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Survey of pesticide application on vegetables in the Littoral area of Togo

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Abstract

Vegetable production in Togo is seriously affected by pests attack. To reduce damage, farmers indiscriminately use pesticides. Various studies have reported high concentrations of pesticide residues more than acceptable limits in vegetables and other edible food. The aim of the presented study is to study the attitudes and practices developed by vegetable growers about pesticides applications. A standardized questionnaires which included socio-professional factors, provisions and operations concerning the use of varieties of pesticides were addressed to 150 growers in vegetable farms along the Littoral of Togo. In order to complete data concerning pesticides, seven runoff private companies and agents of the 'Direction de la Protection des Végétaux' were interviewed. Data were statistical treated using Sphinx Plus. The survey showed that vegetable growers have an acceptable educational level (36% have more than 7 years of formal education) to exploit instructions concerning pesticide use, but more than 97% do not use recommended tools. Only 21% of them received training for pesticide use. Moreover, 84% of them did not usually wear gloves, and less than 30% used oro-nasal masks. Failure to observe minimum intervals between pesticide application and sale is worrying because extremely hazardous (Carbofuran and Cadusaphos) or moderately toxic (Cypermethrin, Dimethoate, Endosulfan, Chlorpyrifos-ethyl, Fipronil) are the products currently used. The presented study indicates that pesticides application in the survey area represents a potential risk for the environment, farmers and consumers. More investigations are needed to quantify pesticides residues on the vegetables currently con,umed and moreover, to determine the potential effect of those products on human and animals health.

Keywords

vegetable growers, practices, pesticides, human and environmental risk

INTRODUCTION

In tropical countries, crop loss is pronounced due to the prevailing high temperature and high humidity which are highly conductive to rapid multiplication of pests [1]. For this purpose, a wide variety of pesticides are applied on crop plants to prevent cereals and vegetables degradation by pests and to increase yields [2, 3]. Due to concerns for human health, pesticides are also used by controlling the population of the vector diseases, such as malaria, dengue, encephaliti and filariasis [1]. It has been demonstrated that Dichlorodiphenyl trichlorethane application for malaria eradication, also leads to soil contamination, as shown in Dhaka city, Bangladesh [4]. The indiscriminate use of pesticides represent one of the main environmental and public health problems in developing countries, resulting in water pollution [5], soil contamination [6], destruction of useful organisms and development of resistance by pests, leading to harmful effects on the ecosystems, and the health of both farmers and consumers [7, 8, 9, 10]. In 2010, FAO and UNEP [11] reported that approximately 30% of pesticides marketed in the developing countries do not conform with set standards, because they contain active ingredients exceeding the threshold, and moreover, do not exclude the inclusion of others toxic substances.

The Littoral of Togo is fully exploited for market-gardening. Vegetable farms are small size, over 75% of them are less than 0.1 ha (0.22 acre), and often the growers carry out spaying operation themselves [12]. The United Nations for the Environment Programme [13] reported an abusive use of chemical pesticides on the soils of this area, the majority of which are currently prohibited. The updated legislation on pesticide use in Togo came has been in force since 2006. According to this legislation, employers of agricultural workers and pesticide handlers are required to protect their employees by providing safety training, safety equipments and safety information. But in fact, the legislation n is not correctly applied. The majority of pesticides used on food crops (80%) and vegetable growing (over 95%) are not registered, and because of the lack of monitoring by control of regulatory agencies [12] there is an increase of the number of unauthorized pesticide distributors. Mawussi [14] noted that it is not easy to record reliable data about the real nature of these pesticides because of the complexity of the trade chains, illicit sale and trafficking. An earlier report from PAN-Togo [15] expressed concerns about health risks due to exposure to pesticides in the country. It was shown that many market-gardeners use toxic products in an anarchistic way [16], and often vegetables harvested in the garden were washed in retaining water tanks which may be previously contaminated by pesticides during the spraying and washing of equipment.

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Moreover, obsolete pesticides are spread on the soil, as well as inside and in the surroundings of the store, an environment that also seems to be contaminated by pesticides. However, investigation has not been carried out among small-scale farmers, on samples taken on cereals, nor vegetables sold in the markets in Togo. Currently, precautions may not be taken during pesticide use (wearing special protective clothing, non-permeable gloves and masks to protect the body) by spray operators. The pesticides are applied without concern for their persistence time and their specificity.

Previously, and during the period 1978–1984, a national institution named the 'Direction Protection des Végétaux' (DPV) established that about half of the first need foodstuffs (maize, sorghum, millet, bean, groundnut, rice and vegetables) were unsuitable for human consumption because they contained pesticide residues, such as lindane, dichloro-diphenyl trichloethane (DDT), endrin, dieldrin, heptachlor and chlordane in quantities far exceeding limits fixed by the WHO and FAO. Sixty percent of vegetables and edible seeds sampled in Lomé contained aldrin higher than the acceptable limits [17]. Recently, Mawussi *et al.* [18] determined the high contamination of drinking water, maize and cowpea grains sampled in cash crop (cocoa, coffee, and cotton) cultivation areas in Togo by various organochlorine pesticides, such as γ-HCH, DDTs, aldrin, dieldrin, endrin, heptachlor epoxide and endosulfan. It was noted that more persistent and toxic pesticides intended for the same cash crop were used on foodstuffs and vegetables [11]. In many African communities, studies frequently highlight poor pesticide practice, and highly inefficient practices include using inappropriate products, incorrect dosage, timing and targeting of application, non-calibrated and poorly maintained or leaking application equipment [19]. Few studies have been carried out in Togo, in particular those concerning the above-mentioned conditions. The lack of data on pesticides application in Togo exposes the consumers to potential health deficits. Therefore, the aim of the presented study was to investigate through a survey the attitude and practices developed by vegetable growers in the garden perimeter in the Togo Littoral.

MATERIALS AND METHODS

A survey was carried out from July – October 2009, in vegetable farms along the Littoral of Togo. Standardized questionnaires were addressed to 150 market gardening producers randomly selected along the Littoral between Lomé and Aného (45 km from Lomé). This number corresponded to approximately 10% of the total manpower estimation in the country. Respondents were selected from list of 34 cooperatives which including 403 growers, provided by the national agricultural monitoring service. A questionnaire was developed and pre-tested on 20 randomly selected vegetable growers. After pre-testing, the questionnaire was modified to include following items: gender; age; education level; professional training; experience in vegetable producing; protection measure during spraying; intoxication accidents during spraying; materials used to quantify pesticides; use of protection equipment (gloves, goggles, masks); types and names of pesticides used to control vegetables pest; frequencies of spraying in a growing season; period between last spraying and harvesting; producers attitudes when plants are attacked by the parasites 3 days before harvest; insecticides, fungicides and nematicides used to control pests of some vegetables (Tab. 1). Not all the information was obtained from the questionnaire because some aspects pertaining to growers required observation. An observation form was therefore developed that made provision for observing and recording the following aspects: materials used to quantify different pesticides, mixing and applying pesticides. With regard to the materials used to quantify pesticides, their weight and volume were assessed by using balance and appropriated glassware. Means of these data were calculated.

In order to verify some data collected from vegetable growers in face-to-face individual interviews, the owners or managers of 7 companies accredited to provide pesticides to farmers were asked questions. The interview guide included items concerning: types, common names, synonyms and trade names, and the use pattern of pesticides.

Data treatment and statistical analyses were performed using Sphinx Plus^2 (ERGOLE INFORMATIQUE, version 4.0).

RESULTS

Social and professional conditions of vegetable growers. Table 2 indicates the social and professional characteristics of the vegetable growers interviewed. Most were male (92%), and 73% were young or middle-aged men, between 21 – 50-years-old. Among the interviewed people, 36% had above primary educational level and only 6% were illiterate. The majority of vegetable growers (79%) had never received professional training regarding pesticide use. The survey showed that 60% farmers have 5 or more than 5 years experience in vegetable farming processes. Generally, appropriate precautions were not taken during pesticides use by spray operators. Results indicate that 84% of vegetable producers did not usually wear gloves and goggles, and moreover, protection oro-nasal masks were used by less than 30% of those interviewed. The results of the investigation revealed that 34% of those interviewed felt faint after spraying pesticides. Symptoms often quoted were: feelings of burns on the face and hands, headaches, cold, conjunctivitis, giddiness, constipation, general weakness and pains of the thorax.

During the preparation of the different formulae, more than 97% of applicators did not use standard pesticide quantification materials. They used inappropriate tools providing from refresher. The equivalent weight or volume of some materials are as follows: 1 spoonful (10 mL, 10 g and 13.2 g to quantify insecticide, fungicide and nematicide, respectively); cap from an insecticide bottle (35 g, 16.25 g and 32 g); small bottle of tomato sauce (75 mL, 29.2 mL and 61.25 g); top from a Coca-Cola bottle (6 mL to quantify insecticide only); sardine tin (170 mL); and disposable syringe (10 mL). The formulae often prepared with water are applied as an aerosol produced from portable knapsacks (capacity: 15 liters) which are manually operated.

Pesticide application. Chemical control of pests was the main strategy in the area considered (98% exclusively synthetic pesticides). The presented study shows that only 2% used biological pesticides alone, made from *Azadirachta indica* as the main ingredient to protect their vegetables from insect damage, against 29% of the interviewed who, alternately, combined chemical and biological pesticides.

Table 1. Frequency of pesticide applications per growing season of the vegetable species cultivated on the Lomé garden perimeter and active ingredients used.

Vegetables	Growing season (days)	Insecticide		Fungicide		Nematicide	
		Not appl.	Active ingredients used	Nb appl	Active ingredients used	Nb appl	Active ingredients used
Abelmoschus esculentus L. Moench. (Malvaceae)	45–75	4	Cypermethrin+dimethoate, Endosulfan Lambdacyhalothrin +Dimethoate, , Cypermethrin+ Chlorpyrifos-ethyl	1	Mancozeb, maneb	1	Carbofuran, Cadusaphos, Phenamifos
Solanum macrocarpum L. (Solanaceae)	60–90	4	Lambdacyhalothrin, Cypermethrin	3	Mancozeb	1	Carbofuran, Cadusaphos
Corcorus olitorius (Tiliaceae)	30–45	4	Lambdacyhalothrin , Cypermethrin, Fenphopathrine	5	Mancozeb	1	Carbofuran, Cadusaphos
Lactuca sativa L. (Asteraceae)	35–50	4	Cypermethrin, Lambdacyhalothrin	4	Mancozeb, Copper hydroxid	1	Carbofuran, Cadusaphos
Lycopercicum esculentus Mill. (Solanaceae)	60–80	5	Cypermethrin+Dimethoate, Lambdacyhalothrin +Dimethoate, Cypermethrin+ Chlorpyrifos-ethyl	5	Mancozeb, Copper hydroxid, Maneb, Metalaxil+ Copper hydroxid	Nothing	Nothing
Capsicum esculentus (Solanaceae) Capsicum frutescens L. (Solanaceae) Capsicum chinense Scotch Bonnet (Solanaceae) Capsicum annum (Solanaceae) Capsicum annum L. cv (Solanaceae)	60–75 45–50 80–90 55–75 60–90	8 7 8 5 6	Cypermethrin+Dimethoate, Lambdacyhalothrin +Dimethoate, Endosulfan, Cypermethrin+Profenophos, Cypermethrin+Triazophos	8 7 7 5 5	Mancozeb, Metalaxil+ Cuprous oxide, Maneb	1 1 1 1 1	Carbofuran, Cadusaphos
Allium cepa L. var. Cepa (Liliaceae)	100–156	4	Cypermethrin+Dimethoate, Endosulfan Lambdacyhalothrin +Dimethoate, Cypermethrin+ Chlorpyrifos-ethyl	3	Carbendazime, Chlorotalonil, Mancozeb	1	Carbofuran, Cadusaphos
Allium schoenoprasum L. (Liliaceae)	60–70		Cypermethrin+Dimethoate, Endosulfan Lambdacyhalothrin +Dimethoate, Cypermethrin+ Chlorpyrifos-ethyl	3	Mancozeb, Copper hydroxide	1	Carbofuran, Cadusaphos
Amaranthus hibridus L. (Amaranthaceae)	60–85	4	Cypermethrin, Lambdacyhalothrin	5	Mancozeb, Copper hydroxide	1	Carbofuran, Cadusaphos
Amaranthus cruentus (Amaranthaceae)	60–85	Every week	Lambdacyhalothrin ,Cypermethrin, Fenphopathrin		Mancozeb, Copper hydroxide		
Brassica campestris L. (Crucifereae)	60–80	11	Fipronil, Cypermethrin+Dimethoate, Endosulfan, Bacillus thurgensis, Acephate	11	Mancozeb, Carbendazim, Copper hydroxide, Thiophanate methyl	1	Carbofuran, Cadusaphos
Brassica oleracea L. var botrytis (Crucifereae)	55–95	7	Fipronil, Chlorpyrifos ethyl, Cypermethrin+Dimethoate, Endosulfan, Bacillus thurgensis, Acephate	4	Carbendazim, Copper hydroxide, Mancozeb, Thiophanate methyl	1	Carbofuran, Cadusaphos
Daucus carotta L. subsp sativus (Hoffm.) Thell. (Ombellifère)	90–115	4	Lambdacyhalothrin +Chlorpyrifos-ethyl	4	Maneb	1	Carbofuran, Cadusaphos
Hibiscus sabdarifa (Malvaceae)	30–45	3	Cypermethrin, Lambdacyhalothrin	Nothing	Nothing	Nothing	Nothing
Cucumis sativus x (Cucurbitaceae)	45–65	5	Cypermethrin+Dimethoate, Endosulfan, Lambdacyhalothrin	3	Mancozeb, Maneb	1	Carbofuran, Cadusaphos
Beta vulgaris (Chenopodiaceae)	55–65	4	Cypermethrin+Dimethoate, Lambdacyhalothrin , Cypermethrin+ Chlorpyrifos, Fipronil	4	Mancozeb	1	Carbofuran, Cadusaphos
Brassica rapa L. (Crucifereae)	43–53	5	Cypermethrin+Dimethoate, Lambdacyhalothrin	6	Mancozeb, Copper hydroxide	Nothing	Nothing
Phaseolus vulgaris L. (Fabaceae)	55–65	8	Cypermethrin+Dimethoate, Lambdacyhalothrin , Cypermethrin+ Chlorpyrifos-ethyl, Cypermethrin+Profenophos	3	Maneb, Mancozeb	1	Carbofuran, Cadusaphos
Solanum aethiopicum L. (Solanaceae)	55–80		Cypermethrin+Dimethoate, Lambdacyhalothrin+Dimethoate, Cypermethrin+ Chlorpyrifos-ethyl	3	Maneb, Mancozeb	1	Carbofuran, Cadusaphos, Phenamifos
Sweet eggplant Solanum melongena L. (Solanaceae)	65–95	Every 2 week	Cypermethrin+Dimethoate, Lambdacyhalothrin +Dimethoate, Cypermethrin+ Chlorpyrifos-ethyl	3	Maneb, Mancozeb	1	Carbofuran, Cadusaphos, Phenamifos
Petroselinm sativum (Ombellifère)	75–90	2	Lambdacyhalothrin	1	Mancozeb	1	Phenamifos
Raphanus sativus (Crucifereae)	18–30	2	Chlorpiriphos-ethyl	Nothing	Nothing	Nothing	Nothing

Nb appl = Number of applications

Table 2. Social and professional characterizations of vegetable growers.

Characteristics	Percentage of responses (n=150)
Gender	
Male	92%
Female	8%
Age groups	
< 21	16%
21 – 30	37%
31 – 40	21%
41 – 50	15%
51 – 60	11%
Education level (years)	
Illiterate	6%
1 – 6	58%
7 – 10	32%
> 10	4%
Professional training (pesticide use)	
Yes	21%
No	79%
Experience in vegetable producing	
< 5 years	40%
5 – 10 years	24%
> 10 years	36%
Protection measure during spraying	
No gloves	84%
No oro-nasal masks	71%
No goggles	84%
Intoxication accidents during spraying	
Yes	34%
No	66%
Use of inappropriate materials to quantify pesticide	
Yes	97%
No	3%

A total of 32 different pesticides active ingredients were reported by vegetable growers (21 insecticides; 8 fungicides; 2 nematicides and 1 biopesticide). The most commonly encountered active ingredients of insecticides belong to 5 groups: 24% of organophosphorus (OP); 33% of synthesis pyrethroid (PS); 33% binary OP+PS; 5% of binary PS+Carbamate; 5% of organohalogen or organochorine (OC). The active ingredients most current ly indexed were: Cypermethrin, Dimethoate, Lambda-cyhalothrin, Endosulfan and Chlorpyrifos-ethyl (Tab. 1). Fungicides containing carbendazime, chlorotalonil, manebe, mancozebe, metalaxil, copper hydroxid, oxide copper and thiophanate-methyl. Carbofuran (carbamate) and cadusafos (organophosphorus) were used against nematodes.

The frequency of pesticide applications depended on the nature of the vegetables and the type of the plant pest. Concerning the 26 listed species (Tab. 1), most of the plants were sprayed with insecticides and fungicides 1 – 11 times during their cultivation. The highest application frequencies (7 – 11) were noted for *Capsicum* sp (pepper), *Phaseolus vulgaris* and *Brassica campestris*. Treatments were weekly for vegetables such as *Corcorus olitorius*, *Amaranthus* sp, *Abelmoschus esculentus, Lycopercicum esculentus, Solanum macrocarpum* harvested more than one time. According to the persistence of pests, producers used up to 4 various formulae. Indeed, when a pesticide was not effective, it was often replaced by those which had a higher toxicity than the previous one, disregarding whether the new product was appropriate for a given crop or not.

Compliance with pre-harvesting interval. As shown in Table 3, the delay separating the last treatment and harvest was not often respected. Indeed, periods after pesticides applications varied between 7 – 21 days in the survey zone. A significant proportion of the producers (42%) may spray pesticides even 3 before harvest. Globally, they don't consider fungicides and nematicides harmful like insecticides. This practice may expose consumers to the risk of residue of pesticides in vegetables.

Table 3. Attitudes concerning respect of the period separating the last treatment and harvest.

Waiting periods (period between last spraying and harvesting)	
Type of pesticides	No. of days
Insecticide	5–15
Fungicide	5–15
Nematicide	30–90
Producers attitudes when plants are attacked by parasites 3 days before harvest	
Action	Percentage of responses
Pesticide treatment	42%
Sale without any treatment	27%
Treatment and shift of harvest	12%
Preventive treatment	11%
Others	6%**

** 4% collected precociously and 2% through harvest

DISCUSSION

The objective of the presented study was to investigate the attitudes and practices developed by vegetable growers about pesticides utilization. The significant male proportion (92%) noted in the market-gardening, confirms the report of Waichman *et al.* [10] who pointed out that this activity is dominated in Brazil by males (97.4%). This numerical importance of males may be due to the hardness of the work. Nevertheless, as herbicides being seldom used, some women are often employed for weeding and are also involved in harvesting harvest job.

Contrary to the investigations carried out by Waichman *et al.* [10] in Brazil, our study showed that levels of education are relatively high. However, a few of them received training about pesticides applications and did not follow instructions related to those chemicals. The pesticide label is one of the most important sources of pesticide information, providing all relevant information for safe application of pesticides and moreover for environmental and health risk reduction [10]. Unfortunately, majority of the farmers interviewed made decisions about pesticide use according only to their own experience as previously mentioned by Isin and Yildirim

[9] in Turkey. Mekonnen and Agonafir [20] also reported that in Ethiopia, written information on pesticide packaging was not read by the sprayers. The negligence of the growers to exploit product label information constrained them to use any inappropriate and non graduated materials. In this situation, no correct dose could ever used. These materials would constitute a source of error for pesticide under-dose or overdose during the vegetables treatment. Under-dose could lead to pest resistance and would increase further application of pesticides by growers, focusing good harvest. Thus, the cumulative effects of such exposure over long periods could constitute a significant risk to farm workers [21], their skin is the most exposed organ in this condition [22].

Like fruit growers in Turkey [1], the use of protective clothing, which is very recommended [23], is very rare. It is mentioned that the non protection of farmers and agricultural workers involved in mixing and spraying of pesticides may encounter much higher dermal and respiratory exposures to pesticides [7]. Biomonitoring studies included gloved and ungloved harvesters allowed Krieger [24] to estimate dermal absorption about 25µg/hour. In spite of significant harmful reduction role played by the protection equipments, farmers do not motivate to use them. Ignorance regarding the harmful effects of pesticides, high cost, no availability of these equipments and their discomfort are the raisons evocated by vegetable growers interviewed. This is in according with studies carried out in other developing countries [25, 26, 27]. Effect of climate can justify discomfort situation, because the sprayers of Ethiopia said that windy and sunny weather were the major problems faced during pesticide applications [20]. Face this situation, Clarke *et al.* [21] thinks that there is also the need to develop and provide protective equipment appropriate to the climate and socio-cultural environment. In addition, previous study [28] reported that the use of protective clothing has been insufficient, particularly in the developing countries, because of the lack of regulations due to the lack of education and sensitization.

Vegetable growers tended to use more pesticides in order to preserve their crops or vegetables to pest alteration for more economic benefits [29]. Our results indicate that the frequency of applications of pesticides is higher. Any farmer did not report the correct knowledge regarding pesticides application interval. Their attitudes could be explained by empirical effect-dose relationship that may lead to better harvests often appreciated by customers. A considerable amount of pesticides application was reported in others countries: in Benin, some farmers spray insecticides every 3–5 days [19]; in Brazil, pesticide spraying frequency ranged from once every 3 days to once a week [10]. Our results revealed that insecticides dominated chemical pest management in all vegetable growing systems, reflecting the serious problems of insect attack in survey zone. Elsewhere in America and in Europe, herbicides, as far as possible, are the most commonly used pesticides followed by insecticides, fungicides and others. This is likely to be because it is cheaper to use this product than hire additional labour during weeding [30, 10]. A short delay between pesticides applications and sale may pose risks to public health, more especially as the majority of pesticides used by vegetable growers are extremely hazardous (Carbofuran and Cadusaphos), or moderately toxic (Cypermethrin, Dimethoate, Endosulfan, Chlorpyrifos-ethyl, Fipronil,). It is known that organochlorine insecticides are very stable chemicals which biodegrade slowly and their metabolites and residues move through the water from the application site to the surrounding area [31].

CONCLUSIONS

The presented study indicates that vegetable growers in the Llittoral area of Togo do not use pesticide in accordance with regulation laws. Their lack of knowledge towards appropriate practices, lead them adopting bad attitudes. They do not take protective measures during spraying, and information on pesticide packaging is not observed. The frequency of pesticide applications is higher, and the delay of harvest after spraying is not respected. This is an indication that pesticides were being used in a wrong way. Malpractice in pesticide application could lead to harmful chemicals getting into human food chains with consequent adverse effects on human health. Education, training and information on the use of pesticides and their residues should be made available to farmers in this vegetable perimeter. In addition, more investigations are needed to evaluate potential toxic effects of the most common pesticides used to control vegetable pests like mancozeb and cypermethrin.

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