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Original Article

Diversity and Management of Use of Phytochemicals in Market Gardening in the Mayo-Danay Division (Far North Region of Cameroon)

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Abstract *- The objective of this study was to evaluate the diversity and the management of the use of phytosanitary products in the Mayo-Danay Division. A survey of 120 market gardeners in two Subdivisions (Yagoua and Vele) was carried out to assess the diversity and compliance with good practices in using phytosanitary products, as well as the risks associated with their use. It appears from the investigations that the most used phytochemicals or phytosanitary products in the Mayo-Danay Division are herbicides (55%), insecticides (10%), fungicides (5%) and NPK fertilizers (30%). A major proportion of insecticides was sold through the informal circuit (20%); unlike herbicides, the majority (60%) comes from this circuit and fungicides with 20%. According to their structure, the pesticides currently used in Mayo-Danay belong to 4 main families: organochlorine compounds (56%), followed by pyrethroids (21%), organophosphorus compounds (17%) and carbamates (6%). This work also showed that 75% of farmers performed the phytochemical treatment without recommended personal protective equipment. 95% of the producers questioned did not complain about the safety measures provided by the regulations to deal with pesticide poisoning, while 5% of the respondents complained about the safety measures. 86% of farmers surveyed did not wear personal protective equipment when preparing and applying pesticides. Most of the farmers surveyed (89%) kept their pesticides in the household, while others kept them in the field (11%). Overall, the results show that farmers in the locality choose pesticides without having an idea about their danger.*

Keywords *- Phytochemicals, Vegetable crops, Practices, Risks, Mayo-Danay division.*

1. Introduction

As the world population increases, the proportion of arable land decreases and the use of chemical pesticides increases [1]. To increase vegetable production and satisfy the food needs of the growing population, farmers use many agricultural inputs that are not without risk to the environment and the consumers [2]. To respond to the demands of the consumer market, farmers must intensify the production of vegetables and fruits of very high quality and quantity to reach the standards required for economically viable production levels [1]. These agricultural inputs are mostly mineral and organic fertilizers and phytosanitary products widely used to fight against pathogens present in crops [3]. The use of these pesticides has experienced a very strong development over the past decades, making them ubiquitous in agricultural practices and contributing to increased yields and regularity of production [4].

Nowadays, pesticides are becoming an essential component of agricultural production techniques. Their use in developed countries is often regulated and monitored because it can cause problems if not used judiciously [4]. However, unfortunately, some developing countries do not have the experience and knowledge of the techniques necessary to solve such problems [3, 5]. These developing countries use only 25% of the pesticides produced worldwide and record 99% of deaths due to this type of poisoning [6]. These pesticides are composed of atrazine, glyphosate and Paraquat, herbicides found in groundwater and streams and are retained in the soil [7]. The amount of insecticide that does not reach the target organism is problematic because of the potential effects on humans and their environment [8]. These pesticides would also be responsible for forest decline and soil fertility, which result in the reduction or even the disappearance of certain populations, such as those of earthworms [7].

Faced with this situation, the development of agriculture in these different countries, which seemed to constitute one of the solutions to the food security of the populations, poses a problem of the excessive use of pesticides [3, 8]. The excessive use of pesticides increases their ability to be resistant and gives the opportunity to non-target secondary pests to become pests [3].

The health effects of pesticide use are felt by agricultural producers through various symptoms of poisoning [9]. Several studies related to pesticide use have shown that pesticides' adverse effects on human health include dermatological, gastrointestinal, neurological, carcinogenic, respiratory, and renal diseases or effects on the endocrine system and reproductive organs [10, 11]. In Cameroon, in general, and the northern part in particular, pesticides are sold in the open areas under the sun by people who have no knowledge of the dangers involved.

Similarly, users obtain these pesticides while being unaware of their use and management, thus resulting in the intoxication of populations and causing damage to the environment [12, 13 and 14]. Therefore, Cameroon organized a workshop in June 2016 through the Ministry of the Environment, Nature Protection and Sustainable Development (MINEPDED) on the consequences of the misused of agricultural pesticides [8 18].

The purpose of this workshop was to identify the pesticide formulations present in Cameroon and those used by producers. Moreover, in Mayo-Danay Division, the populations face a varied range of pesticides in addition to those distributed by the cotton and rice companies in place. This led to the objective of this work to evaluate diversity and management of the use of pesticides in the market gardening of the Mayo-Danay Division.

2. Materials and Methods

2.1. Presentation of the Study Area

This study was carried out in two municipalities of the Mayo-Danay Division, Far North Region. According to statistical data, it represents one of the region's largest production areas of market gardening and the most affected by nephropathy.

The Mayo-Danay Division has a Sudano-Sahelian climate of the dry tropical type with a long dry season. Precipitation is quite low, with an annual average of 800 mm. We note the proximity of the Logone River and the Danay stream, which literally crosses the town of Yagoua and only the Logone River and the Mayo Cléréo (Danay stream) for the town of Vélé in the Commune of Guéméré. A large part of the plain is periodically flooded by water, mainly from overflows of the Logone River. The relief of the locality of Yagoua is fairly uniform. It takes the form of a plain of negligible slope belonging to the natural extension of the alluvial plain of the Lake Chad Basin. [15, 16].

The pedology of Yagoua is characterized by three types of soils, Luvisols characterized by an accumulation of clays found in flood plains of yaérés; the Fluvisols are concentrated towards Lake Chad, along the course of the Logone, and the Mora-Yagoua axis and the Planosols which are characterized by silty surfaces. [15, 16]. These two municipalities (Yagoua and Guéméré) were selected both for their high use of pesticides during the dry season and the abundance of market gardening near water reservoirs (Figure 1).

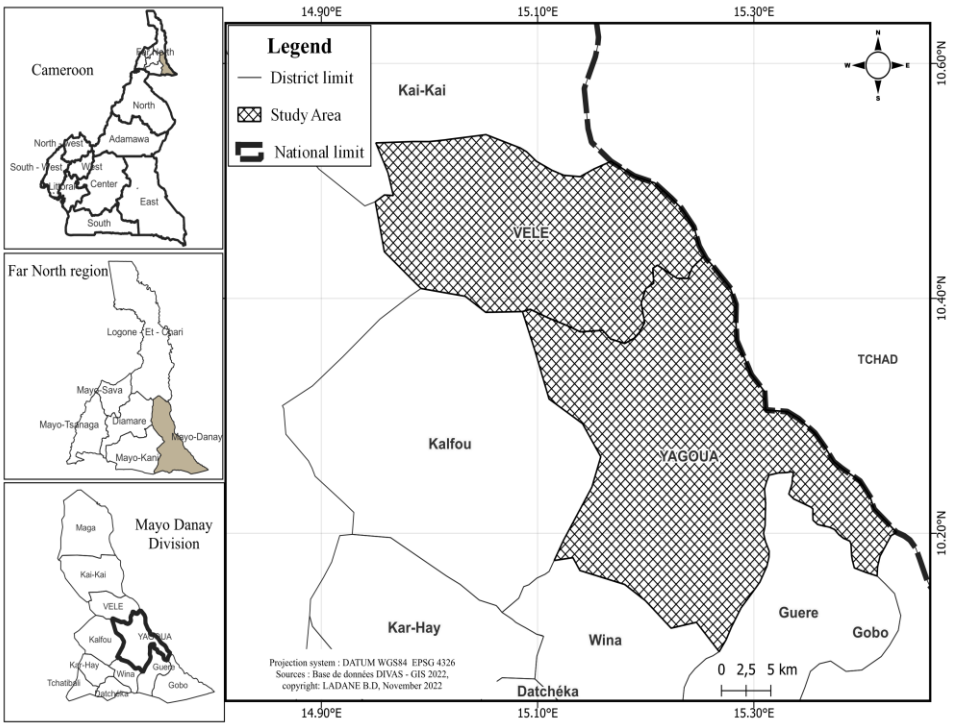

Fig. 1 Map of the Mayo-Danay Division highlighting the study area

2.2. Methods of Data Collection and Analysis

2.2.1. Data Collection Technique

The data collected related to the different phytosanitary products used, their supply circuits, the precautions farmers took during application and the management of packaging. A survey was carried out between 2020 and 2021 to assess the diversity of pesticides used by farmers to protect their crops against attacks of harmful insects, weeds and plant diseases. The names of the agricultural inputs used and sold on the local market were identified in the Mayo-Danay Division with 120 farmers and 10 pesticide traders. These data were collected from individual semi-structured surveys. Given the difficulty for respondents to remember the usual or vernacular names of the pesticides used or to find their packaging, the list of pesticides used was supplemented by those found on the market. In addition, the list of pesticides used was established by consulting the list of pesticides approved in March 2021 by the Ministry of Agriculture and Rural Development [26].

2.2.2. Data Analysis

Data collection was done over a period of 12 months. All of this data was entered into an Excel database. The statistical analysis was carried out using the InStat 3 software. A descriptive analysis of knowledge on pesticides and their impacts in the Mayo-Danay Division was thus obtained. The frequencies of pesticide use in the locality were determined. A cross-table was produced to highlight the proportions of each category of pesticides (authorized or not) by their active ingredient. The data analyzed for this purpose concerned the active ingredients of the most widely used pesticides.

3. Results and Discussion

3.1. Results

3.1.1. People Surveyed

Table 1 shows the distribution of producers by age. Market gardening seems to be a predominant activity in the study area. But it emerges from these results that, among the farmers surveyed, 68% are male and only 32% female. The average age of market gardeners at the time of the survey was 42 years old, with a percentage of 10%, and the minimum age was 15 years old, with 5%. In this Division, market gardening is practiced mainly by old people.

Table 1. Distribution of market gardeners surveyed in the study area according to their age

Age groups (Years)	under 15	16-35	36-50	more than 50	Total
Number	6	12	60	42	120
Pourcentage	5	10	50	35	100%

The survey results also show that the majority of farmers had the Primary School Certificate (CEPE/CEP) (46%), and others did not attend conventional school (34%). 4% of these producers had the Probatoire and 3% the Baccalauréat (GCO secondary education). Others among them have received various training (13%) (Figure 2).

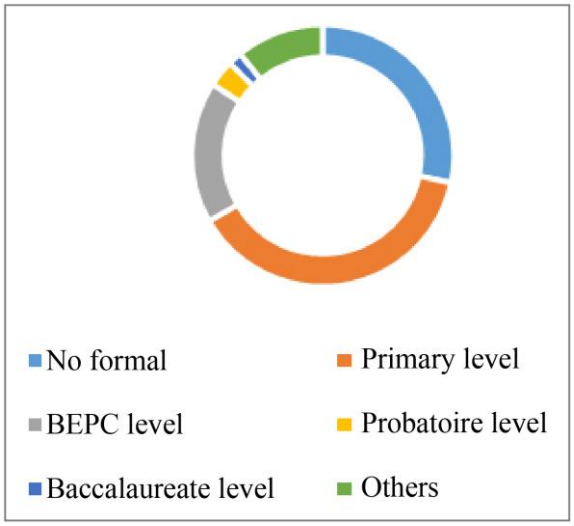

Fig. 2 Distribution of market gardeners surveyed in the study area according to their level of study

3.1.2. Choice of Pesticides use Related to Occupation

Figure 3 gives the distribution of phytosanitary products in the study area according to the farmers' choice. This figure shows that 26% of phytosanitary products in the locality were chosen by agricultural service managers and 20% by sellers. The majority of producers chose their phytosanitary products themselves (47%), and Only 7% of farmers have other choices.

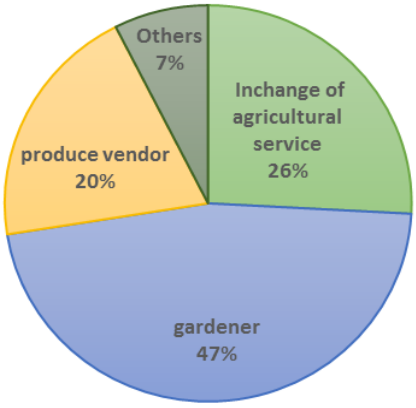

Fig. 3 Distribution of market gardeners in the study area according to their choice of phytosanitary products

3.1.3. Types of Phytosanitary Products used in the Study Area

The pesticides identified during this survey contained 12 different active ingredients (Table 2). These results show that herbicides were the most used by producers and were in the majority, glyphosate (61%), Atrazine (29%) and Paraquat (10%), respectively. Through these herbicides, the active ingredients present in the Mayo-Danay basin are Glyphosate,

Atrazine, Phosphate and Oxdiazon. The insecticides most used by producers of market gardening in the Mayo-Danay Division are respectively Cypercale, optimal and Buta force; the most commonly used fungicides are Fongistar and Agreb 80 WP.

Table 2. List of pesticides used in the Subdivision of Vele and Yagoua in the Mayo-Danay Division and their class

Herbicide		
Usual Name	**Active ingredient**	**class**
Round up	Glyphosate	III
Atrazine*	Atrazine	Ia
Glyphogan	Glyphosate	III
Glycot/ Glycol	Glyphosate 41%	III
Glyvodaire	Glyphosate	III
Power	Duiron	III
Super killer	Glyphosate	III
Super machette	Glyphosate	III
Ristar	*Oxdiazon*	III
Rigold	*Oxdiazon*	III
Gamoxone*	*Paraquat dichloride*	Ib
Diuron*	*Dichlorophenyl*	Ib
Buta force*	*chloroacetanilide*	Ib
Insecticide		
Usual Name	**Active ingredient**	**class**
Cypercal	*cypermethrine+profenofos*	II
Benji	*acetamipride*	III
Chriss	*acetamipride*	III
Optimal	*acetamipride*	II
Cypercot	*cypermethrine*	II
Tema	*Emamectine benzoate*	II
Cyper clean	*cypermethrine*	II
Cyper force	cypermethrine	II
Diuron	*Dichlorophenyl*	Ib
Landrine	Landrine	Ia
Fongicide		
Usual Name	**Active ingredient**	**class**
Agreb 80 WP	Manebe 800	III
Fongistar	Metalayl+mancozebe	II

3.1.4. Preparation of Pesticide Slurry

Figure 4 shows that 67% of the farmers prepared the pesticide mixture for the treatment of their fields in relation to the surface to be treated, 17% from the tank, 9% from the number of km of sidewalk to be treated and 7 % of farmers estimated themselves slurry of pesticides to be prepared for treatment.

Regarding the place of preparation, 82% of farmers prepared the pesticide mixture in the field, while 6% did it in the storage area. Others formulated their preparation next to the water point closest to the field (12%). From this survey, it appears that 73% of farmers used their entire mixture of pesticides to treat fields, while 27% kept pesticide residues for later use. Some producers, i.e. 6%, used empty packaging for domestic purposes, while 94% burned this packaging in the field (Figure 5).

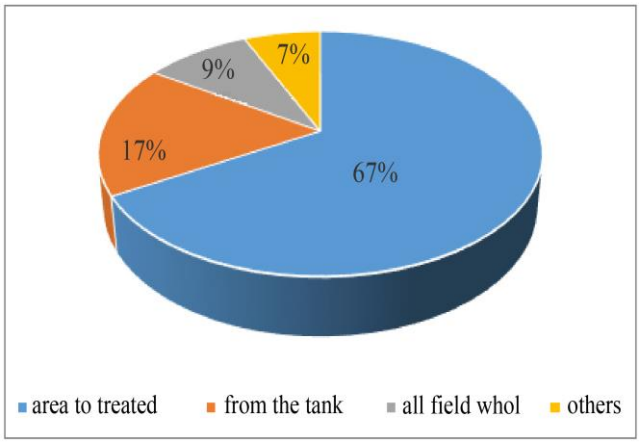

Fig. 4 Determination of the quantity of pesticides to be prepared according to the people surveyed in the study area.

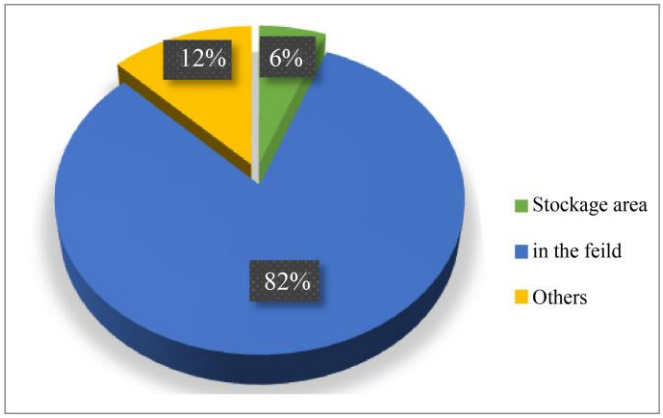

Fig. 5 Place of preparation of pesticide mixture according to the people surveyed in the study area.

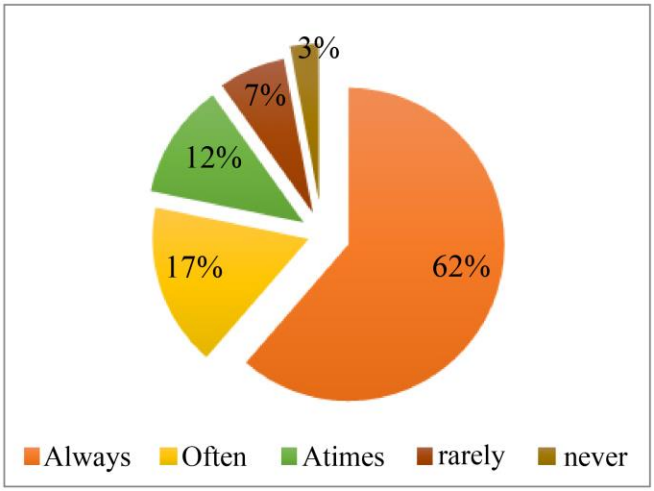

Fig. 6 Distribution of farmers according to dose compliance according to the people surveyed in the study area

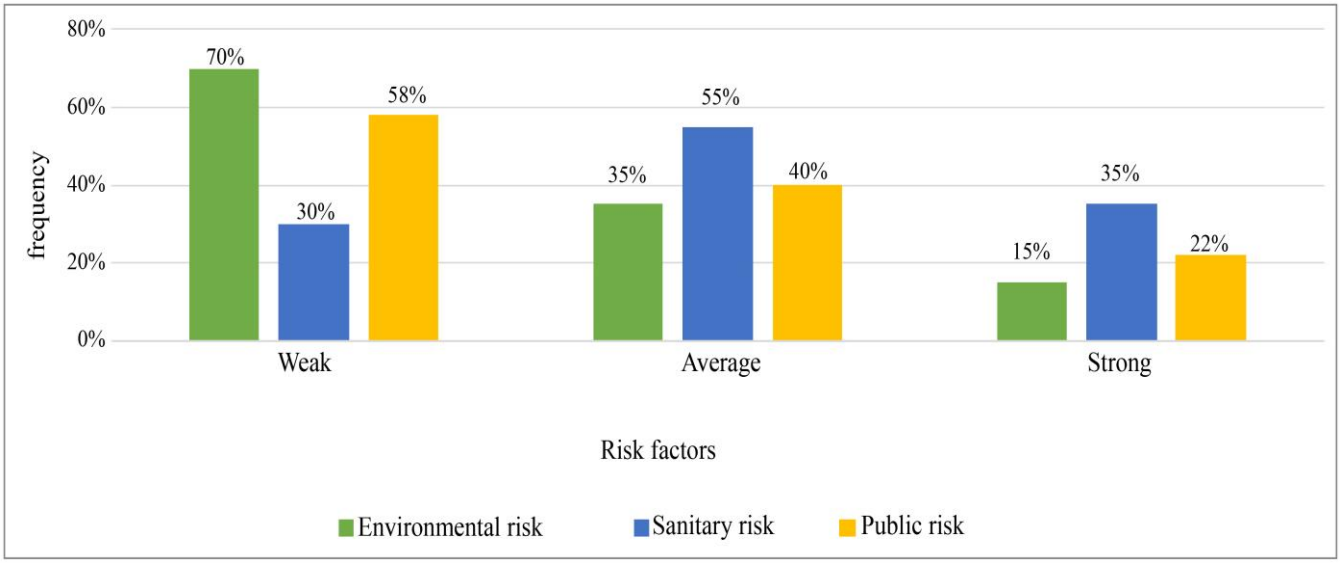

Fig. 7 Sanitary public risk and environmental risk associated with the use of phytosanitary products according to the people surveyed in the study area

Figure 6 shows the compliance with the dose of pesticides used by local farmers. 67% of farmers respected the dose prescribed on the pesticide packaging, 16% often respected the doses, 8% sometimes, while 6 and 3% did not apply or rarely or never applied the pre-registration of pesticide doses.

Local farmers chose pesticides regardless of how dangerous they were. These farmers could hardly consider the risks related to public health (55%) and 70% to the environment (Figure 7). This makes it clear that market gardening uses pesticides that have harmful effects on the health of the public and the environment. We also noticed a greater consideration of the health risk by the applicator himself (35%).

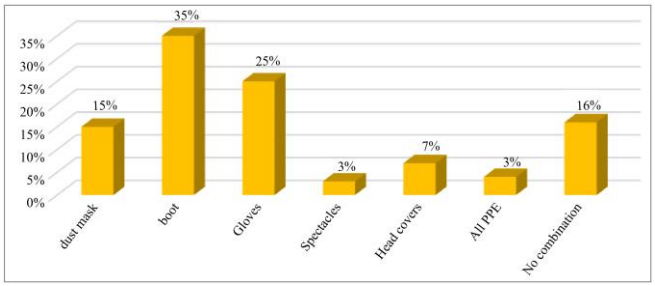

Fig. 8 Personal protective equipment used by farmers in the Mayo-Danay Division

3.1.5- How to use Pesticides

The results of the surveys showed that 75% of the farmers carried out the phytochemical treatment without recommended personal protective equipment, including dust masks, gloves, boots, coveralls and goggles. 80% of farmers protected only one part of their body while preparing and applying pesticides. The most used equipment protection was gloves for 25%, boots for 35%, dust masks for 15%, goggles for 3%, and head covers for 7% (figure 8).

Producers with suitable combinations for the use and management of pesticides represent only 5% of respondents, and farmers with no protection represent 15%. Almost all farmers (95%) do not comply with the safety measures provided for by the regulations. It appears from this survey that some farmers in the locality (38%) lacked finances, 42% were unaware of personal protective equipment, and 20% did not have access to PPE.

3.1.6. Management of Pesticide Mixture and Packaging by Market Gardeners

The results of the surveys show that 62% of the producers used their entire mixture of pesticides for phytosanitary treatment, 20% kept pesticide residues for later use, 10% of them poured the residue on the ground, while 5% buried in the ground, 3% for the double passage (figure 9). The market gardeners do not take into account the concept of the expiry of pesticides; they use expired pesticides (15%) and are sometimes not approved. In addition, there is no management and disposal system for pesticide packaging in the study area. They are anarchically thrown into nature or used for domestic purposes.

Pesticide storage locations are shown in Figure 10. We note that farmers store their synthetic chemical products poorly; only 15% of farmers keep their product in a locked room, less than 10% keep it away from homes, and 75% of these farmers bury or store their pesticides in the ground either at home or in the field.

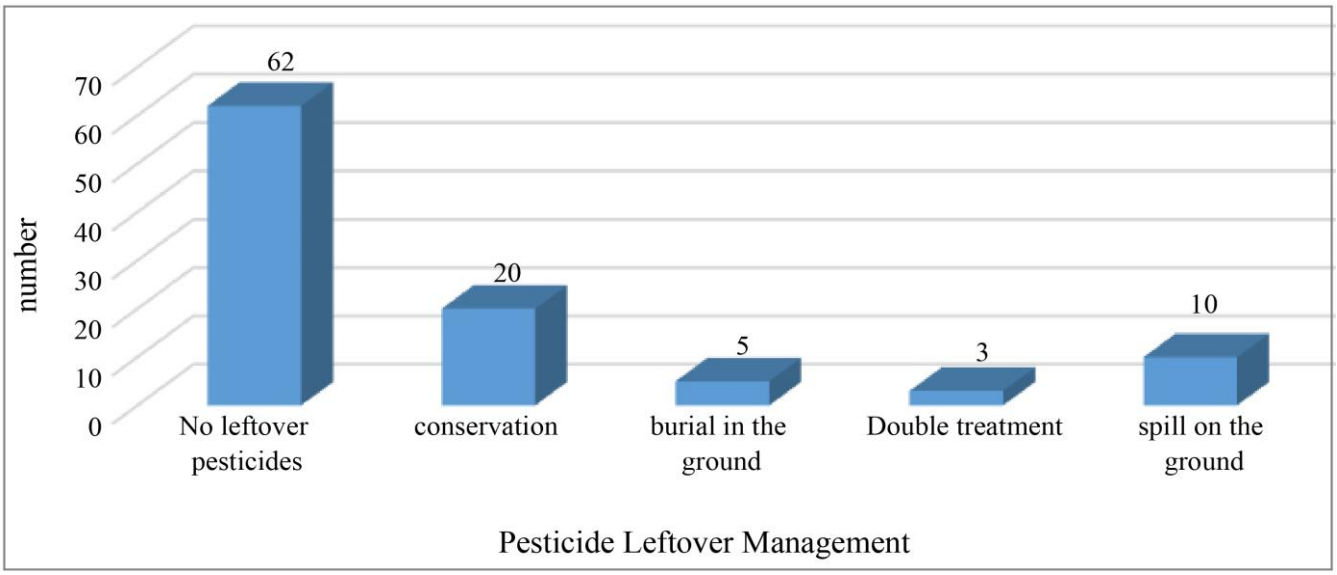

Fig. 9 Management of pesticide residues in the study area according to the people surveyed in the study area

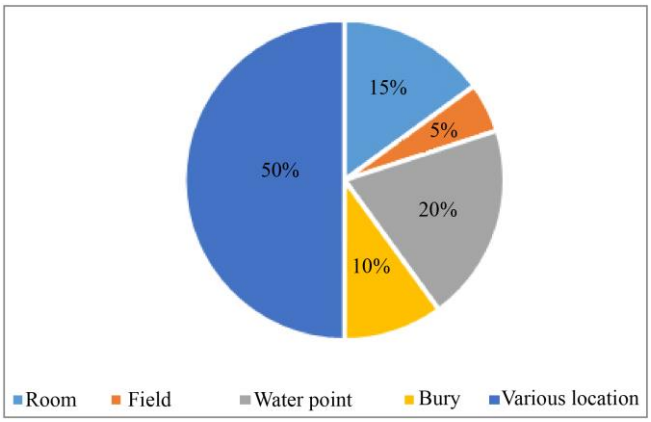

Fig. 10 Pesticide storage location according to people surveyed in the study area

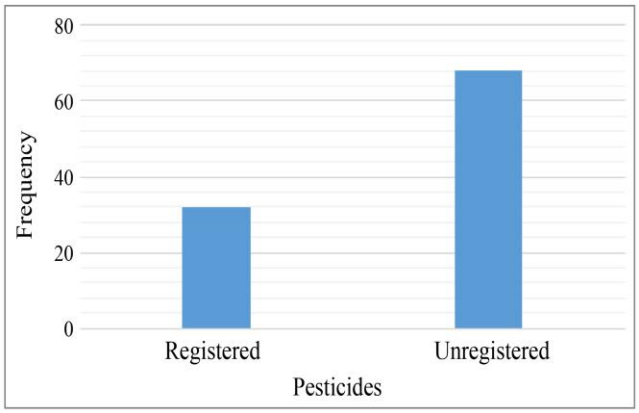

Fig. 11 Status of pesticides identified in the study area

3.1.7. Pesticide Supply Circuits in the Locality

Due to the poverty index in this locality, some farmers use less expensive pesticides, and most are not registered (32%), while others use registered pesticides (68%). These products are also used in the neighboring countries (Nigeria, Chad and the Central African Republic) of Cameroon, where there are counterfeits which flood the Mayo-Danay market (Figure 11).

3.1.8. Poisoning Risk Factor

Figure 12 shows the factors identified as causing pesticide poisoning in Mayo-Danay. According to the results of the surveys, parameters could be at the origin of the intoxication were classified in order of importance: we quote the spraying of pesticides on fresh vegetables before the persistence time in order to be marketed (30%) and pesticides sprayed on dried fish for preservation (9%). 49% of the population states that pesticides pollute drinking water.

According to the results of the surveys, 8% of the population affirms that urea is the cause of poisoning (production of gym salt and animal feed), as well as 4% of the population, believes that peanut paste is inflated with baking powder in order to be marketed.

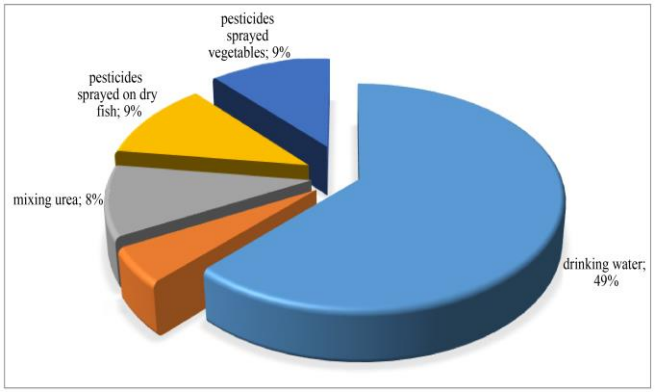

Fig. 12 Risk factors for synthetic chemical poisoning in Mayo-Danay according to people surveyed in the study area

3.2. Discussion

This study made it possible to understand the sex and age of the market gardeners surveyed in Mayo-Danay. It is noted that 68% of the farmers surveyed are male and 32% female. This can be explained by the fact that the survey was based on the chief of the family of the farmers. In some families, the women were the chief of the family following the death of their husbands. The percentage of women practicing market gardening is high in this locality as in many southern countries. The study showed that some young people in the study area are less interested in market gardening than the older ones. They prefer to migrate more to the city to turn to the informal sector and other activities. Muriel et al. [18] stated that market gardening in Nkolo and its surroundings (central Kongo) is an activity mainly done by men. Women represent only 8% to 28%, just as [19] report that 86.6% of market gardeners surveyed are men and women market gardeners reach 13.4% of respondents in intra-urban (Cotonou) and peri-urban (Sèmè-Kpodji) areas in southern Benin. The low involvement of women can be explained by the fact that they are not authorized to apply phytosanitary products to crops [20].

The study also showed that the level of education of farmers influences the frequency of wearing PPE and the risk of poisoning. The higher level of study lets them consider the harmful effects of pesticides on human health and the environment. This result corroborates with those of [22], who showed that better-trained farmers were aware of the risks associated with the use of pesticides and took better precautions to avoid these risks [12].

The study showed that the age of farmers had an influence on the use of personal protective equipment (PPE). This could be explained by the fact that young people are much more aware of the risks associated with handling pesticides and are also more concerned about the harmful effects these products could have on their health (cancer, fertility problem, kidney disease) and the environment [23]. Other market gardeners worked with the managers of agricultural services because they provided them with appropriate advice to simplify the work of choosing the treatment to be carried out.

The results of the surveys showed that up to 95% of farmers carried out phytochemical treatments while 5% did not. Some market gardeners carried out the treatment in the afternoon and others in the morning. These preventive and curative treatments protect plants against insect attacks and fungal diseases. [22] go in the same direction by explaining that most of the market gardeners surveyed in the Mbanza-Ngungu area in Benin carried out the phytosanitary treatment in the afternoon. Producers prepared pesticide mixtures without recommended personal protective equipment (86%), including dust masks, gloves, boots, and clothes. Deviations were explained for 49% of cases by lack of finances, 30% by ignorance of personal protective equipment, and 9 and 12% of cases, respectively, by non-availability and non-accessibility of personal protective equipment. These results corroborate those of [4], who show that the pesticide mixture was done by hand for a long time, without gloves, sometimes by introducing an arm directly into the prepared mixture to crush the lumps. Nearly 75% of farmers had already experienced health problems following phytosanitary treatments, compared to 35% [24]. For respondents who admitted to being victims of pesticide poisoning, 51% gave the exact symptoms of the conditions suffered. These are various sensations of colds, abdominal pain, coughing, itching, skin burning, stomach aches and sore eyes. This result corroborates with those of [25].

4. Conclusion

The study on the diversity and use of pesticides showed that the population of the Mayo-Danay Division uses synthetic chemicals wrongly and through. It is noted that the active ingredients used in this locality are diversed. Most producers do not respect the required doses of phytosanitary products and do not protect themselves. The survey results illustrate that pesticides that flood the market in this locality come from neighboring countries where counterfeits are common. The use of pesticides constitutes a threat to the producers themselves, to the consumers and also to the environment.

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