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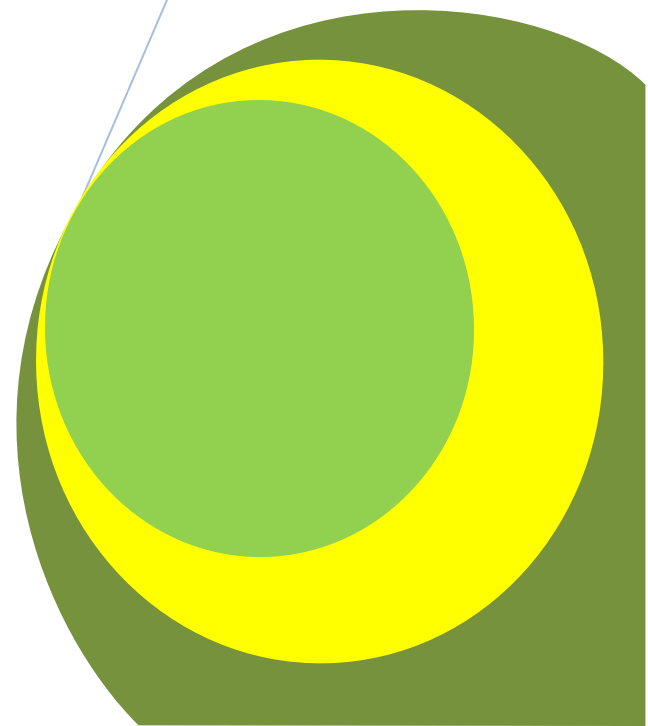Project Aquaculture: Pathway to food security in Kenya. View project

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Research Article

Pesticide Preferences and Pattern of Use along the Shore of Lake Naivasha, Kenya

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ABSTRACT

Improper pesticide application has resulted in high toxicity levels causing environmental risk. The objective of the study was to determine pesticide preferences and pattern of use in farms along the shore of Lake Naivasha. Interviewer administered questionnaires and researcher observation were used to collect data on pesticides being used and pattern of use in 20 major horticultural farms around Lake Naivasha. Secondary data from journals, standards and materials safety data sheets from manufacturers were also used to determine pesticide properties such as toxicity. The results showed there were 4.3% (6) WHO class I and 14.3% (20) class II pesticides of the 141 pesticides used along the shore of Lake Naivasha. The pattern of pesticide use in the area was moderate to high and all the farms were also using Integrated Pest Management (IPM) to control pests. It was concluded that some pesticides in WHO class I that were being used along the shore of Lake Naivasha (e.g. oxamyl, methomyl and fenamiphos) are very toxic to human beings and aquatic organisms since they cause cholinesterase inhibition poisoning by inactivating the enzyme acetylcholinesterase.

Keywords: Pesticides, Environmental pollution, integrated pest management, Lake Naivasha.

INTRODUCTION

Lake Naivasha is located in Nakuru County in the Eastern Rift Valley, about 100km Northwest of Nairobi, Kenya's capital. Lake Naivasha has a farming system that is well expanded in the riparian zone. Bordering the lake are some of the biggest flower farms in the world. The irrigated areas increased from 981.8 ha in 1988 to 7353 ha by 1997 (Tang, 1999). Eighty percent (80%) of the Kenya's horticultural production is found in the Lake basin, making it the most important area for cut flowers in Kenya (Jolicoeur, 2000).

Agricultural products, especially the ones produced for export have to match a high quality standard. To achieve these quality standards it is necessary to have a good program of weed control and pest management. The use of pesticides is one of the most used tools to achieve it. But improper pesticide application results in high toxicity levels causing environmental risk.

Pesticides are chemicals that are used in agriculture and public health for the control of pests, weeds, plant diseases, animals and vectors of diseases (FAO, 1986). These chemicals may be extracted from plants or may be synthetic. Synthetic pesticides present potential hazards to public health. Some pesticides are used both in agriculture and as vector control agents in public health programmes. Agriculture and horticulture, together with vector control programmes, account for the greatest use of pesticides (WHO, 1990). Significant amounts are also used in forestry and livestock production. According to U.S. EPA Pesticide Industry Sales and Usage Report, 1.23 billion pounds active ingredient of conventional and other pesticide chemicals were applied in the U.S. in 1997 (Aspelin and Grube, 1999). Furthermore, 77% (or 944 million pounds) of the chemicals were designated specifically for agricultural use (Aspelin and Grube, 1999).

Investigation on Pesticide preferences and their pattern of use along the shore of Lake Naivasha is presented in this study. This was accomplished by determining the types of pesticides used; their WHO toxicity classification and the pattern of use. The pattern of use was assessed based on the tool developed by Wachter and Staring (1981) using the following parameters: pesticide products and level of use; source and distribution structure of pesticide used in the farms; area of land under pesticide use and; laws and regulations applicable to pesticides in Kenya.

MATERIAL AND METHODS

All the twenty (20) major horticulture farms in Lake Naivasha basin were targeted. The farms that agreed to participate in the study were asked to choose the personnel handling pesticides to fill the questionnaires. Purposive sampling method was used to ensure that only the farms within the major horticultural farms were included in the study.

Interviewer administered questionnaires and researcher observation were used to collect data on pesticide use and preferences, pattern of use and other methods used to control weeds, pests and plant diseases. Literature materials (journals, standards and materials safety data sheets from manufacturers) were also used to determine pesticide properties such as toxicity. The questionnaires were administered to the personnel handling pesticides in the farms that agreed to participate in the study. Some small scale farms were also included where key informants were interviewed. Consent to conduct the study was sought from Moi University's School of Environmental Studies and Lake Naivasha Riparian owner's Association (LNROA).

RESULTS

Pesticide use and preferences

All farms interviewed reported that they used pesticides to control weeds, pests and plant diseases. Some pesticides were used to control a wide range of pests, weeds and plant diseases in the various horticultural crops grown around Lake Naivasha.

The number of pesticides found to be in use along the shore of Lake Naivasha were 141 and in all classes (I-IV) given by WHO. There were 4.3% (6) class I and 14.3% (20) class II pesticides identified as being used along the shore of Lake Naivasha (Table 1). Class I pesticides identified in this study belonged to six chemical groups namely; carbamates, bipyridylium, strobilurin, tetranortriterpenoids, azole and organophosphates.

Table 1: Class I and II pesticides used along the shores of Lake Naivasha

S. No.	Trade Name	Chemical name	WHO Class.	CAS No.	Group (Chemical type)	application rate/Ha/yr	Use/type
1	Fastac	Alpha cypermethrin	II	67375-30-8	Pyrethroid	1600 mls	insecticide
2	Bulldock 025EC	Beta cyfluthrin	II	68359-37-5	Pyrethroid	2000 mls	Insecticide
3	Brigade, Talstar 100 Ec	Befenthrin	II	82657-04-3	Pyrethroid	1600 mls	insecticide
4	Decis, Keshet 2.5EC	Deltamethrin	II	52918-63-5	Pyrethroid	1000mls	insecticide
5	Karate	Lambda cyhalothrin	II	91465-08-6	Pyrethroid	1000mls	insecticide
6	Mavrik	Taufluvalinate	II	102851-06-9	Pyrethroid	360mls	insecticide
7	Vydate	Oxamyl	Ia	23135-22-0	Carbamate	28000gms	Insecticide, nematicide
8	Lannate	methomyl	Ib	16752-77-5	Carbamate		Insecticide
9	Gramoxone	Paraquat	Ib	1910-42-5	bipyridylium	9200mls	Herbicide
10	Stroby	Kresoxim-methyl	Ib	143390-89-0	strobilurin	2000gms	Fungicide
11	systhane	myclobutanil	1b	88671-89-0	Azole		Fungicide
12	Secure 360 Sc	Chlorfenapyr	II	122453-70-0	organophosphate	800gms	Insecticide
13	Pyrinex	Chlorpyrifos	II	2921-88-2	organophosphate	1920gms	Insecticide
14	Spidermec 018 EC	Abamectin	II	71751-41-2	soil bacterium streptomyces	2000mls	Acaricide
15	Pegasus 500 SC	Diafenthiuron	II	80060-09-9	thiourea	2400mls	Acaricide
16	Rubigan	Fenarimol	II	060168-88-9	pyrimidine	1200mls	Fungicide
17	Pyrus	Pyrimethanil	II	53112-28-0	anilinopyrimidine	1600mls	Fungicide
18	Impulse	Spiroxamine	II	118134-30-8	spiroketalamine	4000mls	fungicide
19	Meltatox	Dodemorph acetate	II	31717-87-0	morpholine	10000mls	fungicide
20	Pride	Fenazaquin	II	120928-09-8	quinazoline	2000mls	fungicide
21	Teldor	Fenhexamid	II	126833-17-8	Hydroxyanilide	4000gms	Fungicide
22	Milberknock	Milbemectin	II	51596-11-3	Biopesticide	2000mls	Acaricide/
23	Kohinor, Confidor	Imidacloprid	II	138261-41-3	chloro-nicotinyl	2000gms	insecticide
24	Dicap	Dimethoate	II	60-51-5	organophosphate		insecticide
25	Nemacur	Fenamiphos	Ia	22224-92-6	organophosphate		insecticide
26	Daconil	Chlorothalonll	II	1897-45-6	chlorinated	8000mls	Fungicide

Development pattern of pesticide use

The results of development pattern of pesticide use are given in Table 2 below based on the pattern developed by Wachter and Staring (1981). Table 2 summarizes the percentage responses from farms around Lake Naivasha.

Table 2: Development pattern of pesticide use around Lake Naivasha

Variable	J (%)	K (%)	L (%)	M (%)	N (%)	P (%)	Q (%)	Total
Pattern of pesticide								
Stage I (Very Low)	33.3	25	■	■	■	■	■	58.3
Stage II (Low)	50	75	■	■	■	■	■	125
Stage III (Moderate)	16.7	■	28.6	12.5	62.5	60	25	205.3
Stage IV (High)	■	■	71.4	12.5	37.5	7.1	75	203.5
Stage V (VeryHigh)	■	■	■	75	■	32.9	■	107.9
Totals	100	100	100	100	100	100	100	700

Key

J: Range (products) of pesticides used in farms
K: Source of pesticides used in farms
L: Distribution structure of pesticide used around Lake Naivasha
M: Area of land under pesticide use
N: Laws and regulations applicable to pesticides in Kenya
P: Level of use pesticide in farms around Lake Naivasha.
Q: Level of agricultural development

The percentages reported for each indicator of development pattern of pesticide use in stages I to V (very low to very high patterns) were compared to arrive at a single level that could describe the pattern of use along the shore of Lake Naivasha. Stage III (moderate) and stage IV (high pattern) of pesticide use were found to be the highest (Table 2), indicating the pattern of pesticide use along the shore of Lake Naivasha to be moderate to high.

Other methods of pest, weeds and disease control

The respondents were asked whether their farms use other methods apart from pesticides to control pests, weeds and plant diseases. All the farms reported they used other methods. Weeds were controlled by mechanically removing them from field by hands and weeding tools.

All the farms were using Integrated Pest Management (IPM) to control pests. This involved the use of biological methods such as natural predators and antaporistics such as *Trichoderma spp, Paecilomyces spp, Phytoselius perimilis* and *Amlolysius spp*. Entamopathogenic fungi and biopesticides were also used. Other methods of control included monitoring (scouting), washing of whiteflies using pure water, use of barriers and traps and hand-picking of caterpillars from the plants.

Plant diseases were controlled by methods such as uprooting of the infected plants to prevent the disease from spreading to the healthy ones, pruning of the infected parts of the plant and planting resistant varieties. The use of greenhouses acted as physical cover that prevented the spread of plant diseases from one greenhouse to another. Heating in greenhouses reduced moisture build-up and this in turn controlled plant diseases.

When asked how they compared harvest when other control methods mentioned above were used alone, 62.5% of farms reported that harvests were average, 25% reported below average harvest while only 12.5% got high yields. They therefore used these other methods to complement pesticide use.

DISCUSSION

About 18.6% (26) of the 141 pesticides being used around lake were in WHO classes I and II: (extremely hazardous (Ia) -0.7%, highly hazardous (Ib) -3.6% and moderately hazardous (II) -14.3%) (Table 1). Although pesticides in these classes are hazardous, farmers still preferred using them possibly due to their effectiveness in pest and disease control and their application to a wide variety of crops (US EPA, 2007). Pesticides in these classes are also highly persistence and bioaccumulate (US EPA, 2007). Some class I pesticides such as oxamyl and methomyl were identified as belonging to the carbamates group (Table 1). The two pesticides were detected in groundwater sampled in the same area (Njoroge, 2012). Carbamate pesticides can cause cholinesterase inhibition poisoning by reversibly inactivating the enzyme acetylcholinesterase (Nathaniel *et al.*, 2006; Mohammad, 2007). This can give rise to a large number of clinical effects in the central nervous system, autonomic nervous system and may lead to paralysis (Nathaniel *et al.*, 2006; Mohammad, 2007).

This study also showed that paraquat (WHO class I) which is a bipyridylium herbicide was also a preferred pesticide. This pesticide has been shown to affect the lungs even in very small doses (Fishel, 2008). Its large application rate of 9.2L/ha/year along the shore of Lake Naivasha is of concern given its high toxicity. Myclobutanil (WHO class I) was also a preferred pesticide even though it has been shown to be teratogenic, inducing facial, axial skeleton, and limb defects (Giavini and Menegola, 2010). It is also known to affect endocrine systems of different organisms and this is the reason for environmental concern (Maren *et al.*, 2008).

Class II pesticides with WHO toxicity classification of moderately hazardous (harmful or fatal) are now widely used as many regulatory organizations on pesticide use continue to discourage the use of class I chemicals. Class III pesticides with WHO toxicity classification of slightly hazardous (harmful) were found to be widely used in large quantities in the study area. Though considered less harmful, some pesticides in this class can be harmful if high doses are taken (WHO, 2011).

Pattern of development of pesticide use

The pattern of development of pesticide use in Lake Naivasha basin was moderate to high (Table 2). This is in agreement with general economic development of Kenya, a developing country (Wachter, and Staring, 1981). Other areas of the country are likely to have a low pattern since Lake Naivasha basin is a region where pesticides are extensively used compared to other regions of the country. In terms of the level of use of pesticides 32.9% farms had a pattern of development of 'very high' (active ingredient over 5 kg/ha). Seventy five percent (75%) of farms have over 90% of land area under pesticide use exhibiting very high pattern. These individual patterns of pesticide development are very high for a developing country like Kenya.

A large percentage (62.5%) of respondents said they were aware that Kenya has laws and regulations but which were not adequately enforced. The farms used mainly imported formulated products, but a few products formulated locally. In the developed countries, stringent legal requirements regarding toxicological and ecological effects have to be satisfied before the importation and use of any particular pesticide is permitted. The costs of satisfying these requirements, when a new pesticide is being developed are very high. Before approving the use of a specific pesticide, the responsible government agency may require that the manufacturer provides data from standard animal toxicity tests and from field studies of ecological effects and environmental transfer (WHO, 1990).

Other methods of control

All of the farms were using Integrated Pest Management (IPM) to control pests other than pesticides. IPM seeks to reduce pesticide use to the minimum level necessary to produce high-quality food and agricultural products while protecting human health and environmental quality. IPM encourages natural control with beneficial organisms such as predators, parasites, and pathogens. Monitoring, or "scouting," is used to detect pest infestations so that pesticide applications can be targeted to times of need. Such field monitoring can significantly reduce pesticide use while protecting crop yields therefore, reducing the risk of environmental pollution. In New York State, for example, onion growers who followed IPM thresholds based on weekly monitoring reports from field scouts were able to reduce insecticide use by 54 percent and save $24 per acre in insecticide costs. Thrips populations were 42 percent lower than those on farms that did not participate in the field scouting program, and the quality of the harvested onions was unaffected (Trautmann *et al.*, 2005).

CONCLUSION

The number of pesticides found to be in use along the shore of Lake Naivasha were 141, and ranged from class I to IV. About 18.6% (26) of these were: extremely hazardous (Ia) - 0.7%, highly hazardous (Ib) -3.6% and moderately hazardous (II) -14.3%. Some pesticides in class I that were being used (e.g. oxamyl, methomyl and fenamiphos are very toxic to human beings and aquatic organisms since they cause cholinesterase inhibition poisoning by reversibly inactivating the enzyme acetylcholinesterase. The quantities of pesticides used were categorized as being high to very high. The pattern of development of pesticide use along the shore of Lake Naivasha was moderate to high and in agreement with that of developing countries. All the farms were also using Integrated Pest Management (IPM) to control pests other than pesticides alone.

ACKNOWLEDGEMENTS

RECOMMENDATION

1. The use of class I pesticides should be discouraged in order to minimize their effects on health of the workers, communities and water bodies near farms that extensively use pesticides.
2. The use of IPM should be promoted as it improves the efficiency of pest control while at the same time keeping the cost and environmental damage to a minimum.

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