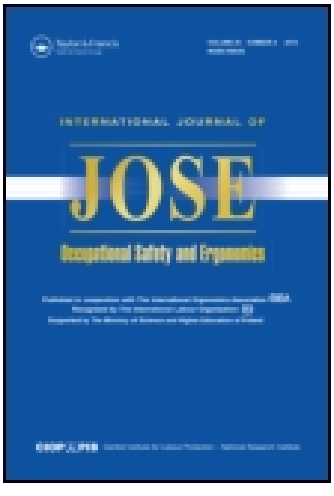

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General Evaluation of Risk Associated With the Use of Pesticides and Other Chemical Substances on Animal Breeding and Plant Production Farms

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NOTES

General Evaluation of Risk Associated With the Use of Pesticides and Other Chemical Substances on Animal Breeding and Plant Production Farms

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A general characteristic of chemical risk on plant production farms in Poland is presented. The paper describes risk associated with the natural occurrence of chemical substances (such as ammonium and hydrogen sulfide) in the process of animal breeding and risk connected with the use of artificial fertilizers and pesticides. Pesticides are briefly described taking into consideration toxicity classes and the toxic effect of individual compounds. Exposure to pesticides is presented for individual methods and related activities. Finally, the author discusses pesticide risk on fruit-growing farms and in greenhouses.

pesticides risk plant production animal breeding

1. EVALUATION OF EXPOSURE TO HARMFUL CHEMICAL SUBSTANCES ON ANIMAL BREEDING FARMS

1.1. Animal Breeding

Ammonia is the main chemical hazardous factor in the working environment, created in the process of decomposition of urine, faeces, and bedding. Its concentration does not exceed adopted health standards. The remaining compounds found in the air are hydrogen sulfide, nitric

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oxide, and carbon dioxide. Their concentrations in the air do not exceed Maximum Allowable Concentrations (MAC).

1.2 Poultry Breeding (Hatcheries, Broiler Houses)

Studies conducted by the Institute of Agricultural Medicine in hatcheries and broiler houses showed the following concentrations of ammonia and hydrogen sulfide:

hatcheries	ammonia up to 14.3/3 (MAC 20 mg/m^3), hydrogen sulfide up to 7.5 mg/m^3 (MAC—10 mg/m^3);
broiler rooms	ammonia 7.3–70.3 mg/m^3—its concentration exceeds MAC;
hydrogen sulfide	up to 2.2 mg/m^3—its concentration does not exceed the health standard for this compound (Dutkiewicz et al., 1974).

2. EVALUATION OF EXPOSURE TO CHEMICAL SUBSTANCES IN AGRICULTURAL CROPS

2.1. Mineral Fertilizers

Mineral fertilizers are applied with distributors, spreaders, and often manually on private farms. During various technological operations connected with the use of fertlilizers (especially in powder form), large amounts of dust are created. The Maximum Allowable Concentration of non-toxic dust in the air may be up to 10 mg/m^3 according to Polish standards (Minister of Labour and Social Policy, 1995). Measurements carried out by the Institute for Mechanisation and Electrification of Agriculture (as cited in Latalski, 1987) showed that the concentration of dust in the air during the use of fertilizers exceeds Polish standards several times.

Apart from mineral components that constitute the basic fertilizing mass, this dust may contain certain amounts of lead, mercury, cadmium, or arsenic.

2.2. Pesticides

Pesticides are chemical or biological agents used to protect crops against rodents, plant parasites, or pathogens and in the hygiene of humans and animals. Ninety percent of pesticides are chemical. Each preparation for plant protection consists of one or more biologically active substances. These chemicals very much vary in their (a) chemical structure, (b) properties harmful to humans and animals, (c) destination, and (d) forms of use.

There are many classifications of pesticides, for example, according to chemical group, destination, class of toxicity, or form of use (Brzeziński, 1994). Pesticides belong to the following chemical groups: (a) chlorinated hydrocarbons, (b) derivatives of phosphoroorganic acids, (c) derivatives of triazine, (d) derivatives of carbamaic acid, (e) dithiocarbamates, (f) derivatives of nitrophenols, (g) derivatives of carbamide, and (h) synthetic pyrethroids.

Pesticides are classified into four classes of toxicity (Ustawa o ochronie, 1995). The classification is based on the studies of toxicity on animals and covers three routes of absorption: oral, dermal, and respiratory. Table 1 shows this classification in detail.

Pesticide preparations are produced and used in various forms: liquid, powder, or granulated. The following formulations are used in liquid form: concentrate for water emulsion, water-soluble concentrate, concentrated suspension, and ultra low-volume liquid. Formulations in solid form include powder for water-suspension, water-soluble powder, granules, dusting powder, and smoke generator.

The process of chemical protection of plants begins with their purchase, transportation, and storage in the farm area. These operations are performed by individual farmers. Each of these operations constitutes risk for the farmer, whereas there is no risk if the operations are performed in accordance with safety regulations. However, situations such as damage to packaging, spillage of the preparation, or its incorrect storage in the farm area do happen. They result in a threat of human and animal poisoning, as shown in Table 2.

A person using pesticides is exposed to various preparations for chemical plant protection. Their concentrations in the breathing zone are especially high and may exceed the allowable standards. Apart from exposure through inhalation, there is also a considerable exposure of the whole body (clothes) and especially of the skin of palms (Pomorska, 1994).

TABLE 1. Classes of Toxicity for Humans

Class of Toxicity		Acute Oral Toxicity LD_{50} (mg/kg)	Acute Dermal Toxicity (Rat or Rabbit) LD_{50} (mg/kg)	Acute Inhalation Toxicity (Rat) $LD_{50}LC_{50}$ (mg/ ¼ hr)
I	highly toxic	$\leqslant 25$	$\leqslant 50$	$\leqslant 0.25$ aerosols $\leqslant 0.50$ gasses and vapours
II	toxic	$25 < LD_{50} \leqslant 200$	$50 < LD_{50} \leqslant 400$	$0.25 < LC_{50} \leqslant 1$ aerosol $0.50 < LC_{50} \leqslant 2$ gasses and vapours
III	hazardous	$200 < LD_{50} \leqslant 2000$	$400 < LD_{50} \leqslant 2000$	$1 < LC_{50} \leqslant 5$ aerosols $2 < LC_{50} \leqslant 20$ gasses and vapours
IV	moderately hazardous	> 2000	> 2000	> 5 aerosols > 20 gasses and vapours

Notes. Acute toxicity is the property of a substance to induce a toxic effect when administered in a single dose as a result of a single exposure; LD_{50}—quantity of a chemical substance calculated on the basis of statistical analysis, the administration of which results in death of 50% of the animals under study; LC_{50}—quantity (concentration in the air during 4 hrs in mg/L) of a chemical substance calculated on the basis of statistical analysis, the administration of which results in death of 50% of the animals under study.

During the preparation of seed dressings high concentrations of active substances are observed in the air. During the treatment of sowing material, both manually and with the use of hand-operated mechanical equipment, the concentrations of active substances are very high and they generally exceed health standards (MAC). Apart from air pollution, there is also high contamination of clothes and the skin of palms (Badach et al., 1979; Majczakowa & Badach, 1982).

TABLE 2. Contamination of Air, Clothes, and Hands by Pesticides at Different Work Sites

Work Site	MAC Value Exceeded	Contamination*	
		Clothes	Hands
Portable backpack tanks	yes	high	high
Preparation of seed dressing	yes	very high	very high
Preparation of solutions for a sprangers tank	yes	high	high
Tractor driver (low crops)	no	low	low
Tractor driver (tall crops)	no	very high	very high
Proportioner driver (low crops)	no	low	low
Proportioner driver (tall crops)	yes	very high	very high
Proportioner driver (soil treatment)	no	very low	very low

Notes. *—high: 0.3–1 mg/cm^2; very high: over 1 mg/cm^2; low: 0.002–0.004 mg/cm^2; very low: under 0.002 mg/cm^2.

Pesticides are introduced directly into the soil in liquid or granulated form with special proportioners. In the case of liquid preparations applied with manual proportioners, there are high concentrations (exceeding Maximum Allowable Concentrations) of the active substance in the air. However, in the case of sowing granulated preparations, these concentrations are very low (Majczakowa, Pomorska, Pieczykolan, & Szwarc, 1989; Majczakowa, Pomorska, Soczewińska-Klepacka, & Pieczykolan, 1987).

One can be exposed to pesticides through inhalation, but pesticides can also penetrate through the skin. Lower parts of the body and the skin of palms become contaminated, with higher contamination resulting from watering plants with preparations. The greatest human risk occurs at the stage of preparing the formulation for use, followed by its use.

Preparations for chemical plant protection can be liquid, solid, or granulated. During preparation of solutions for use and dilution, chemical substances are released into the working environment as dust, aerosols,

or vapours. The level of air pollution depends on the pressure of the active substance and its concentration in the preparation. In many cases, concentrations of individual substances exceed health standards (MAC) several times over.

Apart from exposure through inhalation of contaminated air, there is also dermal exposure—considerable amounts of the preparation settle on clothes and uncovered parts of the skin. The upper parts of the body (upper extremities, especially palms) are most exposed to contamination. (Majczakowa, 1982; Majczakowa, Nazimek, & Soczewińska-Klepacka, 1983; Pomorska, 1994).

A person performing chemical treatment is exposed to contact with chemicals both through inhalation and dermal penetration through uncovered skin. It is noteworthy that such a person is exposed to more than one chemical substance. This exposure depends on the concentration of the solution, the height of the crop, and microclimatic conditions.

Thus, during chemical treatment of low crops, Maximum Allowable Concentrations are not exceeded, whereas for tall crops, some concentrations exceed this standard (Minister of Labour and Social Policy, 1995). Working in fields where the crop is tall, for example, in hop gardens, creates high risk through dermal exposure. During chemical treatment, the whole body is highly contaminated. A high level of exposure in the case of tall crops is evidenced by values exceeding MAC in the air and contamination of both clothes and the skin of the whole body (Pomorska, 1994).

3. EXPOSURE TO PESTICIDES ON SPECIALIST FRUIT-GROWING FARMS

On fruit-growing farms contact with pesticides lasts from over 10 to several dozen days annually. On large farms, this contact may be continuous in spring and summer.

On fruit-growing farms, household buildings are typically located in the vicinity of fruit orchards. As air contamination is common, exposure to pesticides affects both the workers who do the spraying and the inhabitants of the farms. Studies by the Institute of Agricultural Medicine (Majczakowa, Pomorska, Prach, & Szwarc, 1982; Pomorska, 1994; Pomorska, 1997; Pomorska & Majczakowa, 1995; Pomorska, Badach, & Nazimek, 1997) showed that following the use of a preparation for

chemical plant protection, the concentration of the active substance is present in the air for several consecutive days (depending on the physical and chemical properties of the active substance). Measurement of the level of contamination of selected parts of farm buildings showed that the surface of soil, as well as furniture in the house, were contaminated by pesticides.

The majority of operations related to greenhouses are conducted indoors. Therefore, the effect of special microclimatic conditions is considerable. Treatment procedures cover spraying, fumigation of soil, pouring, and evaporation of preparations. Exposure to pesticides may also concern people who carry out cultivation procedures of these crops.

Studies by the Institute of Agricultural Medicine showed that in greenhouses of large cubic capacity no concentrations exceeding MAC are observed during the use of pesticides. In greenhouses of capacity below 400 m^3, however, the concentrations of pesticides in the air may exceed standards (Majczakowa & Badach, 1982; Majczakowa, Badach, & Soczewińska-Klepacka, 1993). Procedures connected with the cultivation of crops in greenhouses are a serious problem as they cause high contamination of clothes and palms with previously applied pesticides.

4. CONCLUSION

According to studies conducted by the Institute of Agricultural Medicine, the following operations connected with the use of pesticides are the most dangerous: (a) preparation of liquids and dilution of concentrates, (b) seed dressing with the use of manual or some types of mechanical equipment, (c) treatment performed in fields of tall crops, and (d) treatment performed in greenhouses.

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