ENVIRONMENTAL HEALTH RISKS TO FARMERS AS A RESULT OF PESTICIDES' MISMANAGEMENT IN KHANYOUNIS GOVERNORATE, GAZA STRIP

Mohammad R Al-Agha*, Naeem S Baroud and Abdel Fattah N Abd Rabou*****

Pesticides Research Group
**Department of Environment and Earth Science,*
***Department of Geography,*
**** Department of Biology, The Islamic University, Gaza, PO Box 108, Gaza Strip, Palestine*

ABSTRACT

Several poisoning and death cases were reported in Khanyounis Governorate as a result of mis-use and mis-handling of pesticides. Carcinogenic and internationally banned pesticides are still available in the markets in all the governorates of the Gaza Strip. This study aims to investigate the awareness and health issues of the farmers. Forty-five farmers were randomly selected to fill a questionnaire prepared for this purpose. The results showed that protective clothing are totally not worn during application of pesticides. Lack of storage faculties, unlicensed pesticide shops, improper disposal of the empty containers and smoking and eating during application are among the hot spots related to pesticides handling and application. Also, 44.5% of the farmers complain of health problems, of which headache, coughing, skin rashes and difficulty in breathing. Only 4.5% of the farmers attended general agricultural training courses. In conclusion the study suggests that the government, public, the non-governmental organizations and all the interested parties should cooperate in a collective and serious work to minimize these environmental and health risks.

INTRODUCTION

Khanyounis Governorate is located at the southern part of the Gaza Strip. The total area of Khanyounis Governorate is about 65 Km^2. The average rainfall is 250 mm/annum. The coastal 1-2 km wide belt along the Mediterranean Sea is covered with sand dunes of about 20-40 m above sea level. The population is about 200,000 people according to the survey conducted in 1997 (Al-Agha, 1995, 1997).

A significant progress was made in the environmental awareness studies on pesticide hazards and their health impacts in Third World countries during the 1990s. This is in fact true, when compared with the negligence of pesticide impacts during the last few decades. Surveys were conducted in different countries e.g. Brazil (Garvalho, 1990; Skalisz, 1991), India (PREPARE, 1991), Paraguay (Abbate, 1991), Pakistan (Chester et al., 1992), Kenya (Emanuel, 1992) and Sudan (Abd Rabou, 1996). These studies are considered important steps in strengthening the role of research in planning and policy-making. This leads to strengthening the capacity building and awareness of the farmers, the governmental and the non-governmental organizations and/or institutions (Abd Rabou and Al-Agha, 1998).

In the Gaza Strip, agriculture is considered as the backbone of the income of many families. Farmers tend to use more fertilizers and pesticides than basically required to increase the agricultural production. Studies on pesticides and their hazards in the Gaza Strip are very limited. Safi and his colleagues started a modest and important work on pesticide hazards in the Gaza Strip. Safi et al. (1993) listed in their preliminary paper the mutagenic and carcinogenic pesticides used in the agriculture in the Gaza Strip. They indicated that about 75 pesticides are used in the area, 19 of which are internationally suspended and banned. Additionally, Safi (1995) displayed the pesticide - related problems in the Gaza Strip. These problems are: environmental pollution, pest resistance, non-target effects of pesticides and finally the health hazards related to pesticide use and mis-use.

PURPOSE OF THE STUDY

The objectives of study are to investigate the sources of the health risks that result during handling and application of pesticides. It is an attempt to understand the problem and to pinpoint the hot issues and/or items that could be placed in the priority list for any action. It is one of the high priority needs to attract the attention of the interested parties, planners, policy makers and decision makers to such hot issues in the environmental and public health.

METHODS OF STUDY

Forty-five small farms in Khanyounis Governorate, were randomly selected for this field survey. The survey was carried out by the authors using an especially prepared questionnaire. Arabic is the language of the questionnaire. It was tested by five experts in agricultural and environmental sciences. The farmers were then, individually visited and informed about the purpose of the study. They have been asked by the interviewer to participate, and were assured that all the information regarding their responses will be dealt as a top confidential matter. All these farmers were then interviewed and their responses were recorded in the questionnaire. The surveyor explained to the farmers any question which was not clear to them. The surveyor used to fill the questionnaire by himself. This study was carried out during June and July, 1997. The data were analyzed by descriptive statistical method.

RESULTS AND INTERPRETATION

The age of the interviewed farmers was found in the range between 20-65 years, with an average of about 37 years and standard deviation of 15. The average number of years of experience for these farmers is 14 years, ranging between 1-40 years, with standard deviation of 11. About 90% of the visited farms produce vegetables, while the rest mostly produces citrus. The area of these farms ranges between 1-40 dunums (1 dunum=1000 square meter), with an average of 6 dunums and standard deviation of 8. Other issues were surveyed during this work; the results are shown in Tables 1-12 and described below.

1. THE EDUCATIONAL LEVEL

The survey showed that 80.2% of the farmers finished the intermediate level of education, while 6.6% are totally non-educated, 13.2% are in the level of primary school, 15.8% are holding university degrees (Table 1). These results illustrate that the education level of the farmers is generally good, which means that over 85% of the interviewed farmers can read and write. This of course will help in any training courses to be held in the future. Such results are normally expected in the Palestinian society as a whole. This is because of the majority of the Palestinians in Gaza are educated as a result of the political, social and economic pressure during the last 4-5 decades. As most of the pesticides used in the Gaza Strip are imported from Israel, none of the farmers can read Hebrew language, by which most of the instructions are written. This suggests that any imported pesticides should have an Arabic translation of the instructions either by the manufacturers or the importers.

Education	Frequency	Percentage
Non-educated	3	6.6
Primary school	6	13.2
Preparatory school	10	22.2
Secondary school	19	42.2
University degree	7	15.8
Total	45	100

Table 1: *Educational level of the farmers*

2. PESTICIDE SOURCES

The farmers were asked about the place from which they buy pesticides, all of them indicated that they get it from the local market (Table 2). This was not the case in Rafah Governorate, where some farmers get their pesticides from other sources, e.g. the extension services, the Israeli settlements in the area (Abd Rabou and Al-Agha, 1998). The pesticide local markets in the Gaza Strip are not governmentally supervised. Obtaining pesticides from the local shops is considered a source of risk to both farmers and crops. This is because the shop's owners are not qualified to guide the farmers to the instructions of pesticide use.

Source	Frequency	Percentage
Local shops	45	100
Extension services	0	0
Others	0	0
Total	45	100

Table 2: *Pesticide sources*

3. EATING, DRINKING AND SMOKING DURING HANDLING AND APPLICATION

Although eating and drinking are prohibited during handling and application of pesticides, only (2.2%) of the interviewed farmers admitted that they drink or eat, while others said that they do not do so (Table 3). Regarding smoking, 57.8% of the farmers are smokers, while 42.2% are non-smokers (Table 4). It was found that 15% of the smokers smoke sometimes during the handling and application of pesticides. The low percentage of the non-eaters or drinkers during work was explained to us by the farmers due to the fact that, they definitely know that pesticides are toxic and may rout to the human body during eating or drinking. The high percentage of smokers is attributed to the fact that all of them do not know that smoking could have harmful impacts on the human body during application of pesticides. Other smokers said that they do not smoke during work only because they cannot do it.

Eating and drinking	Frequency	Percentage
Yes	1	2.2
No	44	97.8
Total	45	100

Table 3: *Eating and drinking during pesticide handling and application*

Smoking	Frequency	Percentage
Yes	26	57.8
No	19	42.2
Total	45	100

Table 4: *Smoking during pesticide handling and application*

4. PROTECTIVE CLOTHING OR WORKING CLOTHES

Protective clothes must be worn during handling and application of pesticides. However, it was found that none of the farmers has real protective clothes. But what they have is just clothes for work, which are different from those clothes clothed by the farmer during his normal life. The definition of the protective clothes by these farmers is not more than "working clothes". We had seen many of these clothes used by the farmers and they are not more than second-hand or even third-

Protective clothing	Frequency	Percentage
Yes	21	46.7
No	24	53.3
Total	45	100

Table 5: *Wearing of Protective clothing (working clothes)*

Storage	Frequency	Percentage
Special store	0	0
Home	36	80
Farm	9	20
Total	45	100

Table 6: *Storage of pesticides*

Disposal	Frequency	Percentage
Burial-burning	24	53.4
Throw way	20	44.4
Use	1	2.2
Storage	0	0
Total	45	100

Table 7: *Disposal of pesticides' empty containers*

Action	Frequency	Percentage
Clothes taken off directly	20	44.5
Finishing, Clothes taken off	22	48.9
No action, no bath	3	6.6
Total	45	100

Table 8: *Drainage of pesticides on the body*

Period (days)	Frequency	Percentage
1-3	17	37.5
4-8	21	46.7
<8	7	15.8
Total	45	100

Table 9: *Pre-harvesting period*

Training courses	Frequency	Percentage
Yes	2	4.5
No	43	95.5
Total	45	100

Table 10: *Attendance of training courses*

Disease	Frequency	Percentage
Yes	20	44.4
No	25	55.6
Total	45	100

Table 11: *Diseases related to pesticides*

Disease	Frequency	Percentage
Yes	4	8.8
No	41	91.2
Total	45	100

Table 12: *Diseases not related to pesticides*

hand clothes. Some of these clothes were found with several holes in it, and some were found as short-legged pants and short-sleeved shirts. Shoes were found occasionally worn, and socks were very rarely worn. Thus, the term -protective clothing- was applied here according to the definition of the farmers themselves. This does not mean that the authors agree on such status. It was found that 46.7% wear these clothes, while 53.3% use their normal clothes (Table 5). 90% of the farmers do not know that pesticides may rout to the human body through skin. Such a risky and striking result needs urgent and serious campaigns among the farmers to raise their awareness and the health risks which they are exposed to.

5. STORAGE OF PESTICIDES

One of the striking results of this study is that 80% of the farmers store pesticides in their homes or houses, while only 20% store them in the farms (Table 6). Some of the farmers were asked why they used their homes for pesticide storage and they answered that pesticides may be lost or stolen in the farm, because they do not have safe stores in their farms.

6. DISPOSAL OF EMPTY CONTAINERS

Most of the empty pesticide containers are considered as one of the dangerous hazardous wastes, if they were not thoroughly washed and rinsed after use. 53.4% of the farmers dispose of these containers either by burning or burial in the farm depending on the type of the material from which the container is made (paper, plastic or metal). 44.4% of the farmers throw these containers away in the farm or along its fence. Both of these do not rinse the containers after use. 2.2% of the interviewed farmers admitted that they could use these empty containers for domestic purposes when the size and the shape are affordable for some kinds of uses (Table 7). In the Third World countries, the use of the empty pesticide containers for domestic purposes is common.

7. DRAINAGE OF PESTICIDES ON THE HUMAN BODY/SKIN

The farmers were asked on their behavior when pesticides drain on their bodies during application. 44.5% said that they take their clothes off and wear others. While 48.9% stated that they do not care when pesticides drain over their clothes and/or bodies and continue their work, after then they will have a bath. The remaining 6.6% of the farmers said that they do not care and even do not bath after finishing their work; they just take their clothes off in the end of the day (Table 8).

8. PRE-HARVESTING INTERVAL

Pre-harvesting interval is the period which must be left between the application of a pesticide in the farm and the harvesting of a crop. This is to ensure that pesticide residue on the crop becomes within the acceptable and safe limits for human use (GIFAP, 1989). 46.7% of the farmers allow for only 4-8 days to harvest their crops, 37.5% were harvesting 1-3 days after application. 15.8% of the interviewed farmers waited from 9-15 days to harvest the crop (Table 9).

9. ATTENDING TRAINING AND/OR AWARENESS COURSES

4.5% of the farmers said that they attended training courses in various agricultural topics, where pesticides were part of the training material. While 95.5% of the farmers pointed out that they never attended such training courses and even they are not invited to these activities (Table 10). This is of course, backdated since they started their work, where we stressed on this point during our survey.

10. HEALTH COMPLAINTS

During the present survey, 44.5% of the farmers stated that they acquire some health complaints during application of pesticides (Table 11). On the other side 55.5% of the farmers indicated that they do not have any health problems during application of pesticides. 8.9% stated that they have diseases that are not related to their work, while the rest 91.1% pointed out that they do not complain of any disease (Table 12). Farmers who have health complaints during the application of pesticides, showed that they have coughing, headache, skin rashes, chest pains and difficulty in breathing.

DISCUSSION

The results of this survey showed that there are many dangerous and hot spots in the life and the health of the farmers during handling and application of pesticides. Several striking results were reported such as protective clothing, eating, drinking, and smoking during pesticide handling and application, pesticide waste disposal, storage and pre-harvesting period. Other issues were of high importance like the health complaints and the low percentage of farmers attending training courses. All these hot issues are of very dangerous impacts on the farmers' health and even the public health in general. The risk of pesticides to the human body depends on the exposure and toxicity. The long exposure periods are very dangerous on the human health, even if the toxicity is not high. On the other side toxicity of pesticides is variable from one type to the other. Long period of exposure of low toxic pesticide could produce risk more than a high toxic pesticide with short period of exposure. In this study, some farmers did not give attention to the exposure period and even the routs of exposure. Such results indicate how the situation is, and these suggest an urgent and serious action. In order to minimize exposure awareness campaigns and training courses are strongly recommended to start soon. However, the issue of the protective clothing is a very hot spot to which the attention of the government and the farmers must be directed. It is very sad situation that none of the farmers wears real and healthy protective clothes.

CONCLUSION

Khanyounis Governorate depends mostly in the agriculture as the main source of income to many of its population. Several poisoning and death cases were reported in this Governarote in the last few decades as a result of pesticide mismanagement. Several types of carcinogenic and internationally banned pesticides are still in use in the Gaza Strip as a whole. The survey indicated that the situation in Khanyounis Governorate is horrible regarding the awareness of the farmers on how to deal with pesticides in a safe and healthy way. It is very obvious that the most dangerous issue is the protective clothing, where none of the farmers found wearing a safe and healthy clothes. Another important issue which is the storage and disposal of pesticides, where about 80% of the farmers uses their homes to store these toxic materials. Eating, drinking and smoking while application and handling of pesticides was found also a hot spot. Pre-harvesting period is not strictly followed by the farmers. The health complaints (coughing, headache, skin rashes, chest pains and difficulty in breathing) were expected as most of the activities related to pesticide handling and application, were done in an improper and unhealthy way. These are the important components of the environmental health and awareness among the farmers in Khanyounis Governorate.

References

Abbate, J. (1993). Country report: Paraguay: In Dinham, B. (1993). The Pesticide hazard: A global health and environmental audit, (pp 117-131), The Pesticide Trust, Zed Books.

Abd Rabou, A. N. (1996). On the hazards of pesticide use and misuse in Khartoum State and some histopathological studies on the effects of carbamate insecticides on experimental animals: A thesis submitted for the award of the degree of M. Sc. in the Institute of Environmental Studies, University of Khartoum, Sudan.

Abd Rabou, A. and Al-Agha, M. R. (1998). Environmental awareness in handling and application of pesticides among farmers in Rafah Governorate – Gaza Strip, The V international HCH and Pesticide Forum, Bilbao, Spain, June, 25-27, 1998.

Al-Agha, M. R. (1995). Environmental contamination of groundwater in the Gaza Strip, Environmental Geology, 25: 109-113.

Al-Agha, M. R. (1997). Environmental management in the Gaza Strip. Environ. Impact Assess. Rev., 17: 65-76.

Chester, G.; Sabapathy, N. N. and Woollen, B. H. (1992). Exposure and health assessment during application of Lambda-cyhalothrin for malaria vector control in Pakistan. Bul. of the World Health Organization (WHO), 70 (5): 614-619.

Emanuel, K. (1992). Country report: South Africa. (pp 148-158) in Dinham, B. (1993). The Pesticide hazard; A global health and environmental audit, The Pesticide Trust, Zed Books

Garvalho, W. A. (1990). Risks from occupational exposure to organochlorine insecticides. Bahia, Brazil, Unpublished; cited from WHO/UNEP, 1990.

GIFAP (1989). Guidelines for the safe and effective use of pesticides. International Group of National Association of Manufacturers of Agrochemical Products, Brussels, Belgium, p 60.

PREPARE (1991). Country report: India (pp 159-172) in Dinham, B. (1993). The pesticide hazard: A global health and environmental audit, The Pesticide Trust, Zed Books.

Safi, J. M. (1995). Special problems associated with pesticide use and its management in Gaza Strip. Egyptian Journal of Occupational Medicine, 19 (2): 267-276.

Safi, J. M.; El-Nahhal, Y. Z.; Soliman S. A and El-Sebae, A. H. (1993). Mutagenic and carcinogenic pesticides used in the agricultural environment of Gaza Strip. Science of the Total Environment, 132: 371-380.

Skalisz, R. O. (1991). Country report: Brazil (pp 81-96) in Dinham, B. (1993). The pesticide hazard: A global health and environmental audit, The pesticide Trust, Zed Books.

INCREASE OF BREAST CANCER INCIDENCE IN ARMENIA: PROBABLE ROLE OF PESTICIDES APPLICATION

H. Avagyan[1], D. Doumanyan[1], L. Karabashyan[2], S. Amiryan[1]

[1]National Institute of Health of Armenia, 49/4 Komitas Avenue, Yerevan, 375051, Republic of Armenia
[2] "Delta" Co. Ltd. (Armenia) 49/4 Komitas Avenue, Yerevan, 375051, Republic of Armenia

INTRODUCTION AND OBJECTIVES

A number of pollutants (pesticides, industrial chemicals, etc.) are potentially dangerous for the living organism, since they are known to activate the formation of toxic intermediates in the organism. A relationship between oxygen activation by pollutants and their toxicity has been suggested due to highly reactive oxygen species formation. As a result, we can use the level of oxygen radicals in the organism as criteria for the harmfulness of the environmental pollutants [1].

Molecular criteria were developed for evaluation of toxicity of different substances used as agro- and industrial chemical substances, which have a potential toxic effect. In particular, in our reports and publications on numerous pesticides, we described that some of them possessed mutagenic and carcinogenic activity [2]. It was shown that the key agents of their toxic action are superoxide radicals [1]. Concomitant with the metabolism of environmental agents such as pesticides, nitrates and industrial chemicals, the rate of superoxide radicals' generation is greatly elevated. Therefore, we consider the high level of superoxide radicals as one of the risk factors.

Apparently, a number of pesticides are not considered direct carcinogens, but in the human organism, carcinogenic metabolites are formed due to the metabolism. There exists the combined effect of two and/or more pesticides as well. The carcinogenic effect itself is a result of joint combined action of pesticides or their metabolites. That is why, to our opinion, the determination of concrete pesticides in human blood samples is not purposeful [3].

Armenia was one of the regions with intensive pesticide application. In the 1980s the territorial load of pesticides in agriculture exceeded the average for the Soviet Union more than 20 times. In 1984 high concentrations of organochlorine pesticides -i.e. DDT, officially forbidden in 1970, and the metabolite of DDT, DDE - were registered in 20% of samples taken from arable lands in the regions of Ararat, Oktemberian, Etchiniadzin, Artashat, Tumanian, Gugarak and Noemberian. DDT concentrations in samples from cultivated land in the Ararat region amounted to 0.02 -0.04 mg/kg in potato fields, 0.06-0.4 mg/kg in samples from orchards, while DDE residues were found at the level of 0.45 mg/kg. DDT and DDE residues in grape orchards were found at 0.3-0.85 and 0.08-0.8 mg/kg, respectively. Excessive contamination with pesticides such as DDT, DDE, dieldrin, aldrin and endrin was found in 2.56% of the tested products, mainly in meat, with potentially adverse effects on human health through accumulation in the food chain. [4]. Till now "fresh" contamination is observed in some regions of Armenia: residues of banned and/or obsolete pesticides are found in samples of water, soil and foodstuffs.

In 1995-2002, according to data of the Department of Statistics and the Centre of Oncology (Ministry of Health, Republic of Armenia), the incidence of breast cancer was on the 3rd place after the cancer of lungs and gastrointestinal tract. Breast cancer, as a known life-threatening malignant lesion in women of many developed countries, has a stable 1st place amongst other oncology states in women. In Armenia there is also a stable tendency to the increase [5].

Data indicate that the stable increase was observed as to the mortality index (as % of morbidity) of breast cancer. In 1997, mortality due to breast cancer was 57.3% (28% proceeded within the 1st year). A similar tendency is observed till now. Such unfavourable indices as well as the tendency towards their worsening are, apparently, conditioned by a number of causes of both socio-economic and environmental character.

Our researches were aimed at the study of medical (carcinogenic) after-effects, probably resulting from pollution of the environment due to pesticide application. It was of both importance and interest to reveal prevalence and morbidity of breast cancer, by the use of specific tumour markers. It would be of high significance to reveal molecular mechanisms of tumour incidence/development through the probable role of pesticide impact in incidence of breast cancer, based on the analysis for tumour markers and generation of superoxide radicals.

MATERIAL AND METHODS

193 women with different oncology problems of mammary glands were directed from the hospitals of Armenia and examined at the Clinical Diagnostic Department (NIH, Armenia). 89 women had the diagnosis of breast cancer; in 35 cases breast cancer was diagnosed later on. 69 women had high risk of breast cancer incidence based on mammography checks.

Patients involved two age groups:

- Group 1 – patients aged 40-49,
- Group 2 – patients aged 50-69.

In recent years, suitable and reliable methods of immune-enzyme tumour markers testing in blood serum are widely used. Tumour markers present themselves a group of factors detected in malignant and malignant growth associated cells. The diagnostic significance of tumour markers is very high in combined testing; the procedure itself is suitable enough. It is especially urgent for the screening and early diagnostics. Tumour markers are irreplaceable in the screening/monitoring of both the disease and the treatment process. The point of prime importance is that the recurrence and metastasis can be revealed with the help of tumour markers six month prior to the clinical manifestation of the disease or even earlier.

Enzyme Immunoassays (EIA) for the quantitative determination of cancer antigens CA 15-3, CA-125, CA 19-9, CEA, HGh, beta-2M in human serum (DRG International, Inc., USA; Syntron, USA) were used.

The Equipment used for early cancer diagnostics included: Microwell Strip Reader – Stat Fax® 303, Microwell Washer – Stat Fax® 2600, Incubator/Shaker - Stat Fax® 2200 Chemistry Analyzer - Stat Fax® 1904 (AWARENESS Technology, Inc., USA).

Superoxide Dismutase (SOD), a known scavenger of superoxide radicals, was evaluated by the ability of aliquots of blood serum to inhibit the colour reaction of reduction of nitro blue tetrazolium with the formation of phormazan by Nishikimi et al., 1972 [6].

The diagnostic significance of tumour markers is very high in such combined simultaneous testing of SOD activity.

RESULTS AND DISCUSSION

It was revealed that 97% of women from all groups CA 15 –3 had tumour marker level above the norm. The analyses of the special questionnaire demonstrated that amongst those examined, there were women from rural districts of intense uncontrolled application of organochlorine, organophosphorus pesticides, nitrates and other agrochemicals.

In both age groups with CA 15-3 above the normal level, our findings revealed a decrease of such an important protective system as SOD activity as compared with the control group of healthy women. It must be emphasised that in Group 1 the decrease made 33% and in Group 2 it was 58%.

The results of our previous experimental studies in laboratory animals showed that formation of superoxide radicals underlies the molecular mechanisms of toxic, carcinogenic, mutagenic and delayed toxic effects of organochlorine pesticides, some phosphorous agrochemicals, and nitrates (2).

Thus, the low level of SOD activity revealed in blood serum of patients might be the result of either generation of superoxide radicals due to the effect of chemicals (pesticides) or due to a direct effect of pesticides on the protective system of the living organism. Superoxide radicals have a probable role in the mechanisms of breast cancer development, especially in women aged 50 and older.

In both Group 1 and Group 2 our analyses revealed no such correlation in concern of ovarian cancer tested by means of tumour marker CA 125.

It cannot be excluded that the SOD activity revealed could be the result of environmental hazards and other known factors.

Data and findings obtained dictate the necessity to suggest the following programme for comprehensive studies:

1. To perform screening examinations in a cohort of women of reproductive age in order to reveal tumour incidence in rural districts (see the Table below);
2. To trace the relationship between the
   • geographic location
   • pesticide application
   • occupational exposure
   • consumption of food polluted by pesticides, etc.
3. To establish the relation between
   • the quantity of pollutants (pesticides) used,
   • amounts, acquired by the individuals from risk groups via the food chain, directly or indirectly, and
   • cancer prevalence.
4. To draw correlation of tumour marker levels with the SOD values and intense application of pesticides;
5. To confirm probable significance of environmental factors (pesticide load) in incidence, onset and development of breast cancer.

Tumour localisation	Laboratory tests recommended
Breast	CA 15–3, CEA, Ferritin, MCA
Uterus (body, neck)	CA 125, AFP, HGh, b–2M, CEA
Ovaries	CEA, CA 125, b–2M, AFP, HGh

Table: *Tests recommended for screening medical examination in order to reveal groups at risk in female population of areas with intense agriculture (application of pesticides)*

References

1. *Avagyan H. New Biochemical Approaches in Environmental Toxicology: Balance of Oxygen Radicals and Protective Systems. In: "Urgent Problems of Ecohygiene and Toxicology", Kiev, 1998, Part 1, p.21-25.*
2. *Avagyan H. Novel molecular criteria for evaluation of toxicity of hydrazine derivatives. Active forms of oxygen as a key link of the toxicity. Pharmacology and Toxicology, 1990, No.1, p.70-73 (Moscow, Russia) (in Russian)*
3. *Avagyan, H. 2000. "Pesticide Application In Armenia: Carcinogenic After-effects". In: 6th International HCH and Pesticide Forum Book, 20-22 March 2001, Poznan, Poland, p.567-568.*
4. *UN. 2000. ECE, Draft Environmental Performance Review of Armenia, July 2000*
5. *Muradyan A., Avagyan H., Doumanyan D., Amiryan S., Karabashyan L. CA 15-3 tumour marker for breast cancer screening and prevention In: Cancer Epidemiology Biomarkers & Prevention, October 2002, vol.11, N 10, Part 2, p.1160s (Proceedings of First Annual International Multidisciplinary Conference "Frontiers in Cancer Prevention Research", October 14-18, 2002, Boston, MA, USA. Abstract # A307).*
6. *Nishikimi M., Rao N.A., Yagi K. The occurrence of superoxide anion in the reaction of reduced phenasine-methasulfate (PMS) and molecular oxygen// Biochem. Biophys Res. Communs. – 1972. – Vol. 46. – P.849-854.*

RISK ASSESSMENT OF ATRAZINE POLLUTED FARMLAND AND DRINKING WATER: A CASE STUDY

Qingbo Li, Jing Song, Yongming Luo, Longhua Wu

Soil and Environment Bioremediation Research Centre (SEBC)
Institute of Soil Science, Chinese Academy of Sciences
P.O. Box 821, Nanjing 210008, P.R. China

ABSTRACT

In late May 1997, a large-scale pollution of Atrazine took place in the rice--growing area of Changtu county, Liaoning province, China. Over 2,800 hm^2 of rice fields were polluted due to irrigation from Atrazine polluted Tiaozi River and Zhaosutai River, leading to a direct loss of 42 million RMB (about 4.4 million EUR).

Four years after the accident, Atrazine residues in the local agro-ecosystem were measured at Bamiancheng and Baoli, two-rice growing areas downstream Tiaozi River and Zhaosutai River, respectively. The survey indicated that higher Atrazine concentration detected in lightly polluted soil at Baoli as compared to that in heavily polluted Bamiancheng was likely due to higher organic matter and higher clay content, which contributed to keep more Atrazine from leaching out of soil profiles. Although Atrazine can still be detected in rice grains, surface water as well as groundwater, the concentrations were below the criteria for human consumption.

It was concluded that Atrazine is persistent, highly mobile and bioaccumulative. Therefore it may pose potential threat to human health through food chain or drinking water in the long term.

INTRODUCTION

Atrazine (2-chloro-4-(ethylamino)-6-(isopropylamino)-1,3,5-triazine) is a commonly used herbicide for corn, sugarcane, grain sorghum, tea and fruits. Since its introduction to China in the early 1980s, Atrazine consumption in China has been increasing by 20% each year (Shu, 2000).

With increasing production and consumption of pesticides, pesticides-related pollution cases tend to increase in China. From July 1995 to August 1996, more than 2000 cases of pesticides pollution have been reported in 19 provinces of China. About 130,000 hm^2 of farmland were polluted to various degrees and the consequent losses were 500 million RMB (about 52.5 million EUR). Overall losses for the whole of China during that period were estimated to be 1 billion RMB (about 105 million EUR) (Jiang and Hua, 2000).

Despite its effectiveness against annual gramineous herbs, Atrazine poses a threat to ecological safety because of bioaccumulation and persistence. Study by Soloman showed that half life of Atrazine was 244 days at pH 4 and 25 ˚C (Soloman, 1996).

Atrazine has been detected in surface waters such as rivers, lakes, gulfs as well as groundwater in many EU countries (Siebers, 1994). The maximum contaminant level of Atrazine in drinking water is 0.1ug l^{-1} in EU countries and 3ug l^{-1} in the US and China. At low soil pH, protonized Atazine becomes more hydrophilic and is likely to move downwards with soil water and reach groundwater. Atrazine leaching is also affected by soil properties such as soil organic matter and clay content, which will determine the partition coefficient of Atrazine between soil particles and water. The higher organic matter and clay content, the stronger Atrazine bonded to soil solid phase. An investigation conducted in Nebraska, USA revealed that 0.07% of total Atrazine applied to a sandy loam infiltrated down to 1.5m below surface (Capriel *et al.*, 1986). In the case of paddy fields, frequent irrigation facilitates Atrazine leaching. It is proposed that leaching and degradation are the two main pathways of Atrazine dissipation in paddy fields while the contribution of surface runoff is limited (Alissara *et al.*, 2001).

In late May 1997, a large-scale pollution of Atrazine took place in the rice-growing area of Changtu County, Liaoning province. More than 2,800 hm^2 of rice fields were polluted as a consequence of irrigation from Atrazine polluted Tiaozi River and Zhaosutai River. The upper reaches of the two rivers were polluted to different degrees by Atrazine due to accidental leakage from a state-owned pesticides manufacturer in the nearby Siping city, Jilin province. Rice seedlings died out in many polluted fields, leading to a direct loss of 42 million RMB (about 4.4 million EUR).

A six-month monitoring was conducted right after the accident. According to the monitoring report issued by Pesticides Safety Evaluation Centre (PSEC), Department of Chemistry in July 1997, Atrazine concentrations detected around Bamiancheng ranged from 0.06 to 0.29 mg l^{-1} in Tiaozi River, from 0.23 to 0.36 mg kg^{-1} in soils and from 1.07 to 2.26 mg kg^{-1} in young rice shoots. In contrast, Atrazine concentrations detected around Baoli were from 0.03 to 0.06 mg l^{-1} in Zhaosutai River, up to 0.08 mg kg^{-1} in soils and up to 0.28 mg kg^{-1} in young rice shoots. Obviously, Atrazine pollution was more serious around Bamiancheng than around Baoli (PSEC-R9734001ST, 1997).

Based on data obtained from field studies and pot trials, remedy measures, including well irrigation, change of crops, postponing transplanting, deep plowing, organic amendments and addition of Atrazine-degrading bacteria, were taken to resume agricultural production in the polluted area.

Atrazine behaviors in the environment have been intensively studied in the past several decades. The aims of these studies were to (1) determine Atrazine residuals in soils, rice grains and drinking water in the polluted area four years after the accident, (2) to gain a better understanding of the persistence and mobility of Atrazine in the multimedia environment and (3) to assess Atrazine exposure risks in the polluted area.

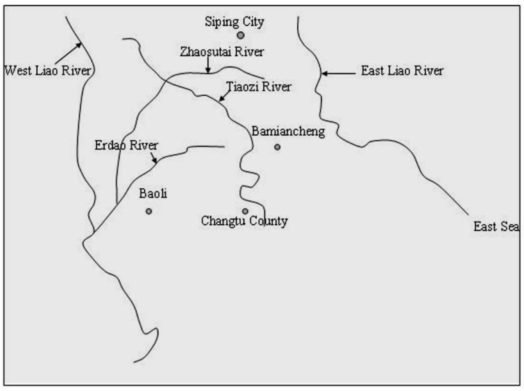

Figure 1: *A schematic map of the water system in Changtu County*

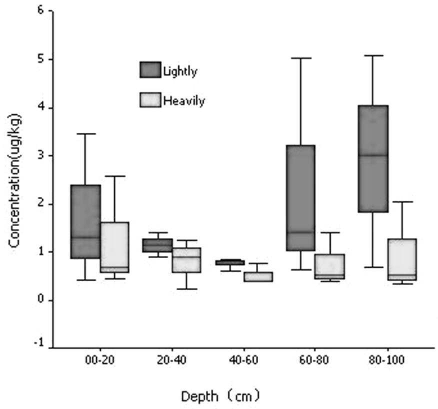

Figure 2: *Vertical distribution of Atrazine in soils*

MATERIALS AND METHODS

1. Site description

Changtu County is located in the north of the northeast province of Liaoning China (E 123º 32’ - E 124º26’, N 42º33’- N 43º29’) and adjacent to Siping city of Jiling province. Zhaosutai River and Tiaozi River are the two main irrigation water sources for the rice growing area of Baoli and Bamiancheng, respectively (see Figure 1).

2. Sampling

In October 2001, vertical distribution of Atrazine was sampled at three locations of Baoli and Bamiancheng, respectively. Soil samples were taken at a depth of 0-20cm, 20-40cm, 40-60cm, 60-80cm and 80-100cm, respectively. Meanwhile, rice grain samples were also taken at the same locations. Surface water samples were taken from a nearby reservoir or tap water. Underground water samples were taken from wells at 10 meters depth.

3. Sample analysis

Soil pH was analysed with compound electrodes (Soil: H2O=1:2.5). Soil organic matter was measured using potassium dichromate oxidation method. Soil particle distribution was determined using a densimeter. As shown in Table 1, the alkaline paddy soil at lightly polluted Baoli has higher organic matter and clay content as compared to that at Bamiancheng.

Atrazine in soil and plant samples was extracted by ultrasonic and analyzed with GC-NPD after purification (Li *et al.*, 2003). Atrazine in water was extracted using solid phase extraction techniques and analyzed with GC-MS as described by Ren et al. (Ren *et al*., 2002).

RESULTS AND DISCUSSION

1. Vertical distribution of Atrazine in soil profiles

Vertical distribution of Atrazine was shown in Figure 2. Statistically, there was no significant difference among Atrazine concentrations at different layers either at Baoli or at Bamiancheng. However, Atrazine residuals in soil profiles were significantly higher in lightly polluted soil at Baoli than in heavily polluted soil at Bamiancheng ($p<0.05$). As the partition coefficient of Atrazine is determined by soil organic matter and clay content, it is therefore understandable that dissipation of Atrazine via leaching will be favoured in soils with low organic matter or coarse texture. A possible explanation for higher Atrazine residuals in lightly polluted soil at Baoli was due to its higher organic matter as well as much higher clay content as compared to heavily polluted soil at Bamiancheng (see Table 1).

2. Atrazine concentrations in rice grain

Four years after the accident, Atrazine can still be detected in rice grains both at Bamiancheng and Baoli. Atrazine residual in rice grains ranged from 0.62 to 1.25 ug kg-1 at Bamiancheng and from 0.54 to 4.25 ug kg^{-1} at Baoli. In both cases, Atrazine concentrations were lower than the French maximum residue limits of 5 ug kg^{-1} for corn.

3. Atrazine concentration in drinking water

Analysis of Atrazine concentration in local surface water and groundwater showed that Atrazine concentrations were between the maximum contaminant level of 0.1ug l^{-1} established by EU and of 3ug l^{-1} established by US for drinking water. For instance, at heavily polluted Bamiancheng, Atrazine concentrations were higher in surface water (ranging from 0.10 to 0.32 ug l^{-1}) than in groundwater (ranging from 0.07 to 0.10 ug l^{-1}). Atrazine concentration in the groundwater of lightly polluted Baoli was below 0.0026ug l^{-1}.

CONCLUSIONS

Four years after the cut-off of the pollution source, Atrazine can still be detected in the agro-ecosystem of the affected area. Although Atrazine concentration in rice grains and drinking water was below or close to the criterion, due

Location	Pollution status	OM %	pH	Sand %	Coarse silt %	Fine silt %	Clay %
Baoli	Lightly polluted	1.37	8.08	25.03	30.50	14.49	29.96
Bamiancheng	Heavily polluted	1.20	6.86	16.44	53.07	22.06	8.41

Table 1: *Selected properties of soil tested*

to its long half time and bioaccumulation, Atrazine could still be an environmental concern and needs to be addressed.

Acknowledgement The authors are grateful to Mr. Ren Tao, director of the Agro-technology Promotion Centre, Changtu County, Liaoning province for providing background information of the accident and support in the course of sampling.

References

1. Alissara R., Thomas B.M. 2001. American Water Resources Association. 37(6), 1681-1692.
2. Monitoring report, 1997. Pesticides Safety Evaluation Centre (PSEC) No. R9734001ST
3. Soloman K.R., Baker D.B. 1996. Environ. Toxicol. Chem. 15(3), 31-34.
4. Capriel P; Haisch A; Khan S, U. 1986. J. Agric. Food Chem. 34, 70-73.
5. Siebers J. 1994. Chemosphere, 28(8), 1559-1570.
6. Wüst S., Hock B.A. 1992. Analytical Letters. 25(6), 1025-1037.
7. Li Q.B., Huang G.H, Luo Y.M. 2003. Analytical Chemistry, 31(3), 383.
8. Ren J., Jiang K., Zhou H.D. 2002. Environ. Sci. 23(1), 126-128.
9. Shu F. 2000. Pesticide Science and Administration, 21(2), 38-39.
10. Jiang X.L., Hua X.M. 2000. Rural Eco-Environment, 16(2), 35-38, 64.

PESTICIDES POLLUTION AS ONE OF THE ANTHROPOGENIC LOAD FACTORS IN CHERNOBYL ZONE

Myhailo Borysiuk

Committee on Environmental Policy, Nature Resources, Utilization and Elimination of the Consequences of Chernobyl Catastrophe of the Ukrainian Parliament
5 Grushevskogo , Kyiv, Ukraine,03020

The Exclusion Zone of the Chornobyl Nuclear Power Plant (NPP) is the most polluted by basic radionuclides territory that measures 2,044 km^2. Its population was evacuated in 1986 and any kind of housekeeping was forbidden. At the same time, the results of recent research work show that the Exclusion Zone is a very effective barrier to the expansion of radionuclides in the inhabited territories of Ukraine and Belarus. Influence of pesticides as one of the anthropogenic factors upon the water quality in the Pryp'yat river within the territory of the Exclusion Zone for the period of 1989-2003 has been researched. Also questions regarding the influence of the Exclusion Zone on the waterbodies of the Pryp'yat river basin has been explored.

The territory of Exclusion Zone belongs to the physical and geographic zone of mixed forest so called Pryp'yat Polissya. Its territory pertains to the waterbasin of the Pryp'yat river, the tributary of the main water-way of Ukraine – the Dnipro river.

The Pryp'yat river crosses the Exclusion Zone from the North West to South East and flows into the Kyiv reservoir. Total length of the river is 780 km, watershed square is 116000 km^2. Within the territory of the Exclusion Zone the river length from Dovlyady village to the mouth is near 50 km, and watershed square is 2000 km^2.

The basin of the Pryp'yat river represents a system of interconnected waterbodies influenced by a number of factors of anthropogenic origin. It is expressed by indexes which negatively characterize hydrological and chemical condition of the river. For instance, water consumption of Dnipro-Bug canal that results in shallowing and degradation of a riverbed aggravate the hydrological regime of upper part of the river. Downstream 80 barriers for fish-catching for fishery supplement the list of anthropogenic factors. These constructions enhance the processes of sedimentation. According to the extreme overloading on the river ecosystem and exceeding the processes of pollution over self-renewal one the upper part of the river (from Richytsa village of Volyn region to the border on Rivne region) must be cleared away. On the whole, the main anthropogenic factor of the Pryp'yat river pollution (outside the Chornobyl zone) is certainly agriculture, especially melioration, and excessive usage of moistened lands. Almost 15% of its waterbasin is meliorated, unfortunately it is mostly land directly adjoining to the Pryp'yat and its tributaries riverbeds. Practically during development of melioration plans neither a number of over-moistened lands within different riverbasins nor a specific gravity of reclamation loading was taken into consideration. As a result drained systems embrace 12-15% of soils of semihydromorphous and automorphous row so that they must not be hydromeliorated, and overdrainage of these soils results in their degradation, carrying-out of useful substances and finally contamination of waterbodies.

The developed agricultural complex of urbanized territories is characterized by release of surface water into waterbodies, which contributes 80% of contamination. The volume of substances carryed-out from agricultural territories by surface waste water depends on the structure of watershed (the percentage of woodland, waterlogging, ploughing), its meliorative transformations, kind and concentration of applied fertilizers, number of livestock, population density, precipitations, relief (down gradient), soil characteristics etc.

In such a way entering the Exclusion Zone water of the Pryp'yat river contains a range of compounds of anthro-

Place	N,n-DDT	N,n-DDE	DDD	Σ-DDT	α-hezachlorcyclohexane	β-hezachlorcyclohexane	γ-heza-chlor-cyclohexane	Σ-heza chlor cyclo-hexane	aldrin	Hepta chlor		ΣDDT+Σ heza-chlor-cyclo-hexane
The Pryp'yat river (left bank)	$2,4*10^{-5}$	$2,4*10^{-6}$	$2*10^{-7}$	$2,7*10^{-5}$	$8,0*10^{-7}$	N/A	$5,0*10^{-7}$	$1,3*10^{-6}$	$6*10^{-8}$	N/A	N/A	$2,8*10^{-5}$
The Nesvich river	$6,3*10^{-5}$	$1,2*10^{-6}$	$1*10^{-6}$	$6,5*10^{-5}$	$1,6*10^{-6}$	$2,0*10^{-6}$	$5,0*10^{-7}$	$4,0*10^{-6}$	N/A	N/A	$4,0*10^{-8}$	$6,9*10^{-5}$
Magistral canal–1, Paryshiv village	$6,0*10^{-6}$	$3,6*10^{-6}$	N/A	$9,6*10^{-6}$	$8,0*10^{-7}$	N/A	$5,0*10^{-7}$	$1,3*10^{-6}$	$1,5*10^{-7}$	N/A	$3,2*10^{-7}$	$1,0*10^{-5}$
MAC, mg/dm3				0,002				0,02	0,002		0,0003	

Table 1. *Chlororganic pesticides concentration in the Chornobyl Exclusion Zone waterbasin, mg/dm³*

pogenic origin including nearly 70% of Caesium-137 of total amount getting the Kyiv reservoir. Moreover, nearly 65% of Strontium-90 comes in waterbody on the territory within Dovlyady village and Chornobyl that makes worse radioactive characteristics of water. To compound the problem widespread flowing slashes on the watershed and overloaded riverbed.

The biggest tributary of the Pryp'yat river within the Chornobyl Exclusion Zone is Uzh river which runs in the South part of Zone and flows into Pryp'yat river downstream Chornobyl town. The Zone contains 20% of waterbasin of the Uzh river. There are two left-bank tributaries such as Hrezlya and Illya and three right-bank tributaries of the Uzh river such as Veresnya, Radynka and Bober, which run on the territory of the Zone.

Entirely the waterbasins of right-bank tributaries of the Pryp'yat river Sahan and Hlynytsi rivers locate within the Zone. In the Southern part of the Zone Pogonyanskyy canal flows into the Pryp'yat river from the left bank. Its waterbasin lies on the territory of Belarus and its hydrological regime is negatively influenced by built supporting dams and locks. It became a reason of drastic decrease of drainage to the Pryp'yat and Braginka rivers which directly flow into the Kyiv reservoir. Nowadays the Pogonyanskyy canal is stopped up in Borschivka village and its drainage directly to the Pryp'yat river occurs only in near-mouth part of the watershed.

Hydrological network of the Chornobyl zone also includes closed and weakly flowing waterbodies, among them the Starik and Azbuchin lakes, Semihodsk and Pryp'yat bays, and a number of waterbodies of left-bank Pryp'yat flood-plain. Near the Chornobyl NPP along the right bank of the Pryp'yat river there is a reservoir-cooler of the plant. Its waterlevel is six metres higher than the river's one, so that it causes constant infiltration process through the bottom and dam of the reservoir-cooler of the Chornobyl NPP. Annual drainage of the Pryp'yat river averaged 12,7 cubic km, 0,05-0,08% of this number belongs to the infiltration process from a mentioned reservoir-cooler.

Nowadays within the territory of the Exclusion Zone there are no functioning agricultural fields that means this territory is not exposed to agricultural loading and considered as control territory to compare agricultiral loading on the ecosystems of other fields.

The assessment of pesticides concentration in the surface waters of the Exclusion Zone is given in table 1.

To define the concentration of stable chlororganic pesticides in the surface waters at the beginning of autumn three samples were taken from the main waterbodies on the left bank of the Pryp'yat river within the Exclusion Zone. Analysis conducted on gas chromatographer "Tsvet-500 M» testifies the presence of six-seven kinds of pesticides (S DDT+ X hexachlorcyclohexane): the Pryp'yat river – 0,000028 mcg/dm³ , the Nesvich river – 0, 00069 mcg/dm³, Magistral canal-1 – 0,00001 mcg/dm³ (table 1).

In such a way the main reasons for worsening of chemical composition of little rivers water and canals of meliorative systems that correspondingly reflects the water quality in the Pryp'yat river are increasing the carrying capasity of riverbeds and flood-plains of the Pryp'yat river, neglect of meliorative systems within the Exclusion Zone (where lock screens stay closed), damming of flood-plain territories and pumping out water highly contaminated by organic substances, and flooding.

Consequently, the concentration of pesticides in the waterbodies of this Zone some times lower than in surface waterbodies running the hymidic zone of Ukraine outside the Chornobyl zone. This fact underlines more intensive decrease of retrospective contamination in the Zone comparing with other regions where chlororganic pesticides are beign used in the agricultural sector.