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New Approaches to Work Wear

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Abstract: In the article the research results on the safety of workers in the greenhouses have been presented. The problem of improving the environmental protection has been considered due to the analysis of production risks of work in the greenhouse. The authors have defined the topography of the influence of hazardous factors of production on the parts of workers' body based on which the recommendations for making up a set of work wear together with means of protection have been worked out. The proposed kinds of protection are based on standard methodics and approaches as well as on the implementation of modern state-of-arts technologies.

Keywords: hazardous factors, greenhouse, work wear, means of protection.

1. Introduction

Today the worsening of economic situation in Ukraine encourages farmers to grow vegetable crops not only for their own consumption, but also for sales in the market. The implementation of growing vegetables in the sheltered soil of greenhouses in agriculture is a highly profitable solution for the productive use of plots of land. This solves such problems as the independence of a manufacturer from the seasons of a year and weather conditions. Another problem is that the plots of land suitable for growing vegetables are too expensive. So, to solve this problem the manufacturers are increasingly building greenhouses. However, the incidence of temporary disability of workers in greenhouses is 5 times higher than that of their colleagues who work with similar chemicals on the open soil, and 10 times higher than in people who do not come into contact with pesticides and fertilizers [1,2].

The funds saved on the means of personal protection and certified pesticides can result in investing much more money in medical treatment of workers. The study of the influence of hazardous production factors at work in the greenhouses on the health of the workers who have found themselves in a vicious circle of toxic effect of pesticides and cases of illnesses of the workers themselves, not to mention the accumulation of pesticides, will give an impetus to a caring attitude to their health.

The authors have set the task – to analyze the existing production risks for the workers of greenhouses with the development of recommendations for making work wear, which will be convenient for performing the production tasks, but will at the same time protect against the negative impact of the working environment [3,4].

2. Materials and Methods

The study was conducted in the greenhouses of Irshava district, Transcarpathia (Ukraine). 3 types of Greta fabrics recommended for making the protective clothing when working in greenhouses have been examined according to the

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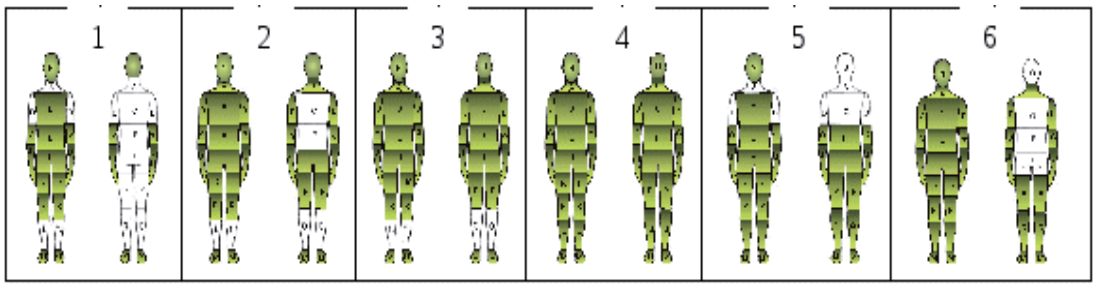


Fig. 1: *The classification of protective clothing as to the influence of dangerous harmful production factors.*

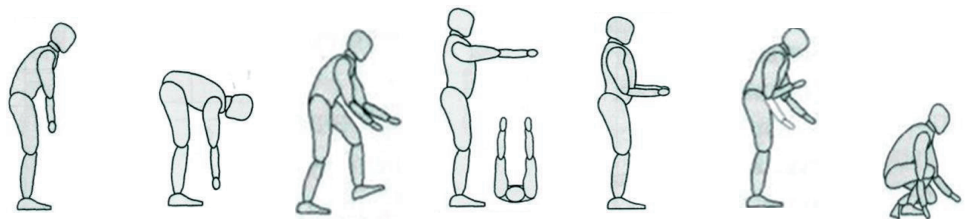


Fig. 2: *The main movements of workers while doing the field work in the agrarian sector.*

regulated methods of determining the physical and mechanical properties [5,6].

The protective clothing that is offered on the market does not always fully correspond to a specific level of requirements that are put to it and the specific needs of the production sector, since for the real working conditions the influence of not one but several dangerous harmful factors is typical.

The basis of the Standard Classification of special clothing put its protective properties from the effects of dangerous and harmful factors and allocated 6 classes of impact on different parts of the body [7].

The protective properties from the effects of dangerous and harmful factors are laid into the basis of Standard Classification of the protective clothing; there distinguished 6 classes (Fig. 1) of the influence on different parts of the man's body [8, 9].

3. Results and Discussion

While studying the problem of production growing of plants it was revealed that despite the risks of the usage of agricultural chemicals it is impossible not to use them [8].

In order to design a work wear of high-quality the research on the scope of labour activity of workers in the greenhouses taking as an example growing cabbage was carried out.

The authors have defined and graphically presented (Fig. 2) the main movements of workers while doing the field work in the agrarian sector.

Among all types of work those are singled out which are done with agricultural chemicals and, consequently, need means of protection for workers.

Table 1: *Scope of labour activity while growing cabbage in a greenhouse.*

Stages of labour activity while growing cabbage	Conditions for carrying out the activity
Seed sowing	By seeders, by hand
Diving of seedlings	With a peg, with a finger
Additional fertilizing and protection	By ammonium nitrate superphosphate potassium phosphate biostimulators and vitamins
Hardening	Ventilation, decrease of watering, temperature mode
Planting of seedlings	By machine, by hand
Care	Fertilizing, watering, mellowing of soil, removing seeds (by hand or by herbicides)
Protection from pests	Automatic, mechanized, by spraying, sprinkling, fumigation

Table 2: *Factors of a negative impact of agrochemicals on the workers' organism while working in greenhouses.*

Factor of impact	Characteristic of influence	
Physical and chemical properties of pesticides	***Chemical:*** ▪ Not enough volatile substances; ▪ Volatile compounds; ▪ Nitrogen fertilizers; ▪ Cotton-mineral substrates.	***Physical:*** ▪ Granulated; ▪ Powder-like; ▪ Solutions, suspensions, emulsions; ▪ Aerosols and vapours.
Low air speed	The air speed in the greenhouse is varying. The average air speed in the middle of the greenhouse is within the range of 0.5 - 0.7 m/s.	
Temperature and concentration	The high temperature in the greenhouse increases the concentration of pesticides in the air of the working area, especially under the conditions of a closed climate (greenhouses)	
Time and duration of exposure to toxin	Treatment by pesticides should be done in the morning or evening The time of workers' presence depends on the ambient temperature and stability of pesticides.	
Condensation in greenhouses	Condensation in the greenhouse creates conditions for the growth of various bacteria spores.	
Ways of getting into the body	▪ Through the skin; ▪ Through the respiratory system; ▪ Through the digestive organs.	
Additional factors of influence	▪ Noise level; ▪ The smell of gasoline; ▪ Exercises; ▪ Direct and reflected shine; ▪ Individual peculiarities of the organism.	

To analyze the diseases that agrochemicals cause and to define the means of protection, the authors determined the topography of influence of hazardous production factors on the parts of workers' bodies (Table 3). There were singled out the diseases that manifest themselves immediately, and those whose influence has a remote action. Due to the specificity of technological processes, the organism of workers (who are mostly women) is exposed to the complex of hazardous production factors: chemical fertilizers, pesticides, plant growth stimulators, disinfectants and products of their metabolism, high humidity, high temperature and considerable physical exercises [10]. As a result of using the complex of chemicals (besides giving fertilizers to the soil, at least 3 times a month spraying is carried out) the air in the greenhouse may contain ammonia, nitrogen oxides, phosphoric anhydride, hydrogen fluoride, sulfur dioxide. This causes the respiratory diseases, the diseases of nervous system, urinary tract and circulatory system. Allergic diseases (dermatitis, bronchitis, asthma) are also observed. The personal protection means that can be recommended to be used when working in greenhouses:

1) special clothing with soaking or a film coating
2) respirator;
3) gloves;
4) rubber boots
5) glasses and protection for ears.

In addition to these diseases, the harmful effects of long-term action should be noted: cancer; change in the reproductive organs; menstrual cycle; spontaneous abortion; the rate of physical abuse and sexual maturation, which is also dangerous for health.

To establish whether the materials recommended for the manufacture of working protective clothing are suitable the experimental research of materials as to some physical and mechanical properties (Table 4) was carried out.

Besides the above mentioned methods of protection from dangerous surroundings of greenhouses, the authors offer modern electronic

Table 3: *Topography of influence of hazardous productive factors on the parts of the workers' body in the greenhouses.*

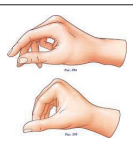
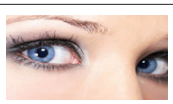
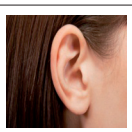
The parts of human body impacted by agrochemicals	Ways of getting into the organism	Action of pesticides	Diseases that are caused by toxins	Means of protection from pesticides
1	2	3	4	5
Skin	Adsorption through skin into blood: Skin - blood	General – resorptive: - irritating; - non-irritating.	- allergy (itching); - skin sores; - skin infection	
	The mucous membrane of the upper respiratory tract – respiratory tract -lungs – blood system	Vasoconstrictive: - irritating; - non-irritating.	- sternutation; -cough.	
	Digestion – liver (neutralization) – general blood circulation	General toxic: - cumulative; - functional; - material.	- diarrhea; - vomiting; - pain in the abdomen; - decrease in blood pressure; - cold limbs.	
	Eye – the mucous membrane of the eye	Irritating	- epiphora; - pyrosis; - reduction in the reaction of the apple of the eye to light	
	Ear – the tympanic membrane		- amblyacosia; - loss of hearing.	

Table 4: *Results of study of some fabrics.*

Physical and mechanical indices	Methods and conditions of conducting tests	Quantity of samples and their sizes, mm	Results of studies		
			TM1	TM2	TM3
Hygroscopicity, %	Desiccator, drying cell, electronic balance	4 samples 50 x 200	9.6	12.1	0
Breaking load, kN ***- along the warp*** ***- along the weft***	Breaking machine	3 samples 50x200 (along the warp and along the weft)	Bl_{warp}=165.5 Bl_{weft}=50.8	Bl_{warp}=108.8 Bl_{weft}=55	Bl_{warp}=142.3 Bl_{weft}=36.5
Moisture permeability, %	Desiccator, glasses, electronic balance	3 samples d=80mm	Vrel.=53.8	Vrel. =51.6	Vrel(b)=36.43 Vrel(l)=32.23
Surface density, g/m²	Electronic balance	3 samples	D_s=198.33	D_s=198.66	D_s=150.33
Resistance to puncture by a needle	Sewing machine, magnifying glass	2 samples 200 x 200	2	1.8	5
Resistance to dry friction, points	Device TI – 1M	1 sample 180 x 80, 1 sample 50 x 50	5	5	5
Resistance to sweat, points	5 gr salt, 6 mgr 20% ammonia, 1liter of water, acetic acid, T = 45°C	2 samples 100 x 40	5	5	5
Resistance to washing, points	Washing machine, detergents	6 samples 60 x 50	5	5	5

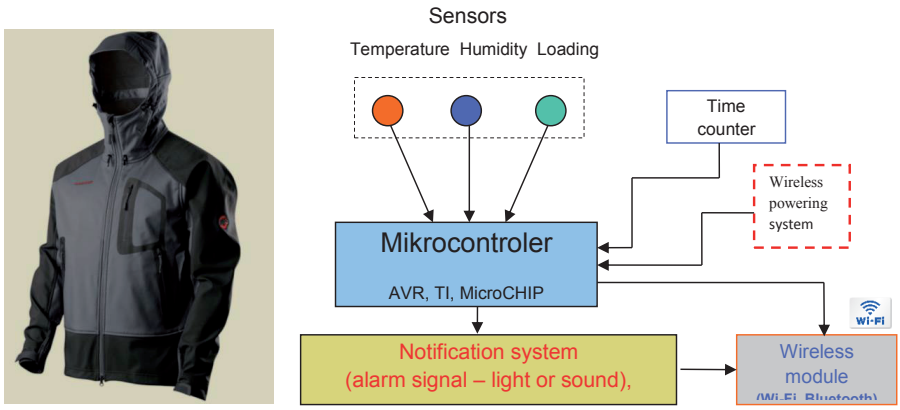


Fig. 3: *Intelligent uniform based on new digital technological.*

controls of vital functions of the human body [11]. The essence of this proposal is that sensors of various types are mounted into the clothing which fix important indicators of internal and external surroundings, such as temperature, humidity, duration of stay, sensors of chemically hazardous substances, and so on (Fig. 3) [12]. Modern developments in the field of microcontrollers' technologies allow to process the data with high speed and efficiency, besides, they are easily mounted into portable systems of various types. It is especially necessary to mention the widespread introduction of wireless [13] admission-transmission systems that can significantly improve the efficiency of the so-called "smart clothes". Thus, in case of critical situations the microcontroller having analyzed the information from the sensors embedded in the worker's clothes by special means of signaling (warning sound or indicative ones, for example [14]) will report on the danger of the worker's state to the controlling remote station, making the occurrence of a critical situation for the health or life of a man impossible.

4. Conclusion

The scope of labour activity of the workers in greenhouses and ways of treatment by pesticides have been studied by the authors. In order to design a special protective clothing the specificity of production - climatic conditions of the activity with the coverage of hazardous and harmful production factors that can have an effect on the workers in greenhouses has been investigated.

In order to assess the level of quality of fabrics for working clothes several studies on appropriateness of fabrics to meet the established requirements have been done.

Modern electronic touch-sensitive control-signalling systems of the life of an employee when he/she performs his/her professional duties have also been offered.

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