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IPM AMELIORATES RISKS OF GROUNDWATER PESTICIDE CONTAMINATION IN LAKE NAIVASHA BASIN, KENYA

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ABSTRACT

Increasing use of pesticides threatens the quality of groundwater with contamination. The objective of the study was to assess the use of integrated pest management (IPM) in reducing the risks of groundwater contamination in Lake Naivasha basin, Kenya. Interviewer administered questionnaires were used to collect data on types and quantities of pesticides used; and other methods used to control weeds, pests and plant diseases. The results showed that 141 pesticides were used in the basin and that 75% of farms were applying pesticides in high quantities. All the farms were also using IPM where pesticides and other conservative means were applied. Majority of farms (62.5%) reported average harvest when IPM methods were used. It was concluded that IPM program around Lake Naivasha is still in its initial stages and in transition from intensive pesticide use. The risk of groundwater contamination in the lake basin is therefore still high.

Keywords: Groundwater Contamination, Integrated Pest Management, Kenya, Lake Naivasha, Pesticides

I. INTRODUCTION

Lake Naivasha is located in Nakuru County in the Eastern Rift Valley, about 100km Northwest of Nairobi, Kenya's capital (latitude 0°49′ S and 0°52′ S and longitude36°18′ E and 36°21′ E). The lake has a surface area of 139 km², an altitude of 1,884 meters and an average depth of 6 m [1]. The Lake is Kenya's second largest freshwater lake, and is a valuable national centre for fishing, agriculture and tourism [2]. Lake Naivasha has a farming system that is well-expanded in the riparian zone and contributes up to 80% of the Kenya's flower production [3]. This intensified horticulture development for export market is thought to have contributed to lake pollution by pesticides [4-6].

Sound pest management program is a prerequisite for marketable export quality horticultural products and aversion of up to 40% of crop losses [7]. But improper pesticide application have been known to pose high risk to the invariably inert ground water elsewhere [8-10]

An investigation on Integrated Pest Management (IPM) as a means of reducing the risks of groundwater contamination along the shore of Lake Naivasha is herein presented. IPM seeks to reduce pesticides use to a minimum level necessary to produce high-quality food and agricultural products while protecting human health and environmental quality [11]. IPM systems range from those that are more chemically intensive, where pesticides are applied based on scouting to those that are biologically intensive, where reduced-risk pesticides may be applied but biological control, conservation, and biologically based preventative approaches predominate [12]. Various IPM practices such as monitoring of pests and disease, the use of population thresholds to determine spray regimes, monitoring and use of beneficial insects to control pests, the use of selective chemicals, the use of growth regulators and the use of mating disruption techniques have been adopted [13]. Other IPM tactics include natural resistance (complete or partial resistance), removal of alternate hosts, sanitation, cultural practices, and behavioral control [14].

Like elsewhere, Lake Naivasha basin's groundwater pesticides risks depends on application rates [15], relative rates of percolation and degradation within the soil profile [16], climate [17], soil properties [18], farming practices [19], aquifer depth [20, 21], and chemical properties [22-24].

Reduction of the quantity of pesticides used and choice of less toxic and less labile pesticides are the most important aspects in the control of groundwater contamination.

II. MATERIAL AND METHODS

Lake Naivasha is located in Nakuru County in the Eastern Rift Valley, about 100 km Northwest of Nairobi, Kenya's capital. The area covered in this study is bounded by latitude 0^{o} 40' 12" S and 0^{o} 51' 12" S and by longitudes 36^{o} 16' 12" E and 36^{o} 27' E.

The study was conducted in agricultural land around Lake Naivasha targeting 20 major horticulture farms within the riparian zone. Major farms were selected based on the wide varieties of crops grown and therefore likely to use varied methods of weeds, pests and disease control.

Structured questionnaires and researcher observation were used to collect data on issues related to pesticides use and application of integrated pest management, in relation to groundwater contamination. The questionnaire captured data on types and quantities of pesticides used; and other methods used to control weeds, pests and plant diseases. The respondents compared harvests when various pest control methods were applied. Complimentary observations were made to verify and identify other practiced control methods.

The questionnaires were administered to the personnel involved in weeds, pests and disease control in the farms participating in the study. Ethical considerations were approved by the Moi University Board of Graduate Studies and Lake Naivasha Riparian owner's Association office (LNROA, 1996).

III. RESULTS

One hundred and forty one (141) different types of pesticides used around Lake Naivasha belong in WHO class 1-IV. Seventy five percent (75%) of farms used more than 5 kg.ha/yr of pesticides of WHO classes I, II, and class III (Tables 1 and 2).

All the farms in the basin reported use of Integrated Pest Management (IPM) ranging from scouting and mechanical removal of weeds by hands and weeding tools, targeted pesticide applications at times of need, washing of whiteflies using water, use of barriers and traps, handpicking of caterpillars to uses of biological control methods such as use of parasitoids and natural predators and antaporistics such as *Trichoderma spp, Paecilomyces spp, Phytoselius perimilis* and *Amlolysius spp*.

Plant diseases were controlled by methods such as uprooting of infected plants to prevent the disease from spreading to the healthy ones, pruning of infected parts of the plant, planting resistant varieties and cut-backing. 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. Biopesticides such as Trichoderma were also used to control plant diseases.

When asked how they compared harvest when IPM 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..

IV. DISCUSSION

The farmers in Lake Naivasha basin used IPM which involved the use of biological control and minimal pesticides application to various degrees. The use of biopesticides such as trichoderma to control plants diseases was reported. In Kenya, trials with biological controls using Phytoselius have resulted in reduction of the spider mite while Diglyphus has resulted in control of white flies and leaf miners while reducing use of chemical pesticides by up to 90% [25, 26]. In a study using soybean IPM system, a mean of about 300,000 *Trissolcus basalis* adults were released per year to control soybean stink bugs [27]. As a consequence of the parasitoid release and the use of more selective insecticides, the number of insecticide applications to control stink bugs was significantly reduced [27].

To reduce the use of insecticides, some studies are trying to improve baiting systems for termite management using biocides and phagostimulants that may influence termite feeding preferences[28-32]. An IPM programme using biological control can therefore be used to reduce the quantity and number of pesticides used while still protecting the crop.

WHO classes I and II are hazardous, are a source of health and environmental risks [33]. Some pesticides in class II and III were applied at rates considered to be high (> 5kg/ha/year) with regards to their potential to contaminate the groundwater [34]. Earlier, we established that oxamyl, a class I pesticides and 8 other pesticides in WHO classes I to III with medium and high risks of contaminating groundwater were applied at elevated levels [35].

Some farms used monitoring, or "scouting, to detect pest infestations so that pesticide applications were targeted to times of need. Such field monitoring can significantly reduce pesticide use while protecting crop yields therefore, reducing the risk of groundwater contamination. 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 [36].

Mechanical controls such as hand-picking and barriers were also reported as methods used to control pests. These methods are especially recommended as the first options to *consider* when a pest reaches an unacceptable level [37].

Majority of farmers using IPM (62.5%) reported that the harvests were average while 25% said the harvest were poor. [38] have stated that the level of damage to the crop may initially increase during transition to an IPM programme in some horticultural crops. The fact that majority of farms had average and poor harvests and that a high percentage of farms (75%) were still using high levels of pesticide means that the use of IPM around Lake Naivasha is still in its initial stages or its efficacy is still not acceptable to the farmers.

V. CONCLUSION

All the farms around Lake Naivasha used Integrated Pest Management (IPM) to control plant pests, diseases and weeds as a complement to pesticide use. The level of use of pesticides was however still high (> 5kg/ha/year), resulting in high risks of groundwater contamination. IPM programme around Lake Naivasha was still in the initial stages and in transition from extensive pesticide use to IPM. The farms were therefore yielding low to average harvests, but this should not discourage them as the benefits of IPM including low risks of groundwater contamination far out way those resulting from pesticide use in crop production.

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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(a.i/Ha/yr)	Use/type
1	Fastac	Alpha cypermethrin	II	67375-30-8	Pyrethroid	1600 ml	insecticide
2	Bulldock 025EC	Beta cyfluthrin	II	68359-37-5	Pyrethroid	2000 ml	Insecticide
3	Brigade, Talstar 100 Ec	Befenthrin	II	82657-04-3	Pyrethroid	1600 ml	insecticide
4	Decis, Keshet 2.5EC	Deltamethrin	II	52918-63-5	Pyrethroid	1000 ml	insecticide
5	Karate	Lambda cyhalothrin	II	91465-08-6	Pyrethroid	1000 ml	insecticide
6	Mavrik	Taufluvalinate	II	102851-06-9	Pyrethroid	360 ml	insecticide
7	Vydate	Oxamyl	Ib	23135-22-0	Carbamate	28000 gm	Insecticide nematicide
8	Lannate	methomyl	Ib	16752-77-5	Carbamate	4000 ml	Insecticide
9	Gramoxone	Paraquat	Ib	1910-42-5	bipyridylium	9200 ml	Herbicide
10	Stroby	Kresoxim-methyl	Ib	143390-89-0	strobilurin	2000 gm	Fungicide
11	systhane	myclobutanil	1b	88671-89-0	Azole	4000 ml	Fungicide
12	Secure 360 Sc	Chlorfenapyr	II	122453-70-0	organophosphate	800 gm	Insecticide
13	Pyrinex	Chlorpyrifos	II	2921-88-2	organophosphate	1920 gm	Insecticide
14	Spidermec 018 EC	Abamectin	II	71751-41-2	soil bacterium streptomyces	2000 ml	Acaricide
15	Pegasus 500 SC	Diafenthiuron	II	80060-09-9	thiourea	2400 ml	Acaricide
16	Rubigan	Fenarimol	II	060168-88-9	pyrimidine	1200 ml	Fungicide
17	Pyrus	Pyrimethanil	II	53112-28-0	anilinopyrimidine	1600 gm	Fungicide
18	Impulse	Spiroxamine	II	118134-30-8	spiroketalamine	4000 ml	fungicide
19	Meltatox	Dodemorph acetate	II	31717-87-0	morpholine	10000 ml	fungicide
20	Pride	Fenazaquin	II	120928-09-8	quinazoline	2000 ml	fungicide
21	Teldor	Fenhexamid	II	126833-17-8	Hydroxyanilide	4000 gm	Fungicide
22	Milberknock	Milbemectin	II	51596-11-3	Biopesticide	2000 ml	Acaricide/
23	Kohinor, Confidor	Imidacloprid	II	138261-41-3	chloro-nicotinyl	2000 gm	insecticide
24	Dicap	Dimethoate	II	60-51-5	organophosphate	4000 ml	insecticide
25	Nemacur	Fenamiphos	Ia	22224-92-6	organophosphate	4000 ml	insecticide
26	Daconil	Chlorothalonll	II	1897-45-6	chlorinated	8000 ml	Fungicide

Table 2: Class III Pesticides Used in High Quantities Along the Shores of Lake Naivasha

S. No.	Trade Name	Chemical name	WHO Class	CAS No.	Group (Chemical type)	Application rate (a.i/Ha/yr)	Use/type
1	Mitac 20 EC	Amitraz	III	33089-61-1	formamidine	6000 ml	Acaricide
2	Kocide	Copper hydroxide	III	20427-59-2	inorganic copper	8000 gm	Fungicide nematicide
3	Acrobat	Dimethomorph/ Mancozeb	III	110488-70-5	morpholine	8000 gm	fungicide
4	Sporekill	Dimethylammonium Chloride	III	506-59-2		8000 gm	Insecticide
5	Alliette	Fosetyl Al	III	39148-24-8	alkyl Phosphonate	8000 gm	Fungicide
6	Melody duo	Improvalicarb	III	140923-17-7	Carbamic acid	9000 gm	Fungicide
7	Avaunt 150 sc	Indoxacarb	III	173584-44-6	oxadiazines	10000 ml	Insecticide
8	Plantyax 20Ec	Oxycarboxin	III	5259-88-1	carboxamide	8000 gm	Fungicide
9	Previcur	Propamocarb Hydrochloride	III	25606-41-1	carbamate	6360 gm	Fungicide
10	Omite 57 EC	Propargite	III	2312-35-8	Organosulfite	6000 ml	Insecticide miticide
11	Kumulus	Sulphur	III			8000 gm	Fungicide acaricide
12	Tedion/V-18Ec	Tetradifon	III	116-29-0		8000 ml	Acaricide
13	Mamba	phosphanoglycine	III	38641-94-0	Glyphosate	6800 gm	Herbcide

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