coveralls, such as long-sleeved shirts, trousers, and aprons. In Korea, farmers preferred long-sleeved shirts and trousers instead of PPE during pesticide application [45]. Cargnin et al. [44] reported that in Brazil, 81.5% of tobacco farmers used coveralls.

Aprons

PVC aprons can be used as an alternative to coveralls. The apron should be long enough to cover the chest and the knees. The apron used during pouring pesticides at any location must be immediately cleanable or washable.

Respiratory protection

Respirators

A respirator is a unit that covers the mouth and the nose to prevent spray droplets of pesticide, small particles, and vapors from getting into the lungs. During pesticide application in the greenhouse, the operators are affected by pesticides in the air. For this reason, farmers must use a respirator in greenhouses. Generally, respirators are divided into two classes. These are the atmosphere supplying respirator and the air-purifying respirator [21].

Hand and foot protection

Gloves

Hands almost always become contaminated when handling and applying pesticides. Contaminated hands with pesticides can often affect human health because pesticides can be easily transferred to the eyes, the nose, the mouth, and the face. For this reason, operators must always use gloves in all pesticide applications. Gloves must be waterproof or pesticide resistant. Suitable

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