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Phytosanitary practices of tomato producers in the western region of Cameroon

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ABSTRACT

To assess the phytosanitary practices of tomato producers in the West Region of Cameroon, a survey was carried out with 90 producers from 3 sub-divisions, Nde, Noun and Menoua. The survey aimed to evaluate the impacts of education level, phytosanitary practices, the chemicals used and their management on tomato yield and on the environment. The results showed that 98% of tomato growers are male, aged 30-40 years old. More than 50% producers reached the high school and 71% did not receive any training in pesticides use and handling. F1 hybrids (63%) are the main varieties cultivated. The main tomato diseases recorded were caused by fungi (42%), insects (39%) and nematodes (13%). Plants are destroyed by these agents at different growth stages: leaves (35%), fruits (29%) and stems (26%) are the most affected. The producers commonly use chemical pesticides, to control pest and diseases. Dithiocarbamates (47%) and Chloronitrile (18%) are the main fungicide families used while Avermectins (45%) and Pyréthrinoids (32%) are the main insecticide. The producers estimated that the protective effectiveness range from 25 to 100%. To optimize the effectiveness of the pesticides, they are applied several times, alternated and mixed with different active ingredients. The majority of these producers (95%) does not use the recommended personal protective equipment (PPE) and throw the packaging wastes at the treatment sites thereby causing environmental hazards. Based on our findings, the phytosanitary practices of tomato producers in the West region of Cameroon are worrying and potentially harmful for both human health and the environment. Urgent measures need to be taken to raise awareness on pesticides use and handling to tomato producers, not only to reduce their incidence on the environment and soil ecosystem, but also to increase tomato yield.

INTRODUCTION

The fruit and vegetable sector contributes to increase biodiversity, create a sustainable environment and improve the livelihoods of farmers and people employed in the sectors concerned (FAO, 2021). Tomato (*Solanum lycopersicon* Mill) due to its high nutritional and marketing value has become a one of the major and important horticulture crop worldwide and in sub-tropical regions including Cameroon. According to FAO (2020), world tomato production is estimated at around 180 million tons. In Cameroon, this production is estimated at 1,182,114 tons with a yield around 12,776 t/ha. This yield is lower than that of Egypt (39 t/ha), the leading tomato producing country in Africa.

To be marketable, tomato must be healthy and impeccable. However it production in subtropical region is hampered due to pests and diseases. Among them, *Aspergillus niger, Botrytis cinerea, Alternaria alternata, Fusarium oxysporum, Phytophtora infestans, Tuta*

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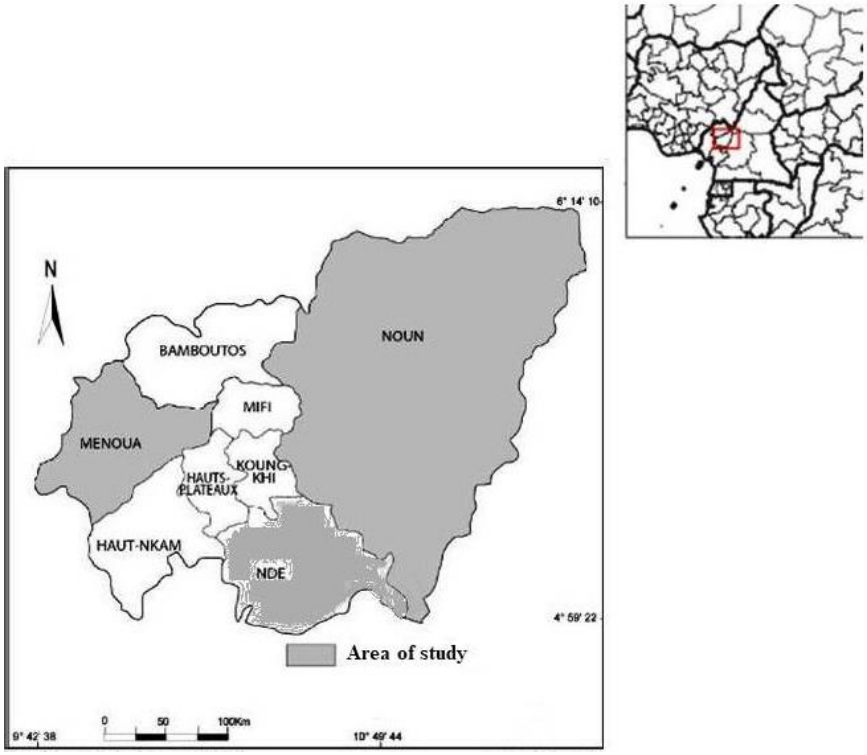

Figure 1. Geographical location of the areas surveyed.

absoluta and Bemisia tabaci are the most devastating agents (Fontem, 1993; Soylu et al., 2010; Gomez-Ramırez et al., 2013; Castellanos et al., 2020; Perveen and Bokahri, 2020).

In the absence of any control methods, yield loss could reach 80-100% (Fontem, 2003). To reduce the effects of pests and diseases, farmers used chemicals. However, some studies demonstrated the existence of non-regulatory phytosanitary practices such as non-compliance with hygiene rules, poor waste treatment, use of non-recommended doses of pesticides and others impacts, resulting in water pollution, and presence of residues in tomato fruits (Moges and Bhat, 2020; Sopkoutie et al., 2021). This can cause certain forms of cancer, congenital malformations and genetic transformations as consequence on human and the development of resistance in pathogens populations (Manfo et al., 2012; Tarla et al., 2015; Medardo et al., 2017).

However, for the best of our knowledge, very few studies have focused on phytosanitary practices in the western region of Cameroon, the main tomato production area (62%) (Abang et al., 2013; FAO, 2018). The present study aims to identify the main difficulties encountered by tomato growers in the sub-divisions of Nde, Noun and Menoua, and to assess the phytosanitary practices and their potential impact on health and the environment.

METHODOLOGY

The survey was carried out in the agro-ecological zone of the high plateaus precisely in the Western region of Cameroon in the sub-divisions of Menoua, Nde and Noun (Figure 1). The choice of the different locations was motivated by their large production at the national level and by a pre-survey carried out at the level of some markets in the city of Douala with tomato traders (Mabhou, 2011; FAO, 2018). The study was conducted from July to November 2019 during the rainy season. The study population consisted of tomato growers from the 3 sub-divisions above mentioned. The main inclusion criteria were to have at least 1 ha of tomato fields and having at least 3 years' experience in this crop. The main no inclusion criteria were the refusal to participate in the study.

The sampling was carried out randomly so as to cover the study area. It was made up of 30 producers per sub-division, for a total of 90 producers. Data collection was carried out through a questionnaire. The questionnaire was established with reference to that described by Muliele et al. (2017), followed by some additions from the

Table 1. Sociodemographic characteristics of tomato producers from Western region of Cameroon.

	Category	Percentage (%)
Gender	Male	98
	Female	2
Age (years)	20-30	20
	30-40	44
	40-50	29
	50-60	6
	≥60	1
Educational level	Nursery	1
	Primary	29
	Secondary	57
	Higher level	13
Training on pesticides use	Yes	27
	No	73

data of pre-survey and information needed to continue this study. It focused on:

-Socio-demographic data of producers (age, sex, their level of education);
-Training on pesticides use;
-Varieties of tomato grown;
-Phytosanitary problems: Diseases, pests, control methods, etc.

The data collected was recorded in Microsoft Excel 2010. Descriptive (percentage) and inferential statistics were used for data analysis.

RESULTS

Socio-demographic and training on pesticides use data

In the 3 sub-divisions of western region of Cameroon studied, tomato is mainly cultivated by 98% of men aged between 30-40 years old. From those, 57% reached the high school and 71% did not receive any training related with the use of pesticides (Table 1). The farmers declare to have learnt by experience and through the advice of the most experienced elders.

Tomato varieties used

The results show that several varieties of tomato are cultivated among which the accounted for 63% are hybrid varieties. The fixed variety Rio Grande (from several breeders) (37%) and the hybrid varieties Kero (16%), Emerald (15%), Nadira (10%) and Zamzam (7%) are the most cultivated (Table 2).

Impact of biotic constraints

All the producers surveyed cultivate tomatoes in the open field and the crops are affected by pests and diseases. Based on information collected from farmers, pests and diseases are due to fungi (42%), insects (39%) and nematodes (13%) (Figure 2). The main diseases reported by these producers are mildew (77%) caused by *Phytophtora* sp. commonly called “direct attack” and rust (19%). These diseases have been reported throughout the year with predominance in the rainy season (59%). The most frequent insects are the Tuta (*T. absoluta*) (62%) commonly called "Boko Haram, Writer or Caterpillar" in this localities, following by the stinging-sucker wasp (*Helicoverpa armigera*) (22%) and the white fly (*B. tabaci*) (16%).These insects are most found in the dry season while nematodes appear on both, dry and rainy seasons. Others biotic constraints (6%) are reported to be bacterial flare, mites and viral diseases. Moreover, the resurgence of pests and diseases in the rainy season encourages producers to abandon the tomato cultivation. All the organs of tomato plants are destroyed by pests and pathogens at different growth stages of plant: during the production of young seedlings in the hotbeds or the nurseries (26%), during flowering (41%) and during fruiting and ripening stage (57%) (Figure 3). However, the aerial part of plant notably leaves (35%), fruits (29%) and stems (26%) are the most affected. Roots Represent 10%. The main symptoms are the presence of black and brown spots

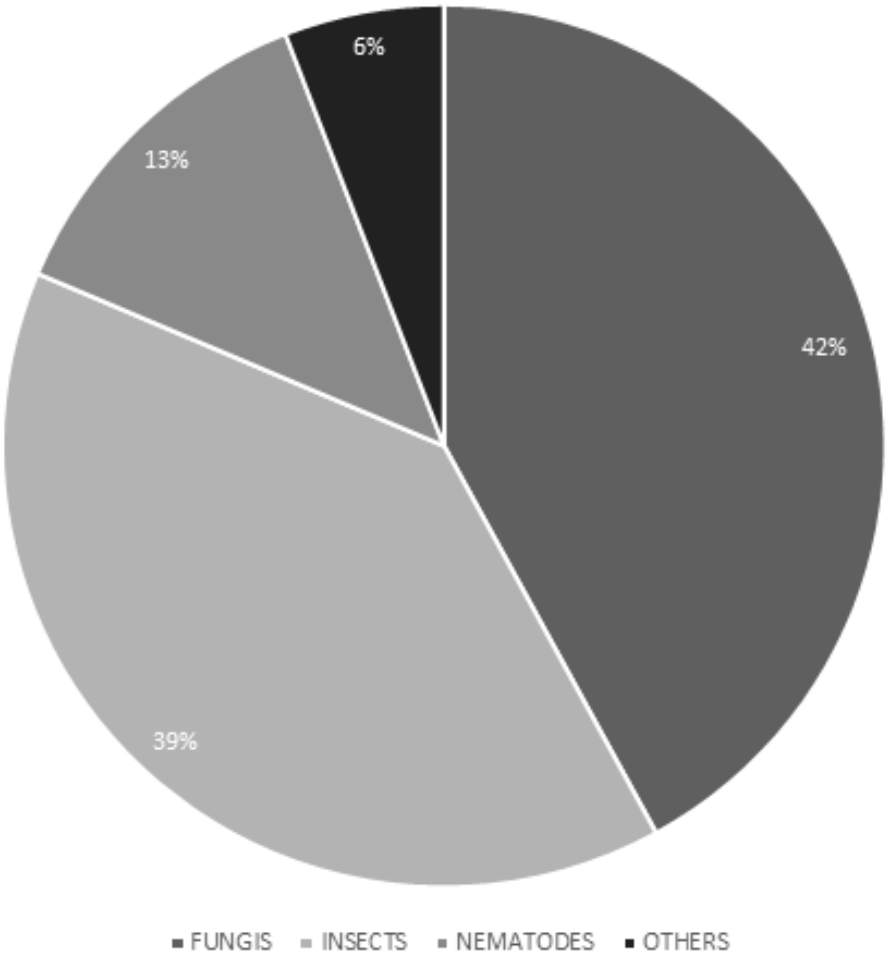

Figure 2. Percentage of diseases and pests reported by tomato producers in the Western region of Cameroun.

Table 2. Name, origin and type of varieties of tomato (*Lycopersicum esculentum*) used by tomato producers from the Werstern region of Cameroon.

Variety	Origin	Percentage (%)	Hybrid or fixed
Kero	Esasem spa	16%	Hybrid
Emerald	Sakata	15%	Hybrid
Rio Grande	Griffaton	14%	Fixed
Nadira	Tehnisem	10%	Hybrid
Rio grande	Others breeders	9%	Fixed
Rio grande	GSN	9%	Fixed
Zamzam	Service plus	7%	Hybrid
Rio Grande	Grenier	5%	Fixed
Rio tinto	Griffaton	4%	Hybrid
Rio power	Grenier	3%	Hybrid
Cobra	Technisem	2%	Hybrid
Padma	East-West seed	2%	Hybrid
Kiara	Techisem	2%	Hybrid
Barnum	Bakker brother	2%	Hybrid

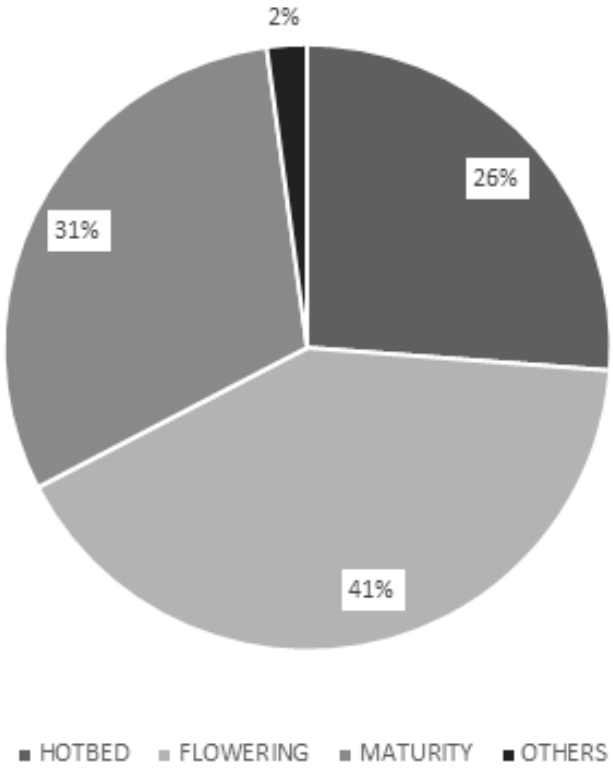

Figure 3. Figure 3 Period of growth in percentage where there is a recurrence of diseases and pests.

(34%), burns (30%), rots (30%) and scabies (3%) (Figure 4).

Management of chemical pesticides and wastes

When no control measures have been applied, losses due to pests and diseases have been estimated around 85% by surveyed tomato producers. To solve the problem, all the producers use agricultural pesticides which are available and obtain in local markets. The most agricultural pesticides used are fungicides (56%), insecticides (40%) and nematicides (4%). The characteristics of main pesticides used are reported in Table 3. Chemicals families and actives molecules discovered are dithiocarbamates (47%) (mancozeb, manebe), Chloronitrile (18%) (chlorothalonil), copper compounds (14%) (copper oxide), acetamid (11%) (cymoxanil), phenylamids (10%) (methalaxyl) as fungicide and avermectins (45%) (emamectin benzoate), pyréthrinoids (32%) (cypermethrin, alphamethrin, lamba-cyhalothrin), neonicotinoids (19%) (acetamiprid), and organophosphorus (4%) (O-ethyl S, S-dipropyl phosphorodithioate) as insecticide and nematicide. Some producers (10%) asserted to know plant pesticide but not use them.

The surveys showed that, tomatoes are mainly cultivated in swampy areas or near rivers and the producers use these polluted waters for watering and pesticide preparation (Figure 5b). Moreover producer's surveyed use liquid pesticides usually with measures provided by the manufacturer while powdered pesticides are randomly used. The frequency of field applications of agricultural pesticides varies with the grower and throughout the seasons. Regardless of the harvest period, agricultural pesticides are applied once a week during the dry season while, it is applied 3 times during the rainy season.

According to the results obtained, the efficacy of agricultural pesticides used is variable. The farmers contacted in this work confirmed about the variability of pesticides efficiencies on protective tomatoes: (54%) of them confirmed that the pesticides used could protect tomatoes from pests and diseases to nearly 100%, while 37 and 9% of them reported an average of protection of 65 and 45% respectively.

To improve the efficacy of these agricultural pesticides, tomato producers of western region of Cameroon adopted prevention strategy by treating tomatoes before the appearance of any symptoms, applied the pesticides many

Figure 4. Symptoms of some tomato diseases and pests observed in tomato plants from the Western region of Cameroun surveyed. **a,** Burns; **b,** leaf caterpillar's; **c,** black spot on fruit; **d,** brown spot on leaf; **e,** brown spot on stem; **f,** scab on immature fruit; **g,** black spots on leaf; **h,** light spots; **I,** fruits rots.

Table 3. Main chemical pesticides used by tomato producers in Western region of Cameroon.

Common name	Type of pesticide	Active molecule	Homologated (Yes or No)	Proportion (%)
Caiman B	Systemic insecticide	Emamectin benzoate	Yes	14
Plantineb	Contact fungicide	Manebe	Yes	14
Mancostar	Contact fungicide	Mancozeb	Yes	11
Balear	Contact fungicide	Chlorothalonil	Yes	10
Penncozeb	Contact fungicide	Mancozeb	Yes	8
Kalao	Contact fungicide	Hydroxyde de cuivre	Yes	7
Emacot	Systemic Insecticide	Emamectin benzoate	Yes	7
K-optimal	Systemic insecticide	Lambda-cyhalothrine + Acetamiprid	Yes	6
Bonsoin	Systemic and contact fungicide	Chlorothalonil + Cymoxanil	Yes	4
Fongiforce	Systemic and contact fungicide	Oxyde de cuivre + Metalaxyl	Yes	4
Lynx	Systemic insecticide	Lambda-cyhalothrine + Acetamiprid	Yes	4
Alphacyga	Contact insecticide	Alphamethrin	Yes	4
Cypercot	Contact insecticide	Cypermethrin	Yes	3
Plantizeb	Contact fungicide	Mancozeb	Yes	2
Mocap	Nematicide / Insecticide	O-Ethyl S, S-Dipropyl Phosphorodithioate	Yes	2

Figure 5. Some aspects of the poor management of the phytosanitary practices of tomato production in the Western region of Cameroon. **a,** Pulverization of pesticides without conventional personal proctective equipment; **b,** Irrigation water; **c,** packages of pesticides abandoned after being used.

times when the symptoms appear, alternate the pesticides, increase the dose and mixed the pesticides which have different active molecules.

Phytosanitary practices

During the use of these pesticides, 88% of the producers wear an outfit consisting of regular pants, shirt and boots, 7% wear a classic bootless outfit and 5% respect the wearing of personal protective equipment (PPE) (Figure 5a).

Managing the packaging of agricultural pesticides used by tomato growers does not appear to be a priority for them. In fact, 67 and 13% of the producers abandon them on the field and the rivers, respectively, while 20% burn the packages (Figure 5b and c).

DISCUSSION

The results of the present study show that, the tomato producers in west region of Cameroon have middle level of education and low level of technical training. Similar observations were obtained by several authors in Benin, Burkina Faso and Nepal on market garden plants including tomato (Ahouangninou et al., 2011; Son et al., 2017; Jhalendra et al., 2018). According to these authors, the low level of technical training favors the misuse of phytosanitary products against pests.

Hybrid varieties were most cultivated. Many studies outlined constraints and tomato improvement programmes which mainly focused on germplasm collection, morphological and agronomic characterization, molecular evaluation, diversity study, as well as screening germplasm against biotic and abiotic stresses (Melomey et al., 2019). F1 hybrid seed production allowed the exploitation of heterosis and facilitated the combination of resistance and other useful genes in a uniform outperforming variety (Natalini et al., 2021). These varieties would respond of growers and consumers requirements.

In this study, late blight was the main fungal disease and Tuta (*T. absoluta*) as the main pest of tomato. Late blight was reported than one of the most important disease of Potato in the Republic of Georgia by Onofre et al. (2021). This disease could be a common to *Solanaceae* plants family. In addition, the development of insecticide resistance is relatively fast in *T. absoluta* species, and the main mechanisms involved are altered target-site sensitivity and/or enhanced detoxifcation, depending on the chemical class (Guedes et al., 2019). This could explain it most frequency in the field.

To control these pests and diseases, the producers surveyed used chemical pesticides which dithiocarbamates, chloronitrile, acetamid, avermectins, pyréthrinoid, neonicotinoids, are the mainly families. On the other hand, the work done by Houndété et al. (2010),

Gnankiné et al. (2013), Fan et al. (2016) and Guedes et al. (2019) showed the pesticides resistance in populations of *B. tabaci*, *B. cinerea* and *T. absoluta* respectively. This situation could lead the producers to increase the doses of pesticides and to intensify the treatments (Sopkoutie et al., 2021). These observations were obtained during our study where the majority of tomato producers did not respect the dose or the application frequency of pesticides used.

During our research, tomato producers did not respect the wearing of PPE. According to Jhalendra et al. (2018), this failure could be explained by the very high cost of PPE which consisting of wearing eyes protective goggles, waterproof protective clothing, waterproof gloves, rubber and nitrile boots. However, the results of Assokeng et al. (2017) and Sonchieu et al. (2019) respectively in Ngaoundere (North Cameroun) and Foumbot (West Cameroun) showed that the wearing of inadequate protective equipment and the consumption of surrounding water represented a danger to the health of market gardeners. Thus, signs and symptoms related to pesticides such as headache, stomach ache, dizziness, skin irritation and breathing difficulties were recorded.

Our study shows that, the percentage of training of the producers on the use of chemical pesticides is quite low. This ignorance is proportional to the illegal and abusive use of pesticides. In addition to the non-compliance with the doses of pesticides, the frequency of application and the management of packaging are factors at the origin of the risks of human intoxication and environmental pollution. These practices were at the origin of pesticides residues found in cultivated food, soil and neighboring waterways as reported by several authors. Analysis of residues by liquid chromatography by tandem mass spectrometry (LC-MS/MS) and gas chromatography with electron capture detection (GC-ECD) in several foodstuffs showed that samples with residues above their MRLs represented 38% of all the positive analyzes; then chilli pepper (6.4%) and kidney beans (5.5%) were found to have the most residues above their MRLs (Galani et al., 2018). Moreover, Sopkoutie et al. (2021) shown that residue concentrations above the maximum residue limit (MRL) were found in all the tomatoes positive samples of lambda-cyhalothrin, and in 92.30% of cypermethrin positive samples. About soil, Silva et al. (2019) reported that 58% of soil samples collected across the EU had mixture of two or more residues and these compounds occasionally exceeded their predicted environmental concentrations in the soil. Likewise, pesticide packaging's abandoned in fields or near rivers was previously shown to cause variations in the physicochemical parameters of the water (Pouokam et al., 2017; Moges and Bhat, 2020).

Conclusion

This study shows that the tomato producers of the 3 sub-divisions of western region of Cameroon cultivate mainly hybrid varieties in particular for their resistance and earliness. Despite this, diseases and pests were encountered. The most important of which are mildew and Tuta which attack the plant in all stages of its growth and mainly the leaves and fruits. To solve the problem, all the producers use chemical control because only 10% confirmed to know plant pesticide but not use them. Some producers (91%) estimate that these pesticides are over 65% effective when they apply their strategy. The low level of technical training observed in this study and their using pesticides strategy deemed dangerous contribute the poor application and inappropriate management of pesticides. These practices expose farmers and consumers to health risks, increasing the environmental pollution and the risk of the emergence of resistance by pathogenic organisms. We recommended to growers and government:

- To use chemical pesticides in accordance with the manufacturer's recommendations and apply those after symptoms appear. To respect the "time before harvest" to avoid persistence of residues in tomatoes. To wear PPE during using of chemical pesticides and wash with plenty of clean water any parts of the body that may have been exposed to pesticides in order to avoid any contamination. Finally, producers should practice crop rotation which helps to maintain soil fertility and to fight against pests and diseases.
- To organize training sessions for producers on the use and management of pesticides. Then, to set up a structure for recycling packages of pesticides in order to limit environmental pollution. Finally, to supply growers with water through the creation of boreholes in order to avoid the use of wastewater this is probably a source of crop contamination.

Conflicts of interest/competing interests: This study is the property of all the above-mentioned authors and is not subject to any conflict of interest.

REFERENCES

Abang A. F., Kouame C. M., Abang M., Hannah R. & Fotso A. K. (2013). Vegetable growers perception of pesticide use practices, cost and health effects in tropical region of Cameroon. Int. J. Agric. Plant Product. 45(5):873-883.

Ahouangninou C., Fayomi B. E. & Martin T. (2011). Evaluation des risques sanitaires et environnementaux des pratiques phytosanitaires des producteurs maraichers dans la commune rurale de Tori-Bossito (Sud-Bénin). Cahiers d'Agriculture. 20(3):216-222.

Assokeng T., Siéliéchi J. M. & Noumi G. B. (2017). Evaluation of health and environmental risks of pesticide products used in market-gardening in the City of Ngaoundere (Cameroon). J. Agric. Chem. Environ. 186-198. https://doi.org/10.4236/jacen.2017.64013.

Castellanos L. M., Olivas N. A., Ayala-Soto J., De La O Contreras C. M., Ortega M. Z., Salas F. S. & Hernandez-Ochoa L. (2020). *In vitro* and *in vivo* antifungal activity of clove (*Eugenia caryophyllata*) and pepper (*Piper nigrum* L.) essential oils and functional extracts against

Fusarium oxysporum and *Aspergillus niger* in tomato (*Solanum lycopersicum* L.). Int. J. Food Microbiol. https://doi.org/10.1155/2020/1702037.
Fan F., Li N., Li G. Q. & Luo C. X. (2016). Occurrence of fungicide resistance in *Botrytis cinerea* from greenhouse tomato in Hubei Province, China. Plant Dis. 100:2414-2421.
FAO (2018). Food and Agriculture Organization of the Union. https://www.fao.org/3/I8571FR/i8571fr.pdf (Consulted on 10/12/2021).
FAO (2020). Food and Agriculture Organization of the Union. Food and Agriculture Data. http://www.fao.org/faostat/en/#data/QC (consulted on 10/25/2020).
FAO (2021). Food and Agriculture Organization of the Union. https://doi.org/10.4060/cb2395fr (Consulted on 10/12/2021).
Fontem D. A. (1993). Survey of tomato diseases of Cameroon. Tropicultura. 11(3): 87-90.
Galani J. H. Y., Houbraken M., Wumbei A., Djeugap J. F., Fotio D. & Spanoghe P. (2018). Evaluation of 99 pesticide residues in major agricultural products from the western highlands zone of Cameroon using QuEChERS method extraction and LC-MS/MS and GC-ECD analyses. Foods. doi:10.3390/foods7110184.
Gnankiné O., Mouton L., Savadogo A., Martin T., Sanon A., Dabire R. K., Vavre F. & Fleury F. (2013). Biotype status and resistance to neonicotinoids and carbosulfan in *Bemisia tabaci* (Hemiptera : Aleyrodidae) in Burkina Faso, West Afr. Int. J. Pest Manage. 59(2):95-102.
Gomez-Ramırez C., Sosa-Morales E. M., Palou E. & Lopez-Malo A. (2013). *Aspergillus niger* time to growth in dried tomatoes. Int. J. Food Microbiol. 164(1):23-25.
Guedes R. N. C., Roditakis E., Campos M. R., Haddi K., Bielza P., Siqueira H. A. A., Tsagkarakou A., Vontas J. & Nauen R. (2019). Insecticide resistance in the tomato pinworm *Tuta absoluta*: patterns, spread, mechanisms, management and outlook. J. Pest Sci. https://doi.org/10.1007/s10340-019-01086-9.
Houndété T. A., Kétoh, G. K., Hema O. S. A., Brévault T., Glitho I. A. & Martin T. (2010). Insecticide resistance in field populations of *Bemisia tabaci* (Hemiptera: Aleyrodidae) in West Africa. Pest Manage. Sci. 6:1181 -1185.
Jhalendra P., Rijal R. R., Rajan G., Krishna D. P., Sudan G. & Sujata P. (2018). Farmers' knowledge on pesticide safety and pest management practices: A case study of vegetable growers in Chitwan, Nepal. Agriculture. 8:16. https://doi.org/10.3390/agriculture8010016.
Mabhou G. S. T. (2011). Diversité de *Ralstonia solanacearum* au Cameroun et bases génétiques de la résistance chez le piment (*Capsicum annuum*) et les solanacées. Thèse de Doctorat. Agro Paris Tech. 191p.
Manfo F. P. T., Moundipa P. F., Déchaud H., Tchana A. N., Nantia E. A., Zabot M. T. & Pugeat M. (2012). Effect of agropesticides use on male reproductive function: A study on farmers in Djutitsa (Cameroon). Environ. Toxicol. 27:423–432.
Medardo A. V., Eduardo M., Agustina E., Flavia S. D. & Bryan M. (2017). Association between cancer and environmental exposure to glyphosate. Int. J. Clin. Med. 8:73-85.
Melomey L. D., Danquah A., Offei S. K., Ofori K., Danquah E. & Osei M. (2019). Review on Tomato (*Solanum lycopersicum*, L.) Improvement programmes in Ghana. Chapter. DOI: 10.5772/intechopen.75843.
Moges D. M. & Bhat H. G. (2020). Watershed degradation and management practices in north-western highland Ethiopia. Environ. Monit. Assess. 192(10):664. doi: 10.1007/s10661-020-08628-0. PMID: 32995923.
Muliele T. M., Manzenza C. M., Ekuke L. W., Diaka C. P., Ndikubwayo D. M., Kapalay O. M. & Mundele A. N. (2017). Utilisation et gestion des pesticides en cultures maraîchères : cas de la zone de Nkolo dans la province du Kongo Central, République Démocratique du Congo. J. Appl. Biosci. 119:11954-11972.
Natalini A., Acciarri N. & Cardi T. (2021). Breeding for nutritional and organoleptic quality in vegetable crops: The case of tomato and cauliflower. Agriculture. 11(7):606. https://doi.org/10.3390/agriculture11070606.
Onofre K. F. A., Forbe G. A., Andrade-Piedra J. L., Buddenhagen C. E., Fulton J. C., Gatto M., Khidesheli Z., Mdivani R., Xing Y. & Garrett K. A. (2021). An integrated seed health strategy and phytosanitary risk assessment: Potato in the Republic of Georgia. Agric. Syst. https://doi.org/10.1016/j.agsy.2021.103144.
Perveen K. & Bokahri N. A. (2020). Management of *Alternaria* leaf blight in tomato plants by mentha essential oil. Plant Protect. Sci. 56(3):191-196.
Pouokam G. B., William L. A., Alice S. N. & Mohamed E. S. (2017). A pilot study in Cameroon to understand safe uses of pesticides in agriculture, risk factors for farmers' exposure and management of accidental cases. Toxics. 5: 30. https://doi.org/10.3390/toxics5040030.
Silva V., Mol H. G. J., Zomer P., Tienstra M., Ritsema J. C. & Geissen V. (2019). Pesticide residues in European agricultural soils – A hidden reality unfolded. Sci. Total Environ. 653:1532-1545.
Son D., Somda I., Legreve A. & Schiffers B. (2017). Pratiques phytosanitaires des producteurs de tomates du Burkina Faso et risques pour la santé et l'environnement. Cahiers d'Agriculture. 26. doi :10.1051/CAGRI/2017010.
Sonchieu J., Bitsoga M. G. & Ngassoum M. B. (2019). Characterization of personal clothing worn by pesticide sprayers in foumbot agricultural area (Cameroon). Agric. Sci. 10(8):1056-1072. https://doi.org/10.4236/as.2019.108080.
Sopkoutie N. G. K., Abdulai A. N., Tarla D. N. & Djeugap F. J. (2021). Phytosanitary practices and evaluation of 17 pesticides residues in tomatoes fruits produced in Foumbot District Western Highland-Cameroon. Eur. Sci. J. ESJ. 17(3):30. https://doi.org/10.19044/esj.2021.v17n3p30.
Soylu E. M., Kurt Ş. & Soylu S. (2010). *In vitro* and *in vivo* antifungal activities of the essential oils of various plants against tomato grey mold disease agent *Botrytis cinerea*. Int. J. Food Microbiol. 143:183-189.
Tarla D. N., Manu I. N., Tamedjouong Z. T., Kamga A. & Fontem D. A. (2015). Plight of pesticide applicators in Cameroon: case of tomato (*Lycopersicum esculentum* Mill.) farmers in Foumbot. J. Agric. Environ. Sci. 4(2):87-98.