Available online at http://www.ifgdg.org

Int. J. Biol. Chem. Sci. 17(2): 304-315, February 2023

ISSN 1997-342X (Online), ISSN 1991-8631 (Print)

International Journal of Biological and Chemical Sciences

Original Paper http://ajol.info/index.php/ijbcs http://indexmedicus.afro.who.int

Cultural practices and use of pesticides on tomato (*Solanum lycopersicum* L.) market gardeners in Loumbila and Ouahigouya (Burkina Faso)

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Received: 18-10-2022 Accepted: 03-02-2023 Published: 28-02-2023

ABSTRACT

The misuse of pesticides and their overdose on vegetables has an impact on people's health. The purpose of this study was to evaluate the cultivation and phytosanitary practices of tomato growers at the Loumbila and Ouahigouya vegetable growing sites. A survey on cultural and phytosanitary practices was carried out among 25 tomato producers at these two market gardening sites. Results show that 16% of producers use dams and 80% traditional wells as a source of water supply. The inputs used are mainly organic (cow's mouth, household waste) and chemical (NPK, urea) fertilizer. The frequency of use of chemical fertilizer is once a week at the Loumbila site and only once a month in the Ouahigouya site. All the producers surveyed used pesticides and 67% do not respect the deadlines for indicated on the packaging labels. A total of 16 pesticides (insecticides, fungicides) are used during tomato production. Cypermethrin and Lambda-cyhalothrin from the pyrethroid family and acetamiprid from the Neonicotinoid family were the most used by producers. Most of these pesticides are not intended for vegetable crops but rather for cotton crops. The pesticides used may remain in the tomato in significant amounts and pose a threat to consumers.

Keywords: Tomato, cultural practices, phytosanitary products, market gardening sites, Burkina Faso.

INTRODUCTION

Urban and peri-urban agriculture has developed in recent years following of the population growth leading to an increase in food needs. Market gardening is an often informal activity that generates income and jobs, practiced by vulnerable groups in urban and peri-urban regions (Thuo, 2010). In Burkina Faso, urban agriculture is essentially market gardening practiced by the most vulnerable segment of the population as a means of subsistence. Market gardening plays an important role in the socio-economic life of the populations of Burkina Faso. They mainly

DOI : https://dx.doi.org/10.4314/ijbcs.v17i2.2

concern tomatoes, onions, okra, amaranth, cabbage, corète, etc. The tomato is one of the most cultivated fruit vegetables in Burkina Faso. It ranks second after the onion bulb in the market gardening sector with an annual production of 167,400 tons in 2018 (DGESS/MAAHA, 2019). The tomato is used in the preparation of many dishes in fresh or processed form. However, despite the use of hybrid varieties, with resistance to nematodes and vascular diseases, the tomato remains subject to attacks by other diseases and pests, sometimes causing very significant damage. To overcome this problem, producers use pesticides. However, these pesticides are often used in excessive or inappropriate quantities and the tomatoes are harvested without respecting the waiting periods. ″Cotton″ pesticides which are prohibited on food and vegetable crops are used (Ahouangninou, Fayomi and Martin, 2011). Obsolete or unregistered pesticides are regularly found in markets or among farmers. Dithiocarbamates and Chloronitrile (18%) are the main fungicide families used while Avermectins and Pyréthrinoids are the main insecticide (Kamsu et al., 2022).

Indeed, many consumers were not satisfied with the quality of the tomatoes. There are also doses of organic and mineral fertilizers which are frequently added to the tomato and household waste is also used with the risk of soil contamination with heavy metals (lead, cadmium, mercury etc.) (Alengebawy et al., 2021). However, the countries member of the Interstate Committee for Drought Control in the Sahel (CILSS) signed common regulations for the registration of pesticides in 1992. The Sahelian Pesticides Committee (CSP), the executive body of CILSS, evaluates each year the registration demands for pesticides submitted by phytopharmaceutical companies and grants sales authorizations for all the Member States. Their existence makes it possible to mitigate their use (CSP, 2019). The use of chemical fertilizers and pesticides during production can have an impact on the sanitary, organoleptic and nutritional quality of the tomato and even on the health of the consumer (Khan et al., 2008). The use of phytosanitary products for the protection of crops or products against parasites, frequent and massive, by spreading or uncontrolled spraying, thus presents significant risks for the health of exposed workers and for the environment (Khan et al., 2008). Direct and/or indirect exposure to pesticides has significant effects on the frequency of certain cancers, neurodegenerative diseases and fetal development (OMS, 2019).

The objective of this study was to evaluate the cultural and phytosanitary practices of tomato in two market gardening location in Burkina Faso in order to sensitize on the harmful effects of pesticides and train them on their appropriate use.

MATERIALS AND METHODS

Cultivation techniques data collection

Cultivation techniques and tomato phytosanitary products use was collected through data collection sheet. The questionnaire was administrated to the producers from the production sites where tomato samples were taken. The questionnaire focused on the socio-demographic data of the producers (age, sex, level of education); the varieties of tomatoes grown; cultural practices (irrigation, use of fertilizers and pesticides, packaging management). The choice of the different localities surveyed was motivated by their significant production at the national level and by documentary research on their market gardening systems. The survey was conducted in June 4 to July 30, 2014 among 25 producers from Loumbila and Ouahigouya who mainly grow tomatoes (Table 1). The main inclusion criteria were to have at least 1/2 ha of tomato fields and to have at least 2 years of experience in this crop. The producers were drawn at random from the two production sites. Figure 1 and Figure 2 present Map of Oubritenga province showing Loumbila commune and Ouahigouya commune respectively.

Statistical analysis

The design of the questionnaire, data entry and data processing were done with the Epi Info software. Descriptive (percentage) and inferential statistics were used for data analysis.

Table 1: Production sites and number of producers surveyed.

Localities	Production sites	Number of samples
Loumbila	Loumbila dam	12
Ouahigouya	Goinre dam Ouattinoma yakin Sector 7 Closed area	13

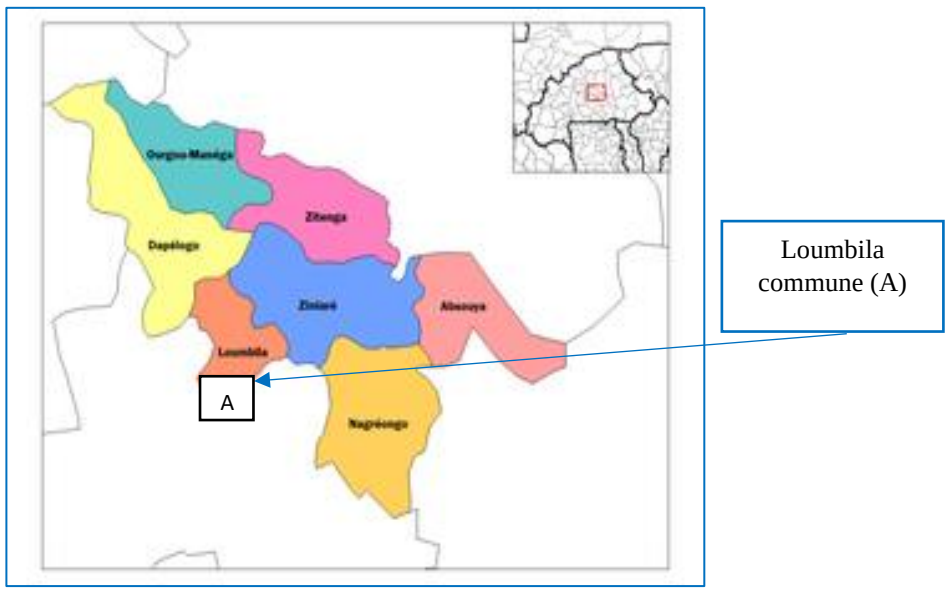

Figure 1: Map of Oubritenga province showing Loumbila commune (A).

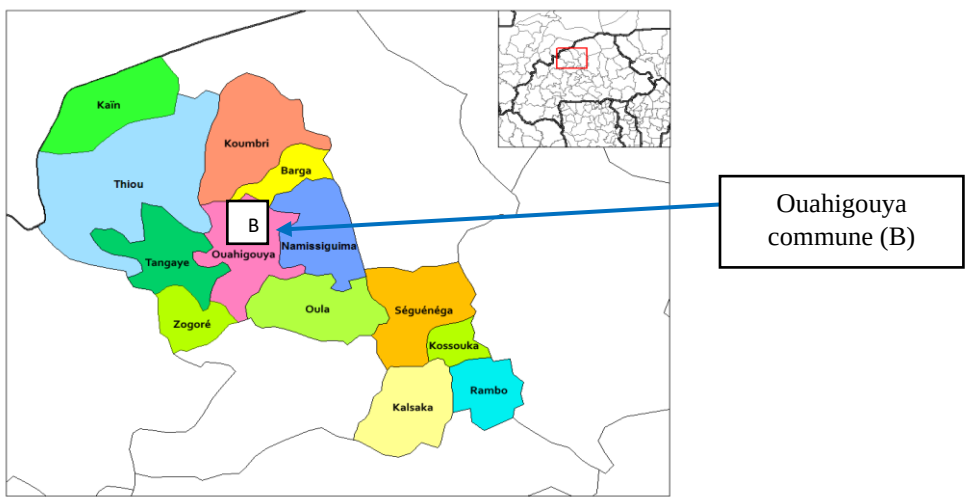

Figure 2: Map of Yatenga province showing the commune of Ouahigouya (B).

RESULTS

Socio-demographic characteristics of the producers

The results of the survey revealed that tomato producers in Loumbila and Ouahigouya were mostly men (96.2%). In both localities, the number of years of experience in tomato production ranged from 04 to 30 years. 28% producers had an experience of less than seven years and 72% had more than 10 years.

Tomato production in Loumbila and Ouahigouya

At the time of the interviews, the Mongal F1 (93%) variety was the most cultivated and available, but other varieties like Roma Vf, Petomech, Roma Vf, Rio Grande, Roma Vf, Tropimech, Cobra 26 F1 were also cultivated at other times. The number of beds occupied by the tomato varied between 12 and 224 beds (one to two feet per bed) per producer.

Cultural practices of tomatoes produced

Water supply

The source of water supply, the equipment used for watering and the frequency of watering are recorded in Table 2. The source of water supply for tomato production in Loumbila is the dam and traditional wells. Indeed, most producers used traditional wells as a source of water but others used either the dam or both. As for Ouahigouya, the dam or traditional wells are used as a water source (Figure 3). The containers and/or materials used to transport the water to the plant were watering cans, buckets (manual drawing) or pipes (motor pump). The tomatoes are watered once a day for the producers of Loumbila against twice a day for the producers of Ouahigouya.

Fertilizers and pesticides used

The results obtained on the tomato cultivation practices in Loumbila and Ouahigouya sites are presented in Table 3. All producers surveyed used organic and chemical fertilizer during production. Cow dung and household waste are the most used organic fertilizers by all producers. This cow dung is mainly used before and at the start of transplanting. As for the frequency of use of organic fertilizer, 32% of producers used once a week or more and 40% less often. The chemical fertilizer used during cultivation was NPK and urea and their frequency of use was once a week and more in most growers. The survey data showed that all producers used pesticides (insecticides and fungicides) to control pests and diseases. 88% of producers used pesticides once a week. The pre-harvest interval (DAAR) of tomatoes linked to pesticides was not respected by 33% of producers. Packaging containing pesticides was abandoned in the fields or in nature after use by 69% of producers; 7% cremated them; 10% burned them and 14% of producers reused them for other purposes. Not all of the producers had knowledge of the chemical composition of pesticides and the waiting period between the application of pesticides and the harvest was not respected by the producers.

Table 4 presents of phytosanitary products used by producers during tomato cultivation in the two localities and Figure 4 presents picture of pesticides used by producers and discarded in fields. The data obtained during the survey revealed the use of 24 pesticides by producers in the market gardening sites surveyed. The pesticides used were mainly insecticides and fungicides and rarely herbicides. Most of these insecticides and fungicides are not intended for vegetable crops but rather for cotton crops and were not approved. The most frequent active molecules in the pesticides used by producers are Cypermethrin, Lambdacyhalothrin. 68% of these active molecules belong to the Pyrethroid family; 24% to the neonicotinoid family and 16% to the organochlorine family (Figure 5). The distribution of the 33 active substances according to the WHO toxicity classes is shown in Figure 6. The majority of active substances listed are part (85%) of class II which is moderately dangerous, 9% belong to class U which is unlikely to present an acute hazard in normal use and 6% Class Ib which is very hazardous.

Table 2: Cultivation practices of tomatoes produced in Burkina Faso by water supply and number of beds at each producer.

Cultural practices		Percentage value (%)
Water supply source	Barrage	16
	Single well	80
	Single well and dam	4
Means used to water the plant	Pipe	12
	Hose, watering can, bucket	8
	Watering can, bucket	80
Watering frequencies outside the rainy season	1 time / day	44
	2 times / day	48
	Less often	8

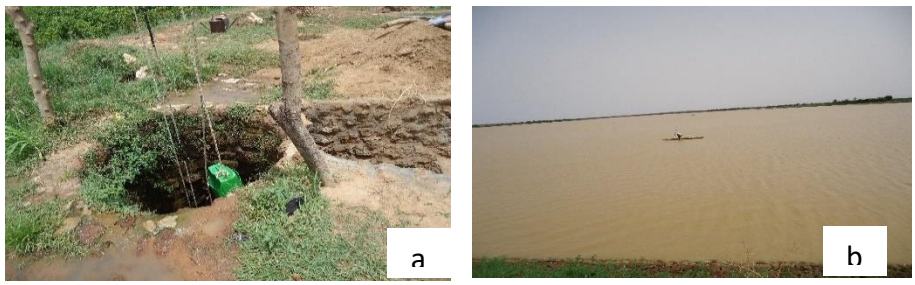

Figure 3: Irrigation water **a**, traditional well used by producers, **b**, barra.

Table 3: Use of inputs in tomato production in Loumbila and Ouahigouya.

	Cultural practices	Percentage value (%)
Organic fertilizers used	Cow dung and household waste	100
Frequency of use of organic fertilizers	1 time/Month	16
	2 times/Month	12
	1 time / week and more	32
	Less often	40
Mineral fertilizers used	NPK	76
	Urea, NPK	16
	NPK, Alwin Eliixer	8
Frequency of use of mineral fertilizers	1 time/Month	28
	2 times/Month	4
	1 time / week and more	68
Pesticides	Insecticide and Fungicides	100
Frequency of pesticide use	1 time / week and more	88
	1 time/Month	12
Pre-harvest interval (PHI) of tomato after pesticide treatment	Compliance with the deadlines indicated on the pesticide labels	67
	Non-compliance with the deadlines indicated on the pesticide labels	33
Method of managing empty pesticide containers	Abandon in the field or in nature	69
	Incinerate	7
	Bury	10
	Reuse	14
Knowledge of the chemical composition of pesticides	Yes	4
	No	96

Table 4: Phytosanitary products used by producers during tomato cultivation in the two localities.

Trade name	Active ingredient (concentration)	Family	WHO toxicity class	Destination / use	Approval
Lambda super 2.5 EC	Lambda-cyhalothrin	Pyrethroid	II	Insecticide for cotton	No
COTALM P318EC	Profenofos (150 g/l) Cypermethrin (36 g/l)	organophosphate Pyrethroid	II	Insecticide for cotton	No
CYMETOX SUPER	Cypermethrin (30 g/l) Dimethoate (250 g/l)	Pyrethroid organophosphate	II	Insecticides	No
Cayman B19	Emamectin Benzoate (19.2 g/l)	Avermectins	II	Insecticide authorized for extended use against caterpillars (Helicoverpa armigera) and the whitefly (Bemisia tabaci) in tomato cultivation	Yes
ATTAKAN C344 SE	Imidacloprid (200 g/l) Cypermethrin (144 g/l)	Neonicotinoid Pyrethroid	II	Insecticide for cotton	Yes
CONQUEST C88 EC	Acetamiprid (16 g/l) Cypermethrin (72 g/l)	Neonicotinoid Pyrethroid	II	Insecticides authorized for the protection of vegetable crops, cotton	Yes
DURSKAN C 188EC	Cypermethrin: (36 g/l) Chlorpyrifos: (150 g/l)	Pyrethroid organophosphate	II	Insecticides for cotton	No
SAVAHALER 1² WP	Methomyl (250 g/l)	Carbamates	lb	Insecticide authorized for the protection of vegetable crops against attacks by leaf moths, chewing insects and sucking insects (eggs and larvae)	Yes
ALMANEB 80WP	Maneb (80 %)	-	U	Fungicides for vegetable and floral crops	No

K-OPTIMAL 35 EC	Acetamiprid (20 g/l) Lambda-Cyhalothrin (15 g/l)	Neonicotinoid Pyrethroid	II	Insecticides for vegetable crops	Yes
CALLIFOL 480 EC	Dicofol (480 g/l)	Organochlorine	II	Insecticides against vegetable mites	No
PASHA 25EC	Acetamiprid (10 g/l) Lambda-cyhalothrin (15 g/l)	Neonicotinoid Pyrethroid	II	Crop insecticide Market gardeners	Yes
IBIS A52 EC	Alpha cypermethrin (36 g/l) Acetamiprid (16 g/l)	Pyrethroid Neonicotinoid	II	Cotton	No
ATTACK	Tefluthrin (200 g/l)	Pyrethroid	lb	Cereal seed	No
AKAPE	Imidacloprid (200 g/l)	Neonicotinoid	II	Vegetable crops	No
DECIS UL 17.5	Deltamethrin (17.5 g/l)	Pyrethroid	II	Insecticides against locusts and grasshoppers	No
CYPERCAL P 230 EC	Cypermethrin (30 g/l) Profenofos (200 g/l)	Pyrethroids organophosphate	II	Cotton insecticide/miticide	Yes
ALLIGATOR	Pendimethalin (400 g/l)	Dinitroaniline	II	Herbicide authorized against weeds in pre-emergence of cotton	Yes
MONCOZEB 80%WP	Mancozeb (750 g/kg)	Carbamate	U	Fungicides for vegetable, fruit and food crops	No
LAMDDA BEST	Lambda-cyhalothrin (25 g/l)	Pyrethroid	II	Maize, rice, cotton	No
BROAD SPECTRUM	Bifenthrin	Pyrethroid	II	Insecticides for vegetable and fruit crops	No
COGA 80WP	Mancozeb (800 g/Kg)	Carbamate	U	Fungicides for vegetable, fruit and food crops	Yes
CYPERCAL 50 EC	Cypermethrin (50 g/l)	Pyrethroid	II	Insecticide authorized against insect pests of tomatoes.	Yes
DELTACAL 12.5 EC	Deltamethrin (12.5 g/l)	Pyrethroid	II	Insecticide Market gardening tomatoes	Yes

Ia = extremely dangerous; Ib = very dangerous; II = moderately hazardous; III = slightly dangerous; U = unlikely to present an acute hazard in normal use; FM = fumigant, unclassified; O = obsolete as a pesticide, not classified. The registered formulations have identified 17 different active substances.

Figure 4: Picture of pesticides used by producers and discarded in fields.

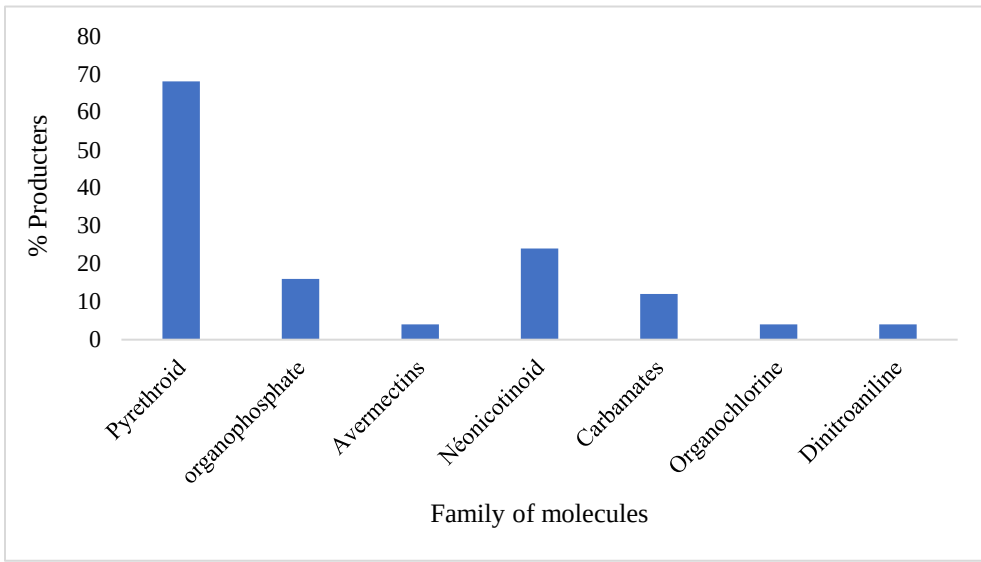

Figure 5: Family of molecules according to producers.

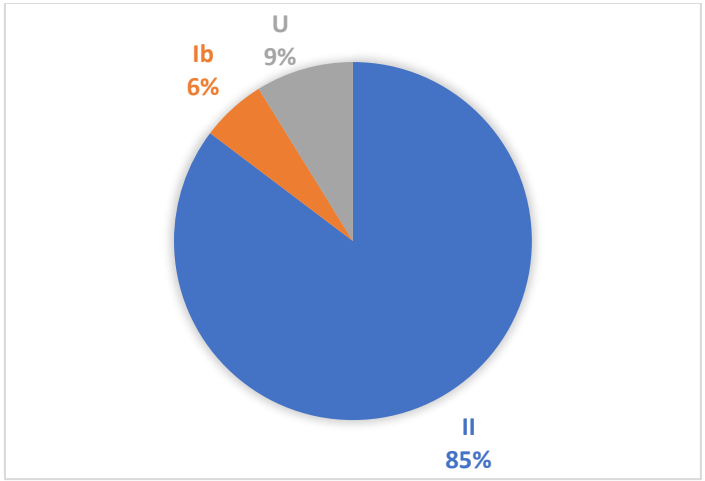

Figure 6: Breakdown of active substances listed in the pesticides used by producers in comparison with those of the WHO toxicity classes.

DISCUSSION

Tomato producers in Loumbila and Ouahigouya were mostly men. According to DGPSA (2007) , the market gardening activity in Burkina Faso include approximately 74.4% of men and 25.6% of women. Son et al. (2017) , during two years of survey showed that tomato producers in seven municipalities were mostly men (92%) aged between 20 and 50 years old. In Cameroon, the survey by Kamsu et al. (2022) in three districts of the western region showed that the tomato is mainly cultivated by 98% of men aged between 30-40 years.

The tomatoes in the market gardening perimeters of Ouahigouya were watered twice against once for those of Loumbila. The frequency of feeding the plant can have an impact on the quality of tomato fruits (caliber, water content). Oboulbiga et al. (2017) had shown that tomatoes watered three times a day had higher weight and contained the highest water contents than those watered twice. In this study, dams and traditional wells were the sources of water supply and whose water were not controlled. The water used may contain trace metal elements that are toxic to humans (Adam et al., 2010; Baby et al., 2011). These heavy metals have been linked to conditions ranging from cardiovascular disease, high blood pressure, insomnia, and others. Exposure to heavy metal pollution has been scientifically proven to be linked to free radical damage resulting in: heart attacks, strokes and cancer (Adam et al., 2010). Market gardening activity, according to the (DGPSA, 2007), is organized around water points, the most important of which are dams (21.6%) and traditional wells (53.3%). It also showed that the main pumping mode used by market gardeners was manual drawing (75.4%) and motor pump (17.1%). The chemical fertilizer used as fertilizer during the cultivation was more NPK and urea. According to the (DGPSA, 2007), fertilizer for market gardeners consists of 65% NPK; 30.2% urea and 4.8% Burkina phosphate. The use of fertilizers can have an impact on the nutritional quality of tomatoes. Colombani et al. (2001) showed that plant feeding conditions, particularly the electroconductivity of nutrient solutions, influence the sugar content in fruits. Ahishakiye and Ait (2010) also showed that the variability of the ash content can be influenced by cultivation methods such as the contribution of organic and mineral fertilizers during production and the nature of the soil such as the composition in organic and mineral elements of the soil. Organic fertilizer was less used by

producers in Ouahigouya and this is due to the fact that potatoes are grown on the same land as tomatoes. In this study, 24 types of pesticides were used by the producers of the Loumbila and Ouahigouya market gardening sites. Most of these insecticides and pesticides were not registered. Kolia (2015) had identified 19 pesticides used for the treatment of vegetables in the Loumbila market gardening site. They have also reported that 73.68% of producers used pesticides that were not approved. According to Brahima et al. (2003), the access to pesticides, sometimes even to prohibited pesticides, is due not only to the multiplicity of points of sale of phytosanitary products, but also and above all to the lack of control over the use and marketing of these substances .The survey showed that all the producers used the pesticides. According to Muliele et al. (2017), producers justify the use of pesticides by mentioning, among other things, "the cultivation of temperate vegetables (for example tomatoes, peppers) cannot succeed without the use of pesticides". Pesticides are essential to obtain healthy plants, nice fruits and good yields. The pre-harvest interval (DAAR) of tomatoes linked to pesticides was not respected by some producers. The PHI is the basic interval between the last pesticide application and the time of harvest. It is essential to obtain a healthy harvest that will contain pesticide residues that are not harmful to the health of consumers (FAO, 2012). The presence in tomatoes of concentrations of pesticide residues could pose a health risk to consumers. It is therefore important to respect the DAAR so as not to exceed the MRL set for tomatoes. The most common active ingredients in the pesticides used by producers are Cypermethrin, lambdacyhalothrin. Son et al. (2017) showed that the active substances most used during the two surveys they carried out were lambda cyhalothrin (67%), acetamiprid (50%) and cypermethrin (37%). Also, pyrethroids were the most used by producers in the study by Ahouangninou et al. (2011). Pesticides used by producers can be sources of pesticide residue contamination in vegetables (Gueye et al., 2020). The reason for the growing trend in the use of pesticides, monitoring continues. The reason for the increasing trend in the use of pesticides, the continuous monitoring of pesticide residues in vegetables is recommended in order to develop the line database on which future strategy could be set up for the protection of consumers and the environment (Ahoudi et al., 2019).

Conclusion

This study made it possible to evaluate the cultural and phytosanitary practices of tomato in the market gardening sites of Loumbila and Ouahigouya. It showed that dams and traditional wells were used as a source of water supply for tomato production. It emerges from the study that the producers surveyed all used pesticides for the protection of tomato plants. Organic fertilizer was used at the beginning and chemical fertilizer during production. The pesticides used were not all intended for market gardening but for cotton growing. The active molecules of the pesticides used by the producers are Cypermethrin, lambdacyhalothrin. Reinforcement of the control of pesticides distributed and sold in these two production sites in particular and throughout the territory of Burkina Faso will be necessary, because several non-registered pesticides are found on the market. It will also be necessary to encourage market gardeners to obtain supplies from approved retailers and approved products.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

The contributions of the authors to the realization of the data collections, to the writing and to the various corrections was established as follows: EBO was the instigator and the principal editor of this article and carried out the work of data collection on the ground; ZS, HKT, JNS, SCWT contributed to manuscript writing and data analysis; KT and ST helped with data processing; HSL, MHD, CP designed, supervised the work and provided insightful criticism and advice.

ACKNOWLEDGMENTS

The authors express their gratitude to the West Africa Agricultural Productivity Program (WAAPP) for its financial support.

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