

Full Length Research Paper

Evaluation of the effect of the use of anti-insect nets on vegetable production in southern Benin

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The objective of this research is to assess the effects of the use of insect nets in vegetable production. To achieve this goal, data were collected in four departments of southern Benin (Mono, Couffo, Ouémé and Plateau) using an interview guide and a structured questionnaire. A total of 223 producers chosen at random from these areas where the CRSP Horticulture Project is located were surveyed. The results of the study show that growers using insect nets have not given up using chemical pesticides. However, a significant reduction in treatment frequencies was recorded in the nursery and after transplanting for most of the pesticides identified. Similarly, a significant reduction (more than 60.0%) in pest attacks (*Helicoverpa armigera*, *Hellula undalis*, *Plutella xylostella*, *Bemisia tabaci* and cochineals) was recorded among producers using anti-insect nets at 5%. These results involve that it is necessary to sensitize farmers to the use of nets to protect plants. This will significantly reduce pest attacks and reduce the use of pesticides in production.

Key words: Anti-insect nets, effects, pests, market gardening, Benin.

INTRODUCTION

Rapid urbanization in sub-Saharan African countries has resulted in a growing demand for staple foods. This ever-increasing demand for food exceeds the level of supply. Almost 33% of the population of sub-Saharan Africa, or nearly 200 million people, were short of food in 2005

(FAO, 2006). In a decade, this population of hungry people has increased to 256.5 million in 2017 (FAO et al., 2018). Since the 2000s, fruits and vegetables have become increasingly important in the development of the agricultural sector in many African countries due to their

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economic returns, nutritional value, and latent capacity to be exported to the international market. Vegetable crops are important sources of protein, vitamins, trace elements and antioxidants and are known to have health benefits (Chu et al., 2002; Singh et al., 2007). Low fruit and vegetable consumption is the cause of 31% of ischemic heart disease and 11% of strokes worldwide (OMS, 2002).

Market gardening is practiced in all regions of Benin, but production predominates in the south, which receives much more water than the north. Vegetable and fruit production have an undeniable socio-economic importance in Benin. It contributes to job creation and, in turn, to the reduction of unemployment. According to PADAP (2003), 600,000 direct jobs have been created in the market gardening sector in urban and peri-urban areas in Benin. However, horticultural production is still far below the level required to meet the requirements. Benin, like other countries in sub-Saharan Africa, has identified vegetable production as one of the thirteen priority sectors to be promoted in the Strategic Plan for the Recovery of the Agricultural Sector 2011-2015 (PSRSA, 2009) and in the Strategic Plan for the Development of the Agricultural Sector 2017-2025 (PSDSA, 2017). Production is faced with many constraints, the most important of which concern the management of pests and diseases (Assogba-Komlan et al., 2007). To control pests, producers most often resort to chemical pesticides (Ahouangninou et al., 2013). These pesticides are often not used safely (failure to respect dosages, pre-harvest safety periods and failure to use personal protective equipment) (Ahouangninou et al., 2015). These practices pose risks to the health of producers, consumers and the environment (Tomenson and Matthews, 2009; Djagni and Fok, 2019; Girard et al., 2020; Gamet-Payrastre, 2020; Le Bars et al., 2020).

Alternative methods of pest and disease control such as the use of natural plant extracts as biopesticides (Isman, 2015; Stevenson et al., 2017) have not proven to be sufficient to control pests. It is therefore becoming important to promote other more environmentally friendly methods of insect control such as physical control. The use of insect netting can help reduce pest and disease problems (Guo et al., 2015). Unfortunately, this technology is unavailable to small-scale farmers in Africa. It is to correct these shortcomings and increase vegetable productivity that the CRSP Horticulture project has been implemented. The project aims to promote the use of insect nets in the control of vegetable pests, thereby reducing dependence on chemical pesticides in order to optimize yields and obtain healthy produce. The first trials were conducted on *Brassica oleracea* (Martin et al., 2006; Licciardi et al., 2008; Assogba-Komlan et al., 2014). But some producers are extending it to other plant species such as nightshade (*Solanum macrocarpon*), tomato (*Solanum esculentum*) and chilli (*Capsicum anuum*) nurseries. The objective of the study is to

evaluate the effects of the use of anti-insect nets in the protection of vegetable crops on the frequency of phytosanitary treatments and pest populations in southern Benin.

MATERIALS AND METHODS

Selection of study area

The present study was conducted in the southern region of Benin in the departments of Mono-Couffo and Ouémé-Plateau. The choice of these areas is justified by the fact that they were the site of the CRSP Horticulture Project. Several market gardeners from the "Groupement Conseil Régional des Maraîchers du Mono-Couffo (CRM-Mono/Couffo)" were involved in the project. The anti-insect nets were made available to these producers for experiments with anti-insect nets on tomato and cabbage nurseries.

The departments of Mono and Couffo are located in the Mono valley between Togo and Benin and precisely between 9°20' and 6°17' North Latitude and between 0°41' and 1°45' East Longitude (Amoussou et al., 2012; INSAE, 2016a). This valley is irrigated by the Mono River, which has a tropical rainfall hydrological regime but is influenced by the sub-equatorial climate with two dry and two rainy seasons. Rainfall varies from 750 to 900 mm. As for the departments of Ouémé and Plateau, they were chosen because the commune of Sèmè-kpodji was the site of experiments on anti-insect nets. This area is part of the department of Ouémé. Plateau was chosen as a control department. The departments of Ouémé and Plateau are located between the 6th and 7th degrees of northern latitude and cover an area of approximately 4,700 km² (INSAE, 2016b). They are bordered to the north by the departments of Zou and Collines, to the south by the Atlantic Ocean, to the east by the Federal Republic of Nigeria and to the west by the departments of Atlantic and Littoral.

Data collection

The data used were collected using questionnaires in the departments of Mono/Couffo and Ouémé/Plateau from September to December 2015 on a random sample of 223 producers, 148 of whom had benefited from the project.

Data collected include socio-economic, socio-demographic, production system data and the effect of insect netting on pesticide application frequency and on pest and disease attack levels. The main variables collected are qualitative and quantitative. The quantitative variables collected are: age, area planted with vegetable crops, frequency of pesticide application, and doses applied. The level of pest and disease attack among beneficiaries and non-beneficiaries is an ordinal variable on a scale of 1 to 5. The qualitative variables include gender, department, commune, village, membership of an association, types of activities practiced, type of labour used, support structures, crops grown, cultivation techniques and control methods used.

Data analysis

The collected data were entered into an Excel sheet and then analyzed with R3.6.1 software. Descriptive statistics (means, standard deviations, frequencies) as well as statistical tests for comparison of means (Student's test, one-factor Anova) were performed. In case of violation of the assumptions of normality and homogeneity of variances, the non-parametric Mann-Whitney or Kruskal-Wallis test was used.

Table 1. Quantitative variables characterising farmers.

Variable	Age (years)		Level of education (years)		Area (ha)		Experience (years)	
	Means	Standard deviation	Means	Standard deviation	Means	Standard deviation	Means	Standard deviation
Couffo	42.3	11.4	4.6	5.0	0.7	0.5	11.7	7.0
Mono	39.6	8.1	5.2	5.1	0.9	0.6	9.7	6.2
Ouébé	49.5	13.8	4.5	4.9	1.6	1.7	11.0	6.6
Plateau	40.7	13.9	8.4	5.5	1.0	0.7	9.3	7.2
All	44.6	12.6	4.9	5.0	1.2	1.3	10.7	6.6
p-value	0.000 (F=10.03)		0.104 (F=2.08)		0.000 (F=6.68)		0.39 (F=1.01)	

Table 2. Qualitative variables characterising farmers.

Variable	Numbers	Frequencies (%)
Sex		
Male	164	73.5
Female	59	26.5
Marital status		
Married	216	96.7
Single	7	3.3
Other types of activities		
Livestock	35	15.7
Non-farming activities	28	12.6
Labour force		
waged labour	33	14.8
family labour	39	17.5
temporary labour	143	64.12
Association membership		
Yes	183	82.2
No	40	17.8

RESULTS

Socio-economic characteristics of farmers

The age of the producers surveyed varies from 19 to 75 with a mean of 44.6 and a standard deviation of 12.6 (Table 1). The average area sown by producers is 1.18 ha with a standard deviation of 1.29 ha (Table 1). These areas vary from 0.01 to 10 ha. A significant difference was observed between departments according to the area sown ($p=0.000$, $F=6.668$). The area sown in Ouébé is significantly higher than in the other departments. The average level of education of producers is 4.9 years with a standard deviation of 5.0 years (Table 1). It is higher in the plateau (8.4 years), but the difference between departments is not statistically significant ($p=0.104$). The

average years of experience of producers is 10.7 years with a standard deviation of 6.6 years (Table 1). The highest average is recorded in Couffo (11.7 years), but the difference between departments is not statistically significant ($p=0.39$).

The majority of the producers surveyed are male (73.5%) (Table 2). Women represent 26.5% of the sample. The number of women surveyed is significantly higher in Ouébé at the 10% threshold. The majority of producers surveyed are married (96.7%) (Table 2). The others are single. Of the 223 producers who answered the question "Do you belong to a producers' association?", all the producers surveyed in Mono report to belong to an association, whereas in Couffo, only 3 producers do not. The proportion of producers belonging to an association is low in the plateau. As for the labour

Table 3. Means used to control pests.

Variable	Regions				Total
	Couffo	Mono	Ouémé	Plateau	
Pacha	36 (70.6%)	39 (63.9%)	56 (56.0%)	3 (27.3%)	134 (60.1%)
Laser	12 (23.5%)	10 (16.4%)	6 (6.0%)	1 (9.1%)	29 (13.0%)
Lambda	23 (45.1%)	34 (55.7%)	35 (35.0%)	2 (18.2%)	94 (42.1%)
Carbofuran	1 (1.9%)	5 (8.2%)	1 (1.0%)	1 (9.1%)	8 (3.6%)
Cyperméthrine	1 (1.9%)	3 (4.9%)	5 (5.0%)	0 (0.0%)	9 (4.0%)
Decis	1 (1.9%)	0 (0.0%)	1 (1.0%)	0 (0.0%)	2 (0.9%)
Topsin M	11 (21.5%)	18 (29.5%)	0 (0.0%)	1 (9.1%)	30 (13.4%)
Mancozeb/Maneb	1 (1.9%)	6 (9.8%)	0 (0.0%)	0 (0.0%)	7 (3.1%)
K-Optimal	0 (0.0%)	6 (9.8%)	0 (0.0%)	0 (0.0%)	6 (2.7%)
Kinikini	3 (5.9%)	0 (0.0%)	1 (1.0%)	0 (0.0%)	4 (1.8%)
Harvet More	0 (0.0%)	1 (1.6%)	0 (0.0%)	0 (0.0%)	1 (0.4%)
Callicuivre	0 (0.0%)	1 (1.6%)	0 (0.0%)	0 (0.0%)	1 (0.4%)
Ash	6 (11.8%)	2 (3.3%)	17 (17.0%)	9 (81.8%)	34 (15.2%)
Botanical pesticides	1 (1.9%)	2 (3.3%)	8 (8.0%)	0 (0.0%)	11 (4.9%)
Others	0 (0.0%)	4 (6.5%)	2 (2.0%)	1 (9.1%)	7 (3.1%)

used, it is temporary for 64.1% of producers; 14.8% use salaried labour and 17.5% use family labour. Apart from market gardening, producers engage in other activities. Thirty-five (15.7%) are engaged in livestock farming and twenty-eight (12.6%) in non-agricultural activities such as trade.

Support structures

Ninety-nine (44.6%) of the producers are in collaboration with the INRAB's Vegetable Crops Program, with whom they receive technical support under the BioNetAgro project. Eighty-five (38.3%) are supervised by the extension agents from the Agricultural Territorial Development Agency (ATDA), while 6.7% are in collaboration with NGOs working in the agricultural field.

Cultivation periods

Of the 223 producers, 20.7% produced in the dry season; 10.8% in the rainy season; 23.4% in the flood season and 38.3% produced all year round. The reasons for producing in the dry season are 'water availability' for 38.1%; flooding in the rainy season (11.7%); high selling price in the dry season (10.3%); wet and rich soil (16.6%); and year-round income (18.8%).

Crop species produced

Several plant species are produced by the market gardeners surveyed. These include chilli, tomato, cabbage, onion, leafy vegetables and other exotic

vegetables. However, the most produced speculations are chilli (88.8%), leafy vegetables (87.9%), tomato (61.4%) and cabbage (45.7%).

Crop pests and control methods used other than insect netting

The great majority of respondents (97.8%) told us that they were confronted with pest attacks. One hundred and twenty-five (56.1%) of the respondents were confronted with attacks by plant-eating caterpillars. For 31.8, 32.7 and 23.0% of respondents, domestic animals, locusts and aerial pests attack their crops. Snails and rodents are also threats to crops. They were cited by 4.9 and 3.6% of respondents respectively.

To control pests, growers use several pesticides. The most commonly used is Pacha, found in 60.1% of growers, followed by Lambda found in 42.1% (Table 3). Topsin M and Laser are used by 13.4 and 13.0% of farmers respectively. Pacha is used less in Plateau (27.3%) compared to Mono (63.9%), Couffo (70.6%) and Ouémé (56.0%). As for the Laser and the Topsin M, they were used more in Mono and Couffo. Topsin M is a fungicide used to destroy fungi causing diseases on plants. Apart from chemical control, some producers use ash from combustion to control pests. But these producers are more numerous in the Plateau department (81.8%). Aqueous extracts are used very little in any of the departments.

Frequency of application of pesticides

The average frequency of pesticide application varies

Table 4. Frequency of pesticides application.

Pesticide	Frequency of use				Total
	Couffo	Mono	Ouémé	Plateau	
Pacha	1.3	1.8	2.5	2.0	1.9
Laser	1.3	1.7	2.0	1.0	1.4
Lambda	1.6	1.6	2.3	1.0	1.9
Carbofuran	1.0	1.4	1.0	2.0	1.3
Cyperméthrine	4.0	1.7	-	-	2.2
Decis	1.5	-	2.0	-	1.7
Topsin M	1.7	1.6	-	2.0	1.7
Mancozebe/Manebe	-	1.5	-	-	1.5
K-Optimal	-	1.5	-	-	1.5
Kinikini	1.5	-	2.0	-	1.7
Harvet More	-	1.0	-	-	1.0
Callicuivre	-	3.0	-	-	3.0
Cendre	3.3	1.5	1.2	1.7	1.9
Botanical pesticides	1.0	4.0	1.0	-	2.2
Others	-	1.8	-	1.0	1.6

from 1 to 4 applications per crop (Table 4). Cypermethrin is applied four times per crop in Couffo while it is applied 1.7 times on average in Mono. Botanical pesticides are used 4 times more in Mono than in Couffo. As for ash, its frequency of use is higher in the Plateau.

Use of insect protection nets

Of all the producers surveyed, 148 (66.4%) use anti-insect nets. One hundred and forty-one or 63.2% use them in the nursery. More than half of the producers surveyed in Mono and Couffo use anti-insect nets in the nursery. The frequency of use of nets in the nursery is highest in the department of Ouémé (78.0%). While more than a third (36.4%) of the producers surveyed in Plateau use nets in the nursery.

Nursery crops under nets and duration of use

About half of the respondents (49.8%) use nets to protect chilli nurseries. More than 3/5 use them in the protection of tomato and cabbage nurseries. Slightly more than a third (36.8%) have adopted netting in the protection of leafy vegetable nurseries while more than 3/10 use it in the protection of onion and other exotic vegetable nurseries. Comparing the four departments, it is in Ouémé that anti-insect netting is most widely used to protect vegetable nurseries.

Some growers use the nets on a temporary basis while others use it continuously during the nursery phase. The average duration of temporary use of nets in the nursery was 3.3 days. No significant difference between departments was recorded for this variable ($p=0.761$;

$F=0.390$). As for the duration of continuous use, the average was 13.1 days with a standard deviation of 11.1 days. The duration of continuous use of nets was highest in Ouémé, at 14.2 days, but no significant difference was observed between departments ($p=0.810$; $F=0.228$).

Nursery practices under insect netting

The producers surveyed engaged in several cultivation practices under the anti-insect nets. These include pesticide treatments, watering and mulching. In Ouémé, 69.0% of producers used pesticide treatments under nets. In the departments of Mono and Couffo, the proportion of market gardeners treating plants under nets was low, at 8.2 and 7.8% respectively. No market gardener surveyed in the Plateau department treats plants under nets. About 1/5 of the producers water the plants through the nets. In Mono and Couffo, more than a quarter of the respondents water the plants through the nets, while in Ouémé and Plateau, this proportion is low (10.0% and 9.1% respectively).

More than half of the producers (55.6%) mulch the beds under nets. In the four departments surveyed, the proportion of market gardeners mulching under nets is lowest in the Plateau (9.1%).

Type of net and type of net installation

The types of nets used by producers are: mosquito nets, anti-insect nets and fishing nets. Of all the respondents, 26.9% use recommended anti-insect nets, 22.9% use fishing nets and 10.8% use impregnated mosquito nets used in the fight against malaria. Of the 148 producers using nets, 74.3% use white nets, 14.9% use green nets,

Table 5. Frequency of pesticide use after transplanting.

Pesticides	Average frequency of treatment		
	Users of nets	No users of nets	P-value
Pacha	1.5	2.2	0.003
Laser	1.6	1.8	0.518
Lambda	1.4	2.1	0.031
Carbofuran	1.0	1.7	0.219
Decis	1.0	2.0	0.000
Topsin M	1.6	1.8	0.471
Mancozebe/Manebe	1.0	1.6	0.573
Kinikini	1.0	2.0	0.000

4.7% use blue nets and 1.4% use black nets. For the installation of nets, 26.0% of the respondents used hoops while the rest of the producers used stakes. A significant difference was observed between departments in the method of installing nets ($p=0.000$). Indeed, the use of hoops is more frequent in Mono (44.3%) and Couffo (47.1%) compared to 6.0% and 9.1% respectively for Ouémé and Plateau. For producers using hoops to install anti-insect nets, the reasons for their choice are: aeration of plants (50.0%), donation of hoops by INRAB (15.5%), protection of nets (3.4%). For non-users of hoops, the reasons given are: non-availability of hoops (1.4%), lack of financial means (70.0%).

Time of netting and how the net is supplied

Eighty-eight producers (39.5%) use nets from sowing to transplanting, sixty (26.9%) use it from emergence to transplanting and fifty-one producers (22.9%) use them after transplanting. Of all the users of nets for crop protection, 42.6% acquired them by purchase, 46.6% received them by donation. A minority of adopters rented anti-insect nets. Only one producer confided to us that he had borrowed the net from one of his peers.

Reasons for using nets

Many producers (39.2%) use nets to control crop pests. Some (24.3%) use them to protect crops from chickens and other birds. Others (16.2%) use the nets to prevent domestic animals from destroying the crops. Another category of producers (6.8%) use them to protect crops from rodents. Six producers (4.1%) use nets to reduce the amount of pesticides used.

Disadvantages of net nursery

To the question, "What are the disadvantages of doing nurseries under nets?", 27.0% of the adopters confided to

us that they have difficulties in putting up and taking down the nets, 6.1% say that it requires a lot of labour; 2.0% report that there is penetration of some caterpillars through the meshes of the nets and 2.0% report that they have found caterpillars on cabbage plants protected by the net.

Frequency of pesticide use by users and non-users of insect netting

During the nursery phase, a significant difference at the 5% threshold was observed in the frequency of application of Mancozeb and Maneb between net adopters and non-adopters. Indeed, the frequency of application of these fungicides during the nursery phase was higher for non-adopters (3 times) than for net adopters (1.2 times). After transplanting, other farmers use insect nets to protect their crops. For all the pesticides listed in Table 5, the frequency of application is higher for non-adopters than for adopters. A significant difference at the 5% threshold was observed in the frequency of application of Pacha, Lambda, Decis and Kinikini between adopters and non-adopters.

Level of pest and disease attack before and after the use of insect netting

During the nursery phase, a significant difference at the 5% threshold was observed in the frequency of application of Mancozeb and Maneb between net adopters and non-adopters. Indeed, the frequency of application of these fungicides during the nursery phase was higher for non-adopters (3 times) than for net adopters (1.2 times). After transplanting, other farmers use insect nets to protect their crops. For all the pesticides listed in Table 5, the frequency of application is higher for non-adopters than for adopters. A significant difference at the 5% threshold was observed in the frequency of application of Pacha, Lambda, Decis and Kinikini between adopters and non-adopters.

Table 6. Level of pest and disease attack using insect netting versus not using insect netting.

Pests or diseases	Average level of attack on a scale of 1 to 5		
	Users of nets	Non-users	P-value
<i>Helicoverpa armigera</i>	1.2	3.5	0.003
<i>Plutella xylostella</i>	1.1	4.3	0.002
<i>Hellula undalis</i>	0.8	3.1	0.003
<i>Spodoptera littoralis</i>	1.1	3.7	0.003
Aphids	1.2	1.7	0.219
Mealy bugs	1.0	3.2	0.000
White flies	0.9	3.7	0.003
Alternaria	1.6	1.8	0.471
Mildew	1.3	1.6	0.573
Powdery mildew	1.6	2.1	0.229

After transplanting, other farmers use insect nets to protect their crops. Significant differences in the level of attack of certain pests between the use and non-use of insect netting were recorded (Table 6). These were attacks by *Helicoverpa armigera*, *Plutella xylostella*, *Hellula undalis*, *Spodoptera littoralis*, mealy bugs and whitefly (*Bemisia tabaci*). For aphids and diseases such as Powdery mildew, Alternaria and mildew, the difference observed was not statistically significant.

DISCUSSION

Crop pests are the primary limiting constraint for vegetable production in southern Benin (Assogba-Komlan et al., 2007). The control of these pests is a challenge for producers who generally use chemical control. The use of chemical products in pest control is not without drawbacks for the health of applicators, consumers (presence of residues in vegetables) and biodiversity (Tomenson and Matthews, 2009; Ahouangninou et al., 2013; Shelton et al., 2014; Cohn et al., 2015; Djagni and Fok, 2019; Girard et al., 2020; Gamet-Payraastre, 2020; Le Bars et al., 2020). The search for alternative strategies to chemical control has become a priority for the scientific community (Martin et al., 2014; Assogba Komlan et al., 2014; Guo et al., 2015). Physical control, such as the use of anti-insect nets, is one of the ecological alternatives. The CRSP Horticulture Project, is an effort to reduce the impact of chemical pesticides and improve yields in vegetable production. It had supported some producers in acquiring anti-insect nets. The present study shows that despite the use of anti-insect nets by some producers, they continue to use chemical pesticides. This is in line with the work of Vidogbéna et al. (2012) in Mono and Couffo. Some studies out of Benin reported that using of anti-insect nets reduce the amount of chemical pesticide application, worker's health risks and environmental pollution (Möller et al., 2005; Castellano et al., 2008). But the frequency of application

of chemical pesticides in the nursery is significantly lower (one application) compared to non-net users (3 applications in the nursery). The same result was recorded after transplanting where the frequencies of application of insecticides such as Decis, Pacha, Lambda and Kinikini are significantly lower among net users compared to non-users and to the frequencies reported in southern Benin in previous studies by Ahouangninou et al. (2011) and Adjovi et al. (2020). Similar reductions in pesticide application frequency have been achieved by IPM methods in rice production (Ali et al., 2017). Many producers use nets in the nursery phase. During the nursery phase, the plants are still weak and effective care of the plants during this phase is crucial for successful production. Some growers use netting temporarily while others use it continuously. The temporary use of netting is related to the fact that daily netting and removal adds work to the growers (Vidogbéna et al., 2012, 2015). As for the type of net used, some market gardeners use recommended nets, others use fishing nets and still others use impregnated mosquito nets recommended for malaria vector control. The diversion of these nets to market gardening could undermine malaria vector control programs. More supervision for the benefit of producers could change these practices. The great majority of market gardeners surveyed use white nets, which is probably linked to the availability of this colour on the market. The use of anti-insect nets has had a significant effect on reducing the populations of some pests. These are the populations of *H. armigera*, *P. xylostella*, *H. undalis*, *S. littoralis*, mealy bugs and whitefly (*Bemisia tabaci*). No significant differences were observed in aphid populations and in the incidence of diseases such as powdery mildew, Alternaria and mildew. The results of these surveys corroborate the results of trials by Assogba-Komlan et al. (2014) in Benin which show a significant difference between some colours of insect nets and control in the populations of pests such as *H. armigera*, *P. xylostella*, *H. undalis*, and *S. littoralis*. Similar results were found by Langat et al. (2017) in

Kenya using different colours of agro-net to control pests such as aphids, thrips and silverleaf whitefly. All these studies showed that insect netting reduces pest populations in the field as well as their damage.

The present study focusing on the effect of the use of insect nets on other phytosanitary practices in vegetable production, it would be important to assess the impact of the use of this technology on the productivity and income of producers.

Conclusion

The horticulture CRSP project consisted of proposing and disseminating physical methods for controlling vegetable crop pests. This project, implemented by the INRAB Vegetable Crops Program in collaboration with CIRAD, involved vegetable producers in Mono and Couffo as well as in Ouémé and Plateau in southern Benin. The present study aims to evaluate the effects of this technology on phytosanitary practices in vegetable production. At the end of the study, the results show that by adopting insect nets, growers did not abandon the use of chemical pesticides, but a significant reduction in treatment frequencies was recorded in the nursery and after transplanting for the majority of the pesticides identified. The use of insect netting in the nursery also reduced the populations of some crop pests. The results of the study imply that market gardeners should be made aware of the use of nets for the protection of seedlings in nurseries and after transplanting for certain crops such as cabbage. This will reduce pest attacks and pesticide use while reducing the cost of chemical pesticides.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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