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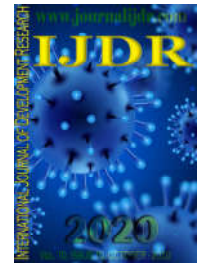
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RESEARCH ARTICLE

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PLANT PROTECTION PRACTICES AND HEALTH IMPACTS IN MARKET GARDENING IN SOUTH BENIN (WEST AFRICA)

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ABSTRACT

The objective of this study is to inventory the types of plant protection products used, risk behaviors during their use and signs of intoxication in market gardeners. It was carried out between May 2019 and January 2020 in southern Benin with 215 market gardeners through individual surveys and direct observations in the departments of Ouémé, Littoral, Atlantic and Mono. The results show that market gardening is mainly carried out by men (74%) who have not received any basic training in phytosanitary practice. The types of pesticides used are insecticides (84.03%), fungicides (14.77%) and herbicides (1.2%). Among the insecticides, some such as Emacot forte EC, Lambdacal P630 EC, Abalam 58 EC..., found on the sites are not specific for speculation. More than half of market gardeners do not comply with the recommendations recommended for handling pesticides. They do not protect themselves adequately and evoke ailments such as rashes and dermatologies (59%), breathing difficulties (53%), digestive problems (49%), vision problems and tight pupils (39%), aches and pains (37%), excessive salivation (35%), and headaches (30%). Ignorance of good phytosanitary practices and illiteracy increase the risk of poisoning and pose a real public health problem. Raising awareness, training market gardeners in good phytosanitary practices, and promoting biocidal plants in cultivation would seriously contribute to the preservation of health and the environment.

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INTRODUCTION

According to United Nations projections, between 2010 and 2030, the number of Africans living in cities will increase by an additional 345 million. In sub-Saharan Africa, growth will be even more spectacular, reaching 595 million (FAO, 2012).

To meet the food needs of this ever-growing population, African countries are turning to the development of agriculture. It is noticed especially through the market gardening which supplies the cities with local vegetables, exotic, herbs and fruits which constitute the principal sources of vegetable proteins, vitamins, trace elements, and

antioxidants. To this end, market gardening plays a key role in most nutrition and poverty reduction programs and contributes significantly to family income (James *et al.*, 2010; Yolou *et al.*, 2015). Notwithstanding the advantages listed, this sector of activity encounters enormous problems linked to land tenure, to the poor soil in nutrients due to their overexploitation, to weeds, to crop pests such as phytophages and parasites (Singbo *et al.*, 2008). The use of phytosanitary products for decades in pest control is no longer to be demonstrated since the practice is routine in Western and African farms (Obopile *et al.*, 2008). Pressure from pests and diseases has been identified as the major constraint due to crop losses inflicted on market gardeners (Kanda *et al.*, 2009; Mondédji *et al.*, 2015). Thus, in order to fight against these pests and diseases in order to improve yields and meet the ever-increasing demand from the markets and achieve economically viable production levels, recourse to the use of synthetic pesticides by producers is almost systematic (Ahouangninou *et al.*, 2011 and 2015; Kanda *et al.*, 2013; Mondédji *et al.*, 2015).

Market gardening practices, far from guaranteeing food and health security, are also seriously damaging to the environment. This is justified by poor cultivation practices characterized by non-compliance with the instructions for the use of plant protection products, ignorance of the risks involved or illiteracy. Several authors have made the same remark, notably Cissé *et al.* (2003), Pazou *et al.* (2006), Assogba-Komlan *et al.* (2007), Ahouangninou *et al.* (2011 and 2015), Kanda *et al.* (2013) and Aïkpo *et al.* (2018). Surveys by the World Health Organization (WHO) have revealed that African countries import less than 10% of pesticides used in the world, yet they account for half of accidental poisonings and more than 75% of fatal cases linked to poisoning involuntary (Tachin, 2011). This indicates a lack of awareness on the proper and effective use of plant protection products in order to minimize the risks associated with handling these products on health and the environment. The misuse of plant protection products leads to the development of pest strains that are resistant to pesticides (Ngom *et al.*, 2012; Roditakis *et al.*, 2015; Lehmann *et al.*, 2016). This situation had as a corollary the loss of productivity and income of market gardeners which will negatively impact their family and social life.

In Benin, market gardening is well developed in the South because of the presence of water bodies and marshy lowlands (Assogba-Komlan *et al.*, 2007). Surveys carried out in Benin revealed that a large part of the plant protection products used in market gardening are prohibited and procured on market garden sites or in the informal sector because of the porosity of the borders (Soclo, 2004; Agnandji, 2018). This smuggling of plant protection products does not spare some approved distribution centers who do not hesitate to deal with the informal sector in search of maximum profit. The use of these products is necessary for market gardeners in order to be able to optimize yields, but it is urgent to recall that several scientific studies have demonstrated their negative and harmful influences on ecosystems, crops, health and the environment (Pazou *et al.*, 2006; Assogba-Komlan *et al.* 2007; Ahouangninou, 2011; Gbaguidi *et al.*, 2011; Allagbé *et al.* 2014; Aïkpo *et al.* 2018). The present study aims to inventory the types of plant protection products used in market gardening in South Benin, risky behaviors during their use as well as signs of poisoning in market gardeners.

STUDY FRAMEWORK AND METHOD

Study framework: The study was carried out in southern Benin, between meridians 1 ° 40' and 2 ° 45' east longitude and parallels 6 ° 15' and 7 ° 30' north latitude (Figure 1). It corresponds to the Guinean or Guinean-Congolese zone which benefits from a subequatorial climate with a bimodal rainfall regime. The rains are spread over two rainy seasons of unequal duration, a large one from March to July and a small one from September to October, interspersed by two dry seasons, a large one from November to February and a small one, centered on the month of August. This zone is characterized by high relative humidity (85 to 90%) and an average annual temperature ranging between 23 and 32 ° C. Rainfall decreases from East to West: from 1300 mm in Porto-Novo to 900 mm in Grand-Popo (Akoègninou *et al.*, 2006). The vegetation is a mosaic of dry semi-deciduous forest, Guinean savannas and plant groups whose floristic composition varies according to the type of substrate and the degree of flooding. The topography is variable ranging from plateaus with ferrallitic soils to alluvial plains via valleys (lowlands) with hydromorphic soils. The dominant economic activities are trade, agriculture, animal husbandry, fishing and crafts.

Data collection method: The data was collected from May 2019 to January 2020 in four departments selected at random in South Benin where market gardening is practiced. These are the departments of Ouémé, Littoral, Atlantique, and Mono. In each department two market gardeners selected at random were visited and information was collected from the market gardeners present on the site at the time of the visits. A preliminary raid on each site made it possible to meet the persons in charge and to obtain their authorization to investigate. Following their agreement, 215 questionnaires were administered to market gardeners distributed as follows: 77 in the Littoral (PLM Alédjo and Fidjrossè sites), 70 in Ouémé (Sémé Kpodji and Akron sites), 33 in the Atlantic (Tori-Bossito site, Tokan) and 35 in the Mono (Zévilatidji and Aziankou-Condji). A focus group was carried out with the market gardeners and the cultivation practices were also observed. The data collected focused on the socio-professional characteristics of market gardeners (sex, age, level of education, seniority in work, etc.), phytosanitary practices (the different crops grown by market gardeners, pests observed on the field, the active pesticide materials used in the treatment of crops, the dose applied, the frequency of pesticide application, the modes of use, the management of empty pesticide packaging or bottles, the use of the Personal protection, the length of time before harvest observed, etc.), the perception of health risks and the discomfort felt after application of the plant protection product. The information collected was recorded in the Excel 2013 software and processed with the R3.4.2 software. 2010. Statistical parameters such as mean and frequency have been determined and a chi-square test of independence is performed to verify whether there is an association between variables and the location of the sites.

RESULTS

Sociodemographic characteristics of surveyed market gardeners: Table I shows that market gardening in the surveyed sites is mainly practiced by men with an overall participation rate of 74%. The highest participation of the fairer sex (47.14%) is noted in the department of Ouémé. The age of market gardeners varies between 18 and 80 years.

The age group most interested in this activity varies from one department to another and is in the range of 20 to 59 years (87.45%). In addition, on the matrimonial level, the market gardeners are in the majority of the married people and for the majority have the secondary level and not having received any basic training in phytosanitary practice. Most of the respondents have a seniority of between 10 and 30 years (59.16%) and for some of them market gardening constitutes a secondary activity (25.7%). There is a significant difference from one department to another with regard to women's market gardening activity ($p = 0.000$) and the secondary education level of the respondents ($p = 0.022$).

Main crops grown on the different sites: In the four departments visited, the market gardeners grow almost the same crops but in varying proportions. The speculations identified on the explored sites have been recorded in (Table II) with their frequency of citation. These are both local, exotic and aromatic vegetables.

Main pests: Pests of crops are pests (mites and insects) and diseases caused by viruses, fungi and bacteria. The most cited are caterpillars, beetles, white flies, lepidoptera, leafhoppers, thrips and aphids. They have the characteristics of causing round holes on the leaves, deformation, discoloration or even yellowing of the leaves, stinging the plant and causing it to dry out. The diseases of fungal and bactericidal origin noted are wilting, necrosis and spots.

Different plant protection products listed on the sites: Table III presents the plant protection products used by market gardeners in the four departments visited. They are mostly non-specific for speculations (Emacot forte EC, Lambdacal P630 EC, Abalam 58 EC...). Others like Duel, Sympérifos, Denominator, Sicozème and Sulfur 80, are used by market gardeners and do not appear in the list of pesticides approved in the Republic of Benin by the National Committee for the Approval and Control of Plant Protection Products (CNAC), nor by the Sahelian Pesticides Committee. Some market gardeners use bio-pesticides made from Neem, Papaya and Basil leaves. The plant protection products used are insecticides (84.03%), fungicides (14.77%) and herbicides (1.2%). In the group of insecticides, the most cited family is that of pyrethroids (53.43%).

Cultural practices observed on the sites

Agricultural training or advice on the application of plant protection products-Market gardening is an activity carried out by people who have inherited the location of production by parents and by dropouts. Whatever the sites visited, most of the half of the market gardeners have received no training and imitate or take advice from colleagues, a high rate of 81.82% for the Atlantic and 71.43% for the Mono. The different behaviors and phytosanitary practices on the sites are summarized in Table IV and by the figures which follow.

Management of phytopharmaceutical product bottles-The market gardeners surveyed have three ways of keeping the bottles of products or products started. They store them in the small huts built on the site which are also of rest room. Others bury them behind the hut or in the bushes. Finally, we have those especially from the departments of Ouémé and Atlantic, in the proportions 30% and 36.36% respectively, who prefer to take them home at the risk of being stolen. On the other hand, empty packaging is either burned, buried, thrown in the trash

or on the ground. on the site or reused for other purposes. They are used to store petroleum, from oil to engine and worse to save cooking salt and peanut or palm oil for cooking. The packaging management varies from one department to another: the market gardeners of the Littoral (49.35%) throw them in the trash but those in Mono prefer to burn them (54.29%). Reuse of packaging is more noted in Ouémé (20%) and in the Atlantic (15.15%). These behaviors can be the basis of contamination and poisoning. The figure 2 below shows how pesticide packaging is managed in the four departments.

Individual protection equipment -Market gardeners barely protect themselves before spraying and talk about due to the high cost of equipment and its unavailability. Some believe that the outfit required for the handling of these products slows down the work. The most protective elements worn are long-sleeved shirts (52.51%), pants (55.14%), mufflers (45.7%), boots (39%) and gloves (37.11) for all market gardeners. Others market gardeners presented respirators, goggles and overalls but do not wear them hardly any.

Dosage, Frequency, Means of Spraying and Elimination Period-The dose written on the packaging of plant protection products is often not respected. Most market gardeners recognize that they adopt an imprecise dose, either 45.45%; 44.30%; 39.40% and 31.43% respectively in the Littoral, Ouémé, Atlantic and Mono. They state that often this is the dose applied by the neighbor or increased according to of attack intensity. However, the dose of 50ml per 16 ml of water is observed in all departments with varying proportions for the Littoral, the Ouémé, the Atlantic and the Mono respectively at 49.35%; 22.86%; 42.42% and 42.86% (Figure 3). The dose of products used is associated with the location of the site ($p = 0.0005$) (Table IV). The application of the product depends, according to the market gardeners, on several factors: speculation, the effectiveness of the product and the intensity of the pest damage. In general, the frequency of a times a week is most observed in the proportions 46.75%; 42.86% and 39.40% respectively in the Littoral, Ouémé and Atlantic departments. In the Mono, the most noted frequency of application is twice a week, i.e. 51.41% (Figure 4). The frequency of application is weakly associated with the location of the site with $p = 0.021$ (Table IV). The majority of market gardeners use sprayers as application tools (figure 5). However, practices such as the use of watering cans and makeshift tools such as preparation of the solutions in the bowls and sprinkling with the tufts of leaves are also observed. In the departments of Ouémé, Atlantique, Mono, respectively 7.41%; 6.06% and 8.57% of market gardeners use tufts of leaves to spray the speculations with pesticide spray. Spraying means are strongly associated with the location of the site with a value of $p < 0.00000$ (Table IV).

Time before harvest-The time between application and harvest, noted waiting period, is characteristic of each plant protection product and is often listed on boxes or packaging. The illiteracy of some or the lack of attention of others means that the leaflet is not respected especially if the demand is urgent, they are obliged to harvest the leaves of vegetables for sale. Thus the period between 14 and 21 days reported by the market gardeners of the Atlantic, Mono and Ouémé departments respectively in proportion to 51.52%; 51.43% and 44.29% was observed most often for exotic vegetables and for the spices. Those of the Littoral (42.15%) observe a delay of less than a week (Figure 6). The delay is not associated with the location of the site $p = 0.11$ (Table IV).

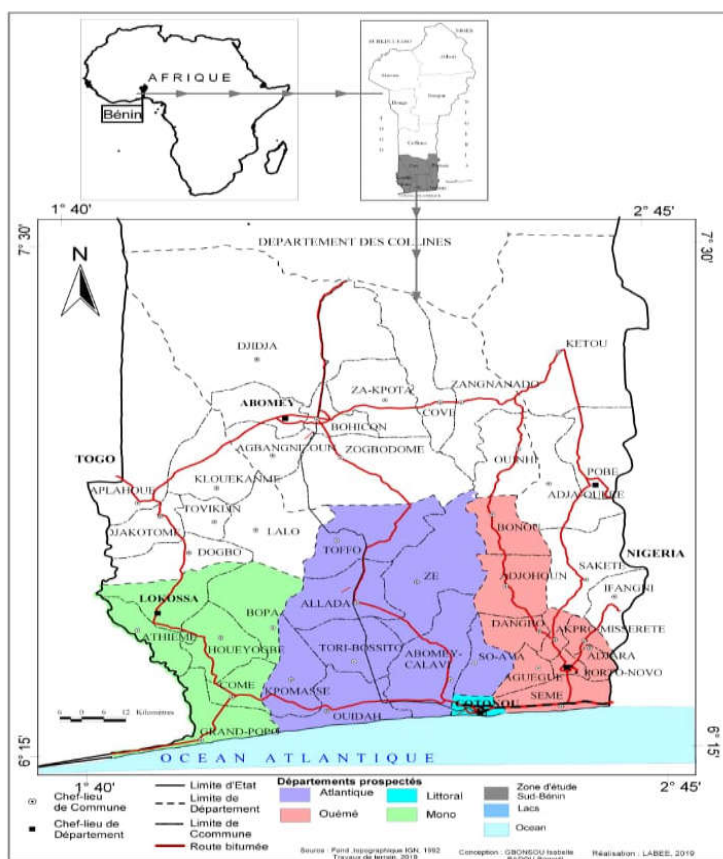


Fig. 1. Geographical location of the departments explored in southern Benin

Table I. Socio-professional characteristics of the market gardeners surveyed

VARIABLES		Littoral (%)	Ouémé (%)	Atlantique (%)	Mono (%)	% global	Khi2 P-value
Genre	-Male	93,50	52,86	69,70	77,14	74,00	39,746
	-Feminine	06,50	47,14	30,30	22,86	26,00	0,000**
Marital status	- Married	90,91	88,57	84,85	75,76	86,05	8,157
	-Single	09,09	11,43	15,15	24,24	13,95	0,418
Educational level	- University	06,34	02,86	09,01	17,14	07,44	29,371
	-Secondary	37,66	22,85	21,21	57,14	33,49	0,022*
	-Primary	30,00	32,86	24,24	14,29	27,44	0,321
	-None	26,00	41,43	45,45	11,43	31,63	0,457

*Significant

** very significant

Table II. Speculations cultivated by market gardeners on the explored sites

Categories	Speculations (common name)	Scientific names	Citation frequencies (%)
Local vegetables	Great nightshade	<i>Solanum macrocarpum</i> L.	84,6
	Tropical basil	<i>Ocimum gratissimum</i> L.	74,4
	Corete vegetable	<i>Corchorus olitorius</i> L.	44,1
	Celosia	<i>Celosia argentea</i> L.	11,6
	Vernonia	<i>Vernonia amygdalina</i> Delile	76,2
	Amaranth	<i>Amaranthus cruentus</i> L.	72
	Green pepper	<i>Capsicum chinense</i> Jacq.	6,9
	Small chili	<i>Capsicum frutescens</i> L.	10,69
	Tomato	<i>Lycopersicon esculentum</i> Mill.	25,58
	Onion	<i>Allium cepa</i> L.	18,1
	Okra	<i>Hibiscus esculentus</i> L.	7,9
	Radish	<i>Raphanus sativus</i> L.	2,32
	Green bean	<i>Phaseolus vulgaris</i> L.	6,97
	Cabbage	<i>Brassica oleracea</i> L.	29,3
Exotic vegetables	Carrot	<i>Daucus carota</i> L.	58,1
	Bett	<i>Beta vulgaris</i> L.	11,6
	Lettuce	<i>Lactuca sativa</i> L.	69,7
	Cucumber	<i>Cucumis sativus</i> L.	31,6
	Turnip	<i>Brassica rapa</i> L.	8,3
	Pepper	<i>Capsicum annum</i> L.	18,1
	Mint	<i>Mentha spicata</i> L.	20,9
	Basil	<i>Ocimum basilicum</i> L.	13,9
	Thyme	<i>Thymus vulgaris</i> L.	5,1
	Fennel	<i>Foeniculum vulgare</i> Mill.	1,3
Aromatics	Parsley	<i>Petroselinum crispum</i> (Mill.) Fuss	16,27
	Celery	<i>Apium graveolens</i> L.	9,3
	Sage	<i>Salviasp.</i>	0,9
	Rosemary	<i>Salvia rosmarinus</i> Spenn.	3,7

Table III. List of plant protection products used by market gardeners

Pesticides Used	Actives ingredients	Families Chemical	Approved in the Republic of Benin under the number	Cultures	Frequency %
Acarius 18 EC	Abemectin	Insecticide	AH-10/R2-0003/CNAC	Leafy vegetables	11,94
Emacot EC*	Emamectin benzoate 48 g/l	Insecticide	APV-14.135/CNAC	Cotton	15,82
Lambda super	Lambdacyalotrin 25g/l	Insecticide	AVP-19 180/CNAC	Vegetables crops	27,01
Pasha 25EC	Acetamiprid Lambdacyalothrin	Insecticide	AH-100092/CNAC	Vegetables crops (cabbage)	15,22
Lambdocal P	Lambdacyalothrin 30 g/l	Insecticide	AH-100093/CNAC	Cotton	2,69
630 EC	Profènos 600g/l				
CYDIM C50***	Cypermehrin	Insecticide	-	-	0,30
Tihan 175 O-TEQ	Flubendamin 100g/l	Insecticide	AH-11.0096/CNAC	Cotton	1,04
Laser	Spirotetramat 75g/l				
Cypercal	Spinosad 480g/l	Insecticide	AH-18/R1-0073/CNAC	Cotton	1,80
	Cypermethrin 30g/l	Insecticide – Acaricide	AH-18/R2-0002CNAC	-	1,65
	Profenofos 300				
TOPSIN M32 (30) ***	Methythiophanate	Fongicide	-	-	5,22
Koptimal**	lambda-cyhalothrine(15 g/l) + Acétamiprid (20 g/l)	Insecticide	0586-HO/In/12-15/HOM-SAHEL Expires at the end of December 2020	Cotton, cabbage	6,26
Abalam 58 Ec*	Lambda cyalothrin 30 g/l + Abamectin	Insecticide	APV-16.153/CNAC	Cotton	0,30
Coga80WP/Mancozeb	Mancozebe 800g/kg	Fongicide	AH-16.132/CNAC	Lettuce, amaranth canker	7,61
Killer 480/SL	Glyphosate 480 g/l	Herbicide	AH-17 138/CNAC	Rice	0,15
Idefix	Copper hydroxid 65.6%	Fongicide-Bactéricide	AH-19137/CNAC	Vegetables crops, cabbage	1,04
Banko more***	Chloronitrile + Benzimidazole	Fongicide	-	-	0,9
Alligator**	Pendimethalin 400g/l	Herbicide	0502-A-1-X1/He/05-17/APV-Sahel. Expires end of mai 2020	Cotton plant	1,04

* Probably withdrawn from sale in Benin, ** Approved in the CSP (Sahelian Committee of Pesticides), *** Not approved

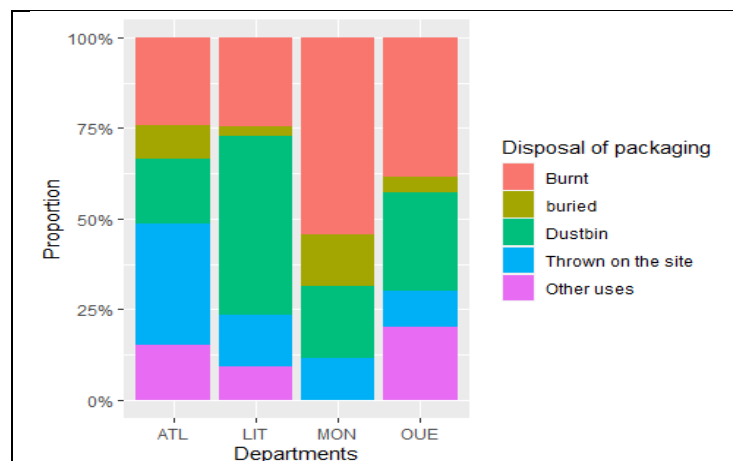


Fig. 2. Management of empty packaging in the departments

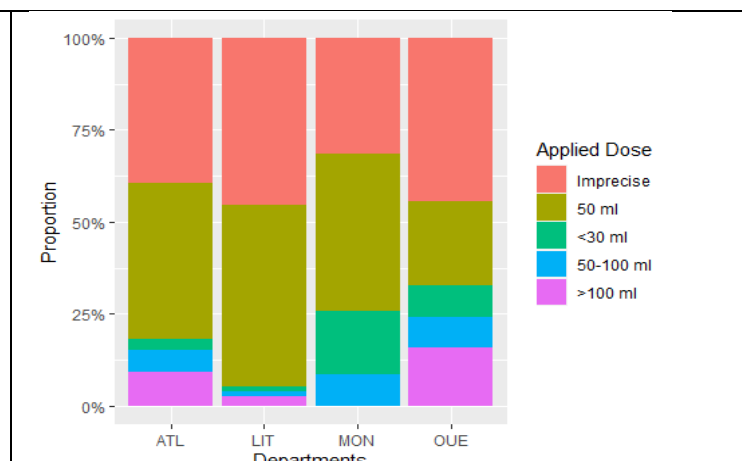


Fig. 3. Dose of pesticide applied in the departments

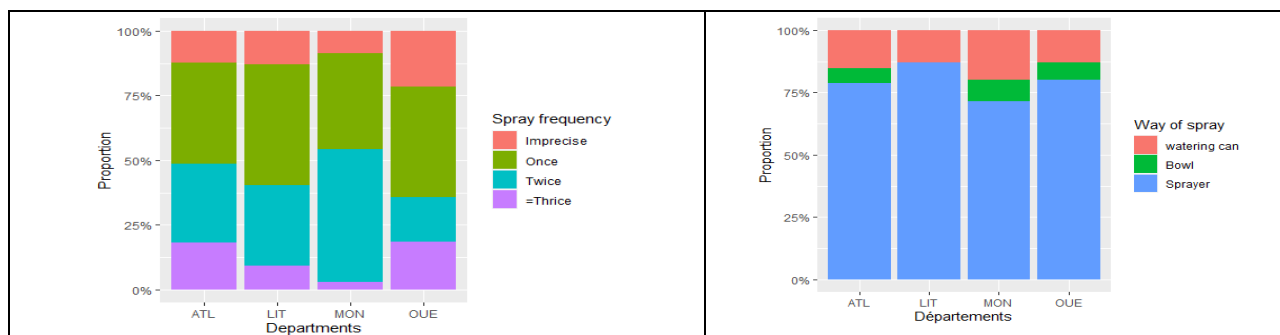


Fig. 4. Frequency of application per week in the departments

Fig. 5. Means of spraying in the departments

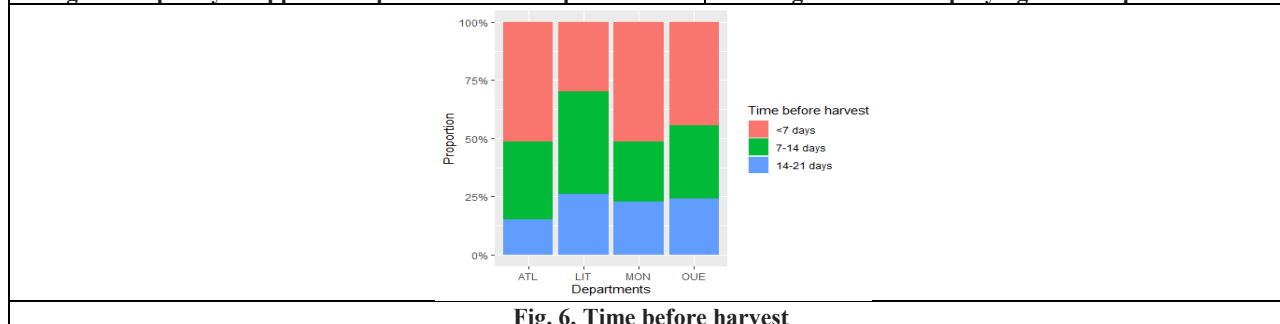


Fig. 6. Time before harvest



Fig. 7. Photos showing: -Handling of products with bare hands (a-, b- and c-); -Products piled up in a jute bag (d-); - Market gardeners spreading products without protection (e- and f-); - Flaky hands of market gardeners (g- and h-)

Table IV. Cultivation practices observed on the sites

Variables	Modalities	Littoral (%)	Ouémé (%)	Atlantique (%)	Mono (%)	Khi2 p-valeur
Location supply	D. approve :	33,76	07,14	21,21	20,00	0,0026*
	M. local :	63,64	88,57	78,79	80,00	
	unclear:	02,60	04,29	00,00	00,00	
Approval	Yes	84,42	72,86	39,40	100	0,00017**
	No	15,58	27,14	60,60	0	
Applied dose in 16 l of water	unclear:	45,45	44,30	39,40	31,43	0,00055**
	<30ml	1,30	8,57	3,03	17,14	
	=50ml	49,35	22,86	42,42	42,86	
	50 -100ml	1,30	8,97	6,06	3,57	
	> 100ml	2,60	15,70	9,09	5	
Spray frequency per week	unclear:	12,99	21,43	12,12	8,60	0,021*
	1 fois :	46,75	42,86	39,40	37,14	
	2 fois :	31,17	17,14	30,30	51,41	
	≥ 3 fois :	9,09	18,57	18,18	2,85	
Means spray	Sprayer	87,01	80	78,79	71,43	0,00000***
	Watering can	12,99	12,86	15,15	20	
	Bowl	0	7,14	6,06	8,57	
Time limit before harvest	≤ 7 days	29,88	44,29	51,52	51,43	0,116
	7-14 days	44,15	31,43	33,33	25,71	
	14-21 days	25,97	24,28	15,15	22,86	
Protective gear	Yes	27,27	10	21,21	20	0,122
	No	72,73	90	78,79	80	
Spray direction	FD wind	93,51	85,71	96,97	83	0,00000***
	CD wind	6,49	14,29	3,03	17	
Shower after spraying	Market gardening site	25,97	0	6,06	0	0,00000***
	Water point	1,30	21,43	9,09	0	
	House	72,73	78,57	84,85	100	
Storage of food	House	77,92	77,14	84,85	100	0,00000***
	Site	22,08	22,86	15,15	0	

* Significant, ** very significant, *** highly significant D. approved = Distributor approved, M. local = Local market, FD wind = Facing the wind direction, CD wind = Against the direction of the wind

Table V. Perception of discomfort after spraying and the symptoms observed

Malaises	Littoral	Ouémé	Atlantique	Mono	Effectifs	Pourcentage %
Dizziness	3	5	1	3	12	5,58
Headache	18	23	13	11	65	30,23
Vision problems	29	33	14	7	83	38,60
Excessive salivation	28	31	10	7	76	35,34
Digestion disorders (nausea, vomiting, diarrhea)	35	54	12	5	106	49,30
Respiratory difficulty	46	38	21	10	115	53,48
Palpitation	13	12	7	1	33	15,34
Skin and dermatological rashes	49	30	25	22	126	58,60
Pain and stiffness	31	32	9	7	64	36,74
Difficulty hearing	1	1	1	2	5	2,32
Insomnia	8	12	2	3	25	11,62
Convulsion	4	13	2	0	19	8,83
Hand tremor	2	2	3	3	10	4,65

Other behaviors at risk of contamination-Market gardeners wash spray equipment on site and at water points. They wash immediately after spraying in the water points, store food, prepare and eat on site. The water used to water the crop beds is runoff, the water collected in boats and basins that are not maintained. Inattention to wind direction before spraying, food storage and showering near water points are strongly associated with site location $p=0.00000$ (Table IV). The figure 7 shows some photos below that illustrate the facts observed at the sites.

Perception of discomfort after spraying and symptoms observed-Market gardeners mentioned some discomfort after using phytosanitary products. The most recorded are: eruptions skin and dermatological problems (59%), breathing difficulties (53%), digestive problems (49%), vision (39%), aches and pains (37%), excessive salivation (35%), and headaches (30%) (Table V).

DISCUSSION

The present study carried out through surveys and direct observations on the market gardening sites explored shows that market gardening is a practiced activity mainly by men. The women involved in this activity are those who often help their husbands and those whose lands have been bequeathed by the parents; which explains the strong participation of women in Sémé-kpodji. The participation of women is significantly associated with the location of the site. Of out-of-school or university youth looking for temporary employment for finance their schooling or equip their workshop are also involved in this activity. The same observation was made by Mondedji *et al.* (2015) in Togo, Muliele *et al.* (2017) in Congo and Kpan Kpan *et al.* (2019) in Côte d'Ivoire. Low level of education, illiteracy and lack of training adequate in phytopharmaceutical practice are all reasons that explain the misuse of products. The risks of short and / or long term toxicity linked to this inadequate plant protection practice are not well known to market gardeners. These are facts that have been mentioned by Ahouangninou *et al.* (2019), Allagbé *et al.* (2014), in Benin and Kpan kpan *et al.* (2017) in Côte d'Ivoire. From a global point of view, phytosanitary practices in market gardening in the South of Sahara are a serious problem of public health and protection of the environment. As several authors have pointed out, the bad behaviors when handling plant protection products are aggravating factors of this situation (Cissé *et al.*, 2003; Pazou *et al.*, 2006; Assogba-Komlan *et al.*, 2007; Ahouangninou *et al.*, 2011 and 2015;

Kanda *et al.*, 2013; Aikpo *et al.*, 2018). The rapid harvest of local crops such as local vegetables (80%) allows market gardeners to provide for the needs of the family and to pay for the education of children, to pay for health care or to save for the purchase of a plot... The same remark was made in Congo by Muliele *et al.* (2017) which stipulate that 95% of market gardeners attach importance to vegetables given the great market value and their quick sale right after harvest. The culinary importance and therapeutic virtues of aromatics are not yet well known to the Beninese population. Only 5% of market gardeners, especially in the Littoral Department combine the cultivation of herbs with other cultures because their demand is rare. The reason is that these products are delivered to certain Westerners in the well-to-do districts of Cotonou and in markets such as Ganhi and Cadjéhoun as well as at supermarket fronts regularly visited by westerners. All market gardeners recognize that it is not possible to make market gardening without using pesticides in the context of the proliferation of parasites. The reason given is that good women selling vegetables leaves prefer the intact beautiful green leaves that once on the shelves will be able to attract customers. However, 98% of respondents are aware and unanimous on the fact that plant protection products are harmful to the health but they persist in using them. The main reason given is that attacked or damaged leaves and less green do not attract customers while well-treated crops look great and capture the attention of customers and allow you to make bigger profits. Studies by Wade (2003), Mawussi *et al.* (2015), Soungangbé *et al.* (2010) and Mondedji *et al.* (2015) confirm our results. Market gardeners recognize that extracts from leaves and seeds solve most pest problems but are expensive and not available. Moreover, speculation processed by extracts will not be profitable for the producer unless that he sells at a high price which is not appreciated by resellers who prefer to source from their colleague. Suddenly they suffer from bad sales and considerable losses. Production sites like Sémé kpodji's where some producers sometimes use bio-pesticides expose speculations at a risk of contamination because the wind can carry free particles of pesticides handled by neighbors. It would be desirable that farms organic crops are grown in other market gardening areas much further away. Insecticides (84.03%), fungicides (14.77%) and herbicides (1.2%) constitute the three main chemical families of products phytopharmaceuticals identified in this study. These formulations were also cited in the work of Ngowi *et al.* (2007), de Snelder *et al.* (2008). Among the insecticides, the pyrethroids which formulate the lambda-cyhalothrin are the most applied, i.e. 53.43%. Our results corroborate those of

Ahouangninou *et al.* (2012), by Agnandji *et al.* (2018), and Son *et al.* (2017) respectively in Togo (97%), Cotonou (39.8%) and Burkina Faso (67%). But several studies have shown that pyrethroids influence hormones, thyroid, testosterone level, hematological, biochemical parameters and impair liver function. (Meeker *et al.*, 2009; Sam *et al.*, 2012; Hénault-Ethier, 2015; Tahaet Yassin, 2017; Priyanka *et al.*, 2017). But the low proportion of herbicides found in the present study testifies that market gardeners prefer manual weeding as observed by Ahouangninou *et al.* (2011). Weeding and other activities such as watering and the amendment are often provided by job seekers who move to length of day at the sites. This shows that market gardening is an activity provider of jobs and profits and allows people to support themselves to their basic needs. Kahane *et al.* (2005) asserted that in terms of economic, market gardening is an excellent source of income for the inhabitants in urban and peri-urban areas. The phytosanitary practices adopted by market gardeners in South Benin are sources of risk to both health and food safety. They do not protect and those who claim to have personal protective equipment (PPE) exhibit long shirts and pants, glasses and muffers, gloves and boots that do not meet standards. For them this equipment is expensive, restrictive, uncomfortable, slow down the work and are not available. For Sougnabe *et al.* (2009), market gardeners do not protect themselves by due to the high cost of protective equipment. Ahouangninou *et al.* (2015; 2019) approach in the same direction by identifying the unavailability, the high cost of PPE and discomfort as a determinant of not using PPE. The average factor financial was also mentioned among farmers in the Philippines (Matthews, 2007). Spraying with twigs or branches reported by Doumbia & Kwadjo (2009), Sougnabe *et al.* (2010), Ahouangninou *et al.* (2011), Kanda *et al.* (2013) is still in practice in the departments of Ouémé, Atlantique and Mono. Market garden products (fruits and vegetables) are likely to contain very important trace elements to fight against free radicals. Sure food safety plan, bioaccumulation of product residues phytopharmaceuticals in market garden products makes them unsuitable for consumption.

The application of a plant protection product that does not comply with culture, failure to comply with the required dose, frequency of application and failure to compliance with the pre-harvest period are all malfunctions observed on the field and testify to the failure to observe the recommendations of the manufacturers. Market gardeners do not bother to read and do not pay attention to pictograms because of the low level of education of most of them (Tourneux, 1993). These behaviors expose them and consumer to a risk of intoxication which is initially minor and can become severe due to bioaccumulation. These facts have been revealed by several authors (Gomgnimbou *et al.*, 2009; Kanda *et al.*, 2013; Agnandji *et al.*, 2018). Behaviors like storing food and taking a shower near water points are significantly influenced by the location of the site ($p = 0.00001$). To these in addition to the washing of spray equipment, empty packaging and boxes lying around the site, thrown into the drains or used to serve as salt or cooking oil containers, which increase the risk to health and the environment. Some authors like Cissé *et al.* (2003); Pazou *et al.* (2006); Traore *et al.* (2006); Kanda *et al.* (2009) and Ahouangninou *et al.* (2011; 2015) also emphasized these health risks and environmental. The packaging had to be recycled and not used by others purposes. Thiam & Sagna (2009) have also shown that packaging is never recycled or returned to distributors, but rather reused.

Non-compliance with recommendations in the application of products phytopharmaceuticals in many African countries such as Benin, Togo, Ghana, Ivory Coast, Congo or Ethiopia, are registering cases of hospitalizations (Matthews, 2009). Even if the cases of hospitalizations are not recorded during this study, the market gardeners listed several symptoms following improper handling and inhalation of the products. Most cited are dermatological, respiratory and digestive problems, disorders of the vision, excessive salivation, aches and / or pains, and headaches. These symptoms and discomforts that we could safely link to the bad phytosanitary practices and non-compliance with hygiene rules during handling of plant protection products have also been announced by other authors in Ethiopia, Ghana, Morocco, Benin, Togo respectively by Williamson *et al.* (2008), Matthews (2009), Derkaoui *et al.* (2011), Ahouangninou (2011), Kanda *et al.* (2013); likewise, our results corroborate those of Aikpo *et al.* (2018) who reported 73.68% skin irritation; 47.06% of breathing difficulties in the municipality of Djidja in Benin. To remedy certain accidents of poisoning, burning and irritation of the eyes and skins and other occurrences on the site, the market gardeners take measures of fortune such as the passage of palm oil, coconut oil or those of palm, shea butter or crush the leaves of tropical basil, vernonia for drink or put in the eyes. They also take Peak milk to alleviate the digestive disorders. These findings are identical to those observed by Ahouangninou *et al.* (2011) and Kanda *et al.* (2013). Products brought home for fear of being stolen or stored in rooms storage on site may constitute a danger to children who could handle or even bring them to the mouth. Our results corroborate those of Cissé *et al.* (2003) in Senegal and Ahouangninou *et al.* (2011; 2015) in Benin. Ultimately, aware of the risk associated with the use of products phytopharmaceuticals, market gardeners would like to replace them with products much less toxic biologicals. The only difficulty is that the products organic, although equally effective in controlling pests, are more expensive and do not allow market gardeners to profit. Indeed, customers will not agree to pay double the price of the board in the case of cultivation organic. However, a minority in the Littoral and in the Mono is trying in making a mixed culture but they pose the same problem of profitability of the activity. Thus, they are launching a cry of alarm at the rulers in order to subsidize biopesticides. Finally, it would be advisable to organize an annual check up of health for the benefit of market gardeners like government professionals public.

Conclusion

Market gardening in southern Benin is an activity mainly carried out by illiterate and out of school. The low level of education of market gardeners makes that they vegetate in the rudimentary methods of practices phytopharmaceuticals and do not measure the dangers in the short, medium or long term incurred. The usual practices observed at the eight sites explored do not meet no standard of good phytosanitary practice. The bad practice in crop pest management is due to the fact that market gardeners in South Benin have not received adequate training in field. This state of affairs increases the risk of poisoning and poses a public health problem. The study allowed us to note that poor phytosanitary practices are the non-use of PPE, non-compliance with the dose and the withdrawal period, spraying with watering cans, spreading the bowl of product spray phytopharmaceuticals with tufts of leaves. It has also been observed that pesticides

like Laser, Alligator, Emacot Fort EC... not suitable for speculation and those mainly applied for cotton are found among market gardeners. The motto of any professional in market gardening would be to ensure their health and that of his customers, a guarantee of the sustainability of his career. The government and non-governmental organizations must be involved in the application of laws relating to the good management of phytosanitary products and must invest in finding the biocides desired by many market gardeners. It is urgent to make market gardeners aware of the dangers associated with using plant protection products and train them on good practices cultural. It will therefore be necessary to support them in the highly desired promotion biocidal plants. Scientific research must intensify on the latter point.

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