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Environmental and hygienic assessment of territorial burden and composition range of pesticides utilized in agriculture of northern region of Kazakhstan

There was analyzed the intensity of pesticide use in the northern region of Kazakhstan by the indicator of territorial pesticide burden and integral index of territorial burden. Despite the average level of territorial burden in the assessed region, the analysis by the Oblasts has revealed that in certain Rayons of the Oblasts this indicator was over 1 kg/hectare. The highest specific weight in the structure of pesticide burden belongs to the active substances of the 3rd class of hazard, with low probability of carcinogenic effect, moderately stable in the soil.
Keywords: pesticides, territorial pesticide burden.

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Қазақстанның солтүстік өңірінің ауыл шаруашылығында пайдаланылатын пестицидтердің ассортименттік құрамы мен аумақтық жүктемесіне экологиялық-гигиеналық бағалау

Қазақстанның солтүстік өңірінде пайдаланылатын пестицидтердің қарқындылығы аумақтық пестицидтік жүктеме көрсеткіші және аумақтық жүктеменің интегралдық индексі бойынша сарапталған. Зерттелген өңірдегі аумақтық жүктеменің орташа деңгейіне қарамастан, облыстар тұрғысындағы сараптама облыстардың жеке аудандарында аталған көрсеткіштің 1 кг/га асатынын көрсеткен. Аумақтық жүктеменің құрылымындағы жоғары үлесті 3-сыныпты қауіптілігі бар әрекет етуші заттектер құрайды, олардың канцерогендік әсерінің ықтималдығы аз, топырақтағы тұрақтылығы әлсіз.
Түйін сөздер: пестицидтер, аумақтық пестицидтік жүктеме.

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Анализ территориальной нагрузки и ассортиментного состава пестицидов, применяемых в сельском хозяйстве северного региона Казахстана

Проанализирована интенсивность применения пестицидов в северном регионе Казахстана по показателю территориальной пестицидной нагрузки и интегральному индексу территориальной нагрузки. Несмотря на средний уровень территориальной нагрузки в исследованном регионе, анализ в разрезе областей выявил, что в отдельных районах областей данный показатель превышал 1 кг/га. Наибольший удельный вклад в структуру пестицидной нагрузки внесли действующие вещества 3-го класса опасности, с маловероятным канцерогенным действием, умеренно стойкие в почве.
Ключевые слова: пестициды, территориальная пестицидная нагрузка.

Introduction

Intensification of agricultural production is traditionally associated with use of crop protection chemicals, primarily, pesticide preparations. On the one hand, use of pesticides is a coercive measure, and on the other hand, there are no pesticides safe for a human being and environment [1]. At the same time, researchers express their serious con-

cerns regarding the level of dependence of intensive agricultural methods on use of agricultural chemicals, followed with negative effects on health and humans and ecosystems [2]. It is well known that since 1990-s the use of pesticides dropped in the Republic due to decline of agricultural production, lack of funding the mentioned production sector, etc. However, starting 1998 there is noted the trend towards increasing the use of pesticide preparation, primarily, insecticides, caused of abrupt growth of locusts in the natural reservations. To date, the total number of registered pesticides preparations is over 650 [3], while in 1970-1980-s only 112 preparations were registered for use in the Republic.

One of important factors characterizing the ecologic situation in region and risk level used pesticides on people's health is the assessment of territorial pesticide burden and composition range of pesticide preparations. In this connection, we have conducted the study of intensity of use of crop protection chemicals in agricultural Rayons of the northern region of Kazakhstan.

Materials and Methods

Specially designed cards-questionnaires have been used to collect information on composition range, amounts of used pesticides (in kilograms of marketed preparations) and sizes of agricultural land treated with pesticides in 2009-2011, based on data from Oblast Departments of the Committee of State Sanitary and Epidemiology Surveillance of MOH RK and Oblast Territorial Inspections of the Committee of State Inspection of AIC on MA of RK. In each Oblast under study the following Rayons have been chosen for analytical activities: Akmolinskaya Oblast – 17 Rayons; North Kazakhstan Oblast – 13 Rayons; Kostanayskaya Oblast – 16 Rayons. The intensity of pesticide use was estimated by the following two indicators: territorial burden (TB) (ratio of 1 kg of active ingredient of pesticide preparation to 1 hectare agricultural area treated with such pesticide) and integral index of pesticide TB (calculated with use of assessment score of pesticide properties characterizing its hazard by environmental and hygienic, toxic indicators). Integral TB index combines properties determining environmental, biological aggression of agricultural chemicals and their remote consequences – stability in the soil, contamination of ground waters, general toxicity, carcinogenicity, effect on endocrine system. Integral TB index reflects qualitative composition of preparations in use, with consideration of their level of hazard to human health and environment, and is used both for assessment of hazard, and pesticide use risk. Analysis of the collected data allowed calculating territorial burdens and integral TB indices of pesticides by Rayons and the Oblast as a whole. To calculate TB on agricultural areas, the following groups of crop protection chemicals have been used: herbicides, insecticides, acaricides, fungicides, dressers, growth regulators, defoliants and desiccants. The following preparations were not used for analysis: biopreparations, rodenticides and surfactants. Statistical data processing was made with use of software Microsoft Excel 2010.

Results and Discussion

The study of pesticide composition range and territorial pesticide burden in the Akmolinkaya Oblast has demonstrated the decline of intensity of pesticide use per unit of agricultural area in 2009-2001 from 0.73 kg/hectare down to 0.49 kg/hectare. Average annual pesticide burden on the territory of Oblast (TB) in 3 years was 0.57 kg/hectare, while Rayon-related analysis indicated that in the Yesilsky, Zharkainsky, and Shortandinsky Rayons the TB was over 1 kg/hectare. Breakdown of TB was as follows: herbicides – 35.4%, fungicides and dressers – 34.1%, insecticides and acaricides – 30.5%. The highest specific weight in TB was after the pesticides of 3 class of hazard (WHO) – 49.4%. In average, during the study period 18.8% of total TB constituted probable carcinogens, 48.5% - low-probability carcinogens. The share of pesticides with established potential effect on endocrine system was 28.2%, pesticides with suspected endocrine effects – 41.6%. Assessment of pesticides used by their capacity to contaminate ground waters showed that 13.9% of total TB were such contaminants, and 60.7% were potential contaminants of ground waters. At classifying the used pesticides by their stability in soil in aerobic conditions, the moderately stable pesticides (38.4%) held the highest proportion in the total TB of the Oblast.

Analysis of data collected in the North Kazakhstan Oblast also indicated to the decline of intensity of pesticide use per unit of agricultural area in 2009-2011 from 0.78 kg/hectare down to 0.65 kg/hectare. Average level of pesticide TB during the period of study was 0.69 kg/hectare, while the Rayon-wise analysis showed that in the Rayon named after G.Musrepov, Aiyrtausky, and Akzharsky Rayons the TB was

above 1 kg/hectare. Assessment of integral TB index has revealed in the structure of pesticide burden the similar trends as in the Akmolinskaya Oblast. Thus, share of herbicides was in average 41.9%, fungicides and dressers – 38.8%, insecticides and acaricides – 19.3%. Pesticides of 3 class of hazard had the highest specific weight in pesticide TB of the Oblast (58.9%). In average, during the study period 17.4% of total TB belonged to probable carcinogens and 37.2% to low-probability carcinogens. The share of pesticides with established potential effect on endocrine system was 42.1%, pesticides with suspected endocrine effects – 37.5%. During the study period no contaminants of ground waters were used in the Oblast, while the potential contaminants of ground waters constituted 57.6% of total TB. At classifying the used pesticides by their stability in soil in aerobic conditions, the moderately stable pesticides held the highest proportion in the total TB of the Oblast (46.9%).

It was found that on the territory of Kostanayskaya Oblast the average annual pesticide burden (TB) was during the study period on the same level (0.67 kg/hectare), and only in Zhetikarinsky, and Kostanaysky Rayons the TB was over 1 kg/hectare. In the structure of TB the share of herbicides did prevail (over 60%), while the shares of fungicides and insecticides amounted in average to 29.1% and 10.8%, respectively. Assessment of the structure of total TB by the class of hazard (WHO) of active ingredients showed prevalence of pesticides of 3 class of hazard (63.5%). Grouping of used pesticides by carcinogenic effect showed that substances with low-probability of causing cancer constituted 44.5%. Share of pesticides with established potential effect on endocrine system was 29.4%. Assessment of sued pesticides by their ability to contaminate ground waters, 18.1% of them were the contaminants and 49.7% potential contaminants of ground waters in the total TB. Moderately stable pesticides had the highest share in the total TB of the Oblast by their level of stability in the soil (49.9%).

Comparative analysis of total TB by the Oblasts of the northern region of the Republic has demonstrated that the average annual burden in the Oblasts under review was on the similar level and could be classified as a mean burden (Table 1). The Oblasts under the review do not differ much from each other in terms of pesticide composition range due to specialization of agriculture in the region on grain growing that found its reflection in the pattern of territorial pesticide burden.

Table 1 - Comparative Assessment of Total Territorial Burden (TB) by the Oblasts of the Northern Region of the Republic, with Consideration of Share of Pesticides of High-Level Hazard in the Structure of TB.

Oblast	Specific Weight (%) of Pesticides in Average Annual TB					TB, kg/ hectare
	1 Class of Hazard (WHO)	Probable Carcinogens	Potential Endocrine Effects	Ground Water Contaminants	Very Stable in Soil	
Akmolinskaya	0	18.8	28.2	13.9	17.0	0.57
North Kazakhstan	0	17.4	42.1	0	17.6	0.69
Kostanayskaya	0	21.5	29.4	18.1	16.4	0.67

Although the most of used preparation contained active ingredients falling in the 3 class of hazard, with low-probability carcinogenic effect and moderately stable in the soil, the certain share in the TB was after the highly hazardous pesticides (probable carcinogens, with potential effect on endocrine system, ground water contaminants, and very stable in soil).

Thus, at regular annual selections and recommending for use of pesticide preparations in agriculture of various regions of Republic, it is necessary to take into account the environmental and hygienic and toxicological characteristics of active ingredients of pesticides, in order to decrease and potentially to exclude the use of very hazardous pesticides to minimize risks for health and environment.

In the last decades the developed countries, especially in European region, started shifting to the integrated system of crop protection which is often referred to as the Integrated Pest Management (IPM). According to the ENDURE , is a rational approach to management of pests via combination of biological, economic, agrotechnical and chemical tools, in order to minimize economic, ecological risks and

risks to health [4]. Since 2007, EC countries are targeting the considerable decrease of contents of chemical preparations in human habitat (REACH system). According to the resource and power saving strategies, in the conditions of strict competition of agricultural sector of the Republic with producers of imported foods, it would be expedient to develop measure for shifting from intensive sue of chemical through integrated systems to the increasing use of natural agrobiocenosis and non-chemical methods.

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