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Research Article

CHARACTERIZATION OF WATERMELON (*CITRULLUS LANATUS*) INSECT PESTS AND THE DIFFERENT CONTROL METHODS USED IN SOUTHERN BENIN

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ABSTRACT

The majority of watermelon pests have long been controlled by the often-excessive use of pesticides, whose harmful effects on ecosystems are well known. These impacts are all the more worrying when they affect crops. In light of this, integrated pest management (IPM) appears to be a sustainable alternative aimed at limiting the use of chemicals. This study aims to improve the productivity of Citrullus lanatus in southern Benin through integrated pest management techniques. It focuses on the classification of pests and diseases encountered, as well as the evaluation of the control methods used. The survey was conducted in several municipalities, including Missérété, Covè, Za-kpota, Comè, Dangbo, Dogbo, Lokossa, Tori-Bossito, Allada, Adjohoun, Kétou, Grand-Popo, and Ouidah. The results reveal the presence of flies, beetles, root-knot nematodes, downy mildew, leaf spot, anthracnose, fusarium wilt, and mosaic virus. Growers mainly use chemicals such as Pacha 25EC, Acarius 018EC, Emacot019EC, Kaobtimal, and Lambda. However, their overuse leads to the destruction of beneficials and pollution. Few studies mention the use of biopesticides, although various cultural practices can effectively control these pests.

Keywords: Insect pests, Biological control, Chemical control, Integrated control, Watermelon.

INTRODUCTION

Agriculture constitutes an essential foundation of the Beninese economy, representing 27% of the national GDP and employing over 70% of the working population, primarily in rural areas (MAEP, 2019). Market gardening, driven by growing urban demand, offers regular and rapid income, particularly attractive to young people and women (Yarou *et al.*, 2015). Among these, watermelon (Citrullus lanatus) stands out for its nutritional qualities and strong economic potential. Native to Africa, this cucurbit is widely cultivated in southern Benin, particularly in Sèmè-Kpodji, Grand-Popo, and Ouidah, where the agroclimatic conditions are favorable (Agbangla *et al.*, 2017). However, its production is hampered by significant phytosanitary

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challenges, linked to a wide variety of insect pests that affect leaves, stems and fruits, reducing yields and crop quality (Adandonon *et al*., 2009; FAO, 2020). The main pests include aphids (Aphis gossypii), thrips (Thrips tabaci), whiteflies (Bemisia tabaci), leafminers (Liriomyza spp.) and fruit moths (Diaphania indica), often vectors of serious viral diseases such as watermelon mosaic (Sikirou *et al*., 2013; Atachi *et al*., 2016). Their proliferation is facilitated by inappropriate agricultural practices, such as monoculture, lack of crop rotation and irrational use of pesticides (Hounkpèvi *et al*., 2020). Producers' response to these threats relies largely on synthetic insecticides. Although effective in the short term, their overuse generates resistance among pests, destroys natural beneficial organisms, and disrupts ecological balances (Ryckewaert, 1998; Tamo *et al*., 2014). Furthermore, soil and water contamination, as well as the presence of chemical residues in fruit, pose a major risk to human health (Yarou *et al*., 2015). In response, research institutions and NGOs recommend alternative methods such as integrated pest management, which combines sustainable cultural, biological, and chemical techniques, or biological control through the use of natural enemies (Goudegnon *et al*., 2012).

In this context, this study aims to identify the main insect pests of watermelon in southern Benin and to evaluate producers' phytosanitary practices. It focuses on the municipalities of Sèmè-Kpodji, Abomey-Calavi, Ouidah and Cotonou. The specific objectives are: to identify the dominant pest species, analyze their mode of attack, determine the critical periods of their appearance, and evaluate the control strategies in use. The study is based on a combined entomological, agronomic and sociotechnical approach, in order to propose ecologically sustainable, economically viable and technically adapted solutions for local producers (Ryckewaert, 1998; Tamo *et al*., 2014; Goudegnon *et al*., 2012).

STUDY MATERIALS AND METHODS

Study Area

The Republic of Benin is located in West Africa between latitudes 6°100 N and 12°250 N and longitudes 0°450 E and 3°550 E (Akoègninou *et al*. 2006). It covers a total area of 112,622 km2. The study was conducted in the southern part of the country, characterized by a relatively humid agro-ecological zone with two rainy seasons and annual rainfall ranging from 1100 to 1400 mm/year. Average annual temperatures range from 26°C to 28°C, and the vegetation types are semi-deciduous forests or forests or forests and savannah forests (Gbaguidi *et al*. 2013; Yabi and Afouda 2012). The surveys were conducted in several municipalities, including Missérété, Covè, Za-kpota, Comè, Dangbo, Dogbo, Lokossa, Tori-Bossito, Allada, Adjohoun, Kétou, Grand-Popo, and Ouidah.

Study Materials

Watermelon (Citrullus lanatus) is an annual, monoecious herbaceous plant with a creeping or climbing habit, reaching 4 to 10 meters in length. It clings to the ground using simple tendrils (Photo 1) and develops a superficial root system composed of a taproot accompanied by numerous lateral roots. Its ribbed stem is covered with long, soft hairs (E.O. Kichah, 2016). Its leaves are simple, alternate, without stipules, and borne on a 2 to 14 cm petiole that is also hairy. They have lobes with weakly toothed edges and long, hairy veins. The flowering, axillary and solitary, produces yellow, unisexual flowers, measuring 2 to 3.5 cm in diameter, with a campanulate calyx and petals fused at the base. Male flowers have three free stamens, while female flowers have an inferior ovary (E.O. Kichah, 2016). The fruit, a large globose to ellipsoidal berry, measures 5 to 70 cm long and can weigh between 1.5 and 30 kg. Its epidermis varies from white to green, gray or yellow, plain, spotted or striated. The flesh, juicy and sweet, can be white, pale green, yellow or red. The seeds, numerous, are elliptical, flat, smooth, 0.5 to 1.5 cm, yellow, brown, black or rarely white. Germination is epigeal, with rounded to oblong leaf-like cotyledons (Y.I. Pawendkisgou, 2021).

Study Methods

To achieve the objectives set out in this study, the methodology employed is based on three stages: the division and categorization of the study area, a document review, and data collection and processing.

Division and Categorization of the Study Area

The selection of the study areas was based on an in-depth document review and data from the Territorial Agricultural Development Agencies (ATDA). On this basis, watermelon-producing municipalities were divided into three categories: low-production municipalities ("tailing municipalities"), medium-production municipalities, and high-production municipalities ("leading municipalities"). To ensure balanced representation of the different production dynamics, a random sample was conducted, including the following municipalities:

• **Tailing municipalities**: Bonou, Covè, Za-Kpota, Zogbodomey ;

• **Medium-production municipalities**: Aguégués, Athiémè, Comè, Dangbo, Djidja, Dogbo, Lokossa, Tori-Bossito, Zè ;

• **Leading municipalities**: Abomey-Calavi, Adja-Ouèrè, Adjohoun.

The main selection criterion was the proven presence of active watermelon farms in these localities (ATDA, 2023).

Literature review

This step allowed for the collection, analysis, and synthesis of existing data on watermelon production in Benin, particularly on insect pests and diseases affecting the crop.

It provided an essential theoretical and empirical framework to guide the rest of the study (Yarou *et al*., 2017; FAO, 2020).

Data collection and processing

With the help of ATDA, a targeted survey was conducted in the thirteen identified municipalities to identify producers actually active in the watermelon sector. The data collected was structured by department, municipality, number of villages visited, and number of producers surveyed. This phase provided a reliable basis for subsequent analyses.

RESULTS AND DISCUSSION

The results reflecting the watermelon production targets and customer types are shown in Table 1. The primary production objective is sales, and the potential customers are consumers and wholesalers (Table 1). The graphical representation of the data in Table 1 is shown in Figure 1 opposite.

Table 1. Production Target and Customer Types.

Designation	Terms and conditions	Rate
Production target	Consumption	4.17
	Sales	95,83
	Consumers	100,00
Types of customers	Wholesalers	95,83
	Transformers	2,78

Source : Field surveys, March 2023.

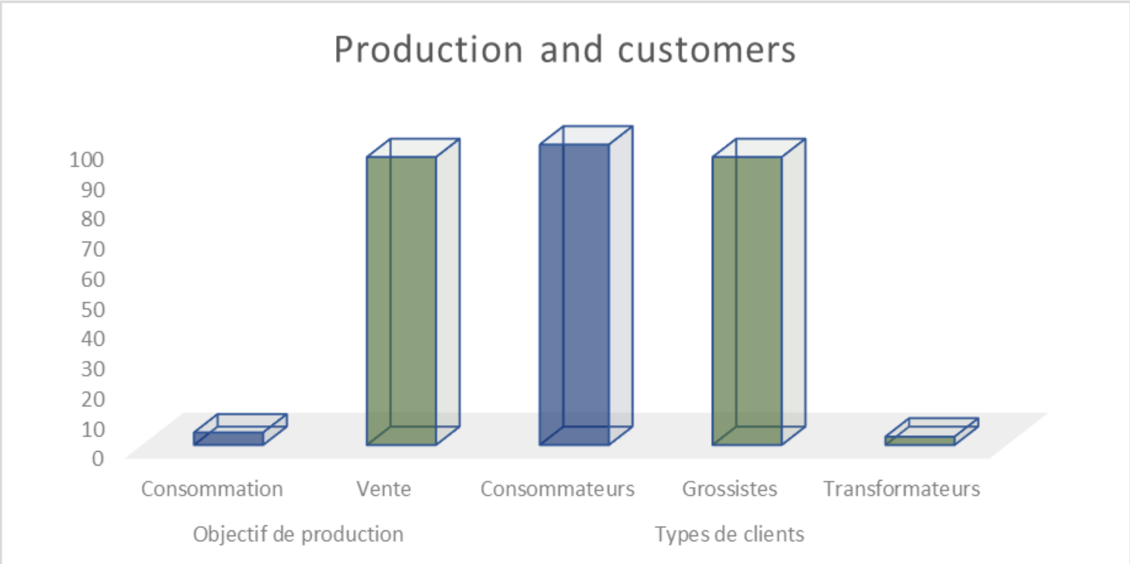


Figure 1. Production and Customer Graph.
Source. Field Surveys, March 2023.

The graph in Figure 1 from Table 1presents the production objectives and customer types received by watermelon producers in southern Benin. It should be noted that 95.93% of producers have a production objective for sale, compared to 4.17% for consumption. Regarding customer types, 100% of watermelon producers deliver part of their production to consumers, 95.83% to wholesalers, and 2.78% to processors. These results fully justify the availability of watermelon customers in the study area. Watermelon is susceptible to various fungal diseases such as downy mildew, leaf spot, and powdery mildew, as well as mosaic virus. The insect pests are thrips (Thrips spp.), mites (Tretranychus spp.), aphids (Aphisgossypii), fruit flies (Dacusciliatus), cucumber beetles (Diabrotica spp.), pumpkin leaf beetles (Aulacophara spp.), looper caterpillars, ladybugs (Epilachna), and leaf miners (Liriomysa spp.). The results relating to the distribution of watermelon pests and diseases in the thirteen municipalities receiving the surveys in southern Benin are presented in Table 2 below. Table 3 shows the presence of watermelon pests and/or diseases in the thirteen municipalities in southern Benin considered without exception. This represents a widespread, almost uniform distribution of watermelon pests and/or diseases. The survey conducted on the distribution of watermelon pests and diseases in southern Benin reveals that the pests that attack watermelon crops are flies, beetles, and root-knot nematodes, and the diseases that commonly affect them are downy mildew, leaf spot, anthracnose, fusarium wilt, and mosaic virus. Figure 2 opposite presents the schematic distribution of watermelon pests and diseases in the municipalities receiving the surveys.

Tableau 2. Distribution of watermelon pests and diseases in the thirteen affected communes of southern Benin.

Municipalities	Fly	Mildew	Coleoptera	Mosaic	Anthracnose	Nematodes	Fusarium wilt	Cladoporosis	Effective
Adjohoun	1	1	1	0	0	0	0	0	3
Allada	0	0	0	1	1	1	0	0	3
Comé	0	1	0	0	0	1	1	0	3
Covè	0	1	0	1	0	0	0	0	2
Dangbo	1	0	1	1	0	0	0	0	3
Dogbo	1	1	0	0	0	1	0	1	4
Grand-Popo	0	1	0	1	1	1	0	0	4
Kétou	1	1	1	1	0	0	0	0	4
Lokossa	1	1	0	1	0	1	0	0	4
Missrété	0	1	0	1	0	1	0	0	3
Ouidah	0	1	0	1	0	1	0	0	3
Tori-Bossito	1	1	0	0	1	1	0	0	4
Zakpota	1	1	0	1	0	0	0	0	3

Source : Field surveys, March 2023.

Note: The numbers 0 and 1 indicate the absence and presence of the watermelon pest or disease in the municipality, respectively**.**

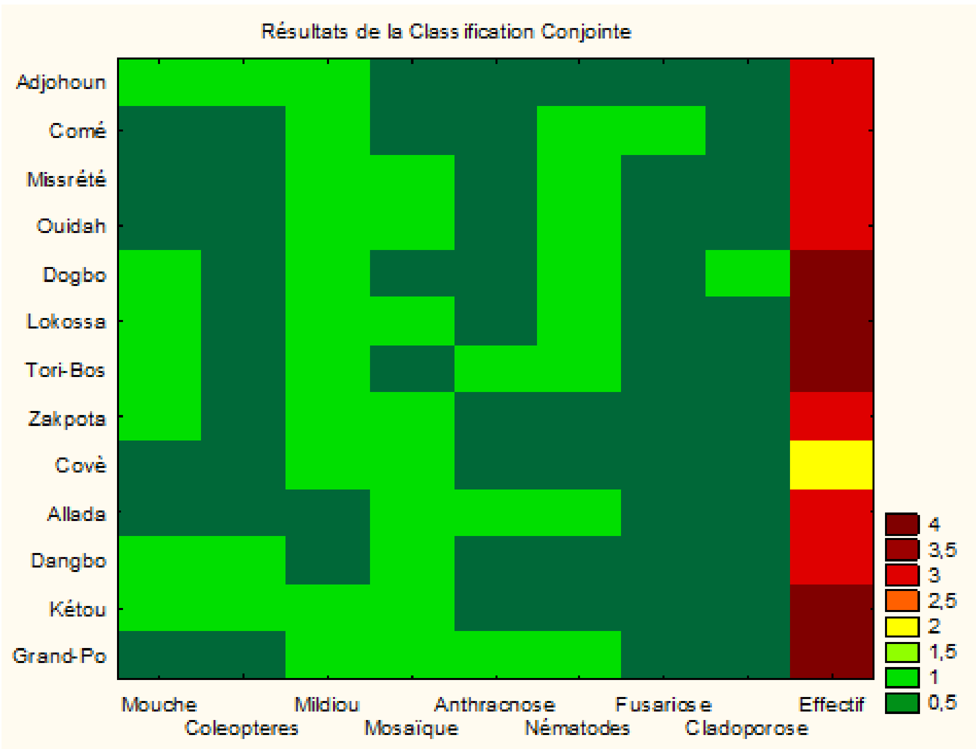


Figure 2. Distribution of watermelon pests and diseases across municipalities. **Source**: Field surveys, March 2023.

Classification, description of affected organs, and types of losses caused by watermelon pests and diseases. Tables 3 to 4 present the classification, description of affected organs, and types of losses caused by watermelon pests and diseases.

Table 3. Classification and description of defoliating beetles and some watermelon flies.

INSECTS					
Affected organs		**Types of losses**			
Leaves	**Fruits**	**Number of plants**	**Number of fruits per plant**	**Fruit size**	**Quality of ripe fruit**
Defoliating beetles: Chrysomelidae (Aulacophora africana, Monolepta spp., Acalymma vittata, Diabrotica undecimpunctata, Asbecesta cyanipennis, Asbecesta transversa, Podagrica spp.)					
Leaf perforation by adults. Larvae can also attack the stem at the collar and the roots.	Perforation of the skin due to feeding by adult beetles.	Death of young plants in the event of a strong attack			Decrease in market value, export impossible.
Fruit flies: Dacus vertebratus; Dacus ciliatus; Bactrocera cucurbitae; Bactrocera invadens; Bactrocera latifrons; Bactrocera zonata					
	Maggots thrive in fruitv		Sharp decrease if fruits are attacked at an early stage.	Fruit rot. Infested fruits lose all value..	

Source: Field surveys, March 2024

Table 4. Classification and description of whiteflies and some fungi.

INSECTS (continued)					
Affected organs		**Types of losses**			
Leaves	**Fruits**	**Number of plants**	**Number of fruits per plant**	**Fruit size**	**Quality of ripe fruit**
Whiteflies: *Bemisia tabaci*					
Adults and larvae feed on leaves.			Decrease, due to a reduction in photosynthesis following the development of sooty mold on the honeydew secreted by whiteflies.		Honeydew decreases the market value of fruits, due to the reduction in aesthetic value.
MUSHROOMS					
Fusarium wilt: Fusarium oxysporum, Fusarium sp. ; Fusarium niveum					
The mycelium grows in the stem		Death of young plants due to rot or death of older plants due to successive wilting.			If the fruit is already formed, it stops growing and loses all commercial value.

Source: Field surveys, March 2024

Tableau 5. Classification and description of some watermelon fungi.

MUSHROOMS (continued)					
Affected organs		**Types of losses**			
Leaves	**Fruits**	**Number of plants**	**Number of fruits per plant**	**Fruit size**	**Quality of ripe fruit**
Anthracnose: Collectotrichum orbiculare; Collectotrichum lagenarium					
Mycelium development on the stem, leaves and fruits.					Even if the infection does not reach the flesh, secondary rot can develop and cause significant damage. Infected fruits lose all commercial value.
Downy mildew: Pseudoperonospora cubensis					
Development on the leaves.			Premature death of plants in case of heavy infection.	Decrease due to leaf loss.	The fruits are rarely directly affected, but may remain small and tasteless. Such fruits cannot be exported.
Cladosporiose : *Cladosporium cucumerinum*					
Development on leaves, leaf petioles, stems and fruits.					Les fruits comportant des cavités perdent toute valeur commerciale.

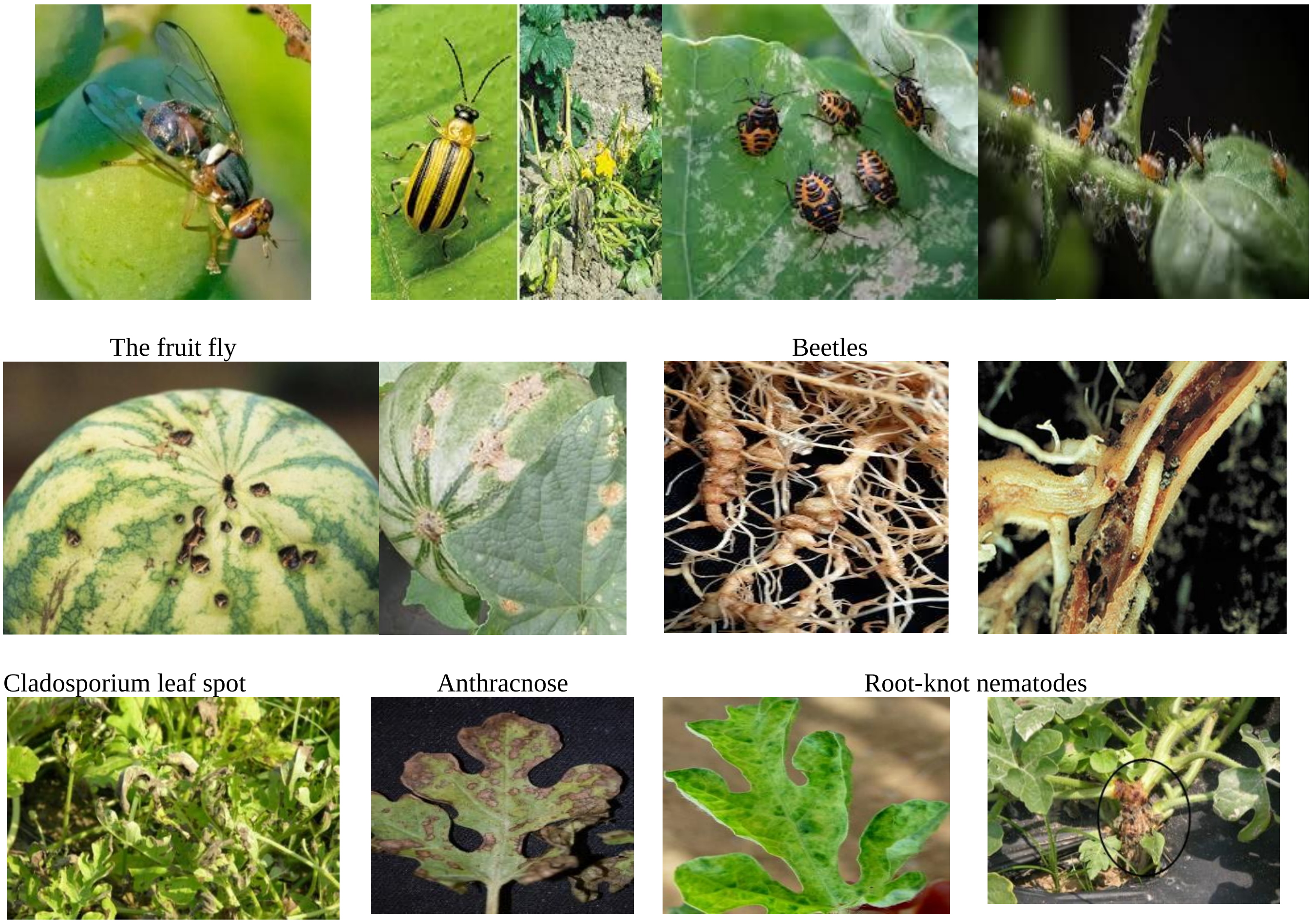
Source: Field surveys, March 2024.

Tableau 6. Classification and description of watermelon viruses.

VIRUS				
Affected organs		**Types of losses**		
Plante entière	**Number of plants**	**Number of fruits per plant**	**Fruit size**	**Quality of ripe fruit**
Watermelon mosaic virus: (Potyviridae: Potyvus)				
Viruses are transmitted from plant to plant by aphids (e.g. Aphis gossypii; Myzus persicae etc.). Aphids are infected with the virus present in an infected plant and then transmit it to a healthy plant through their bites. They can transmit the virus after feeding for 9 seconds. These viruses are not carried by seeds.				
Once transmitted, the virus spreads throughout the plant		Significantly reduced growth if plants are attacked during the early stages before flowering.		Diseased fruits cannot be exported or traded upstream in local urban markets
NEMATODES				
Root-knot nematodes: Meloidogyne spp.				
The presence of **Meloidogyne** promotes and aggravates infection by soil-borne fungi such as Fusarium spp. Infected plants are very sensitive to drought and irregular irrigation.				
Infested roots develop galls and rot if conditions are humid.	If plants are heavily attacked during the early stages, they may die.	Significant decrease if plants are heavily attacked during early stages.		

Source : Enquêtes de terrains, Mars 2024.

The analysis of Tables 3 to 6 shows, on the one hand, that among the plant organs of watermelon plants, the most vulnerable and frequently attacked are the leaves, followed by the fruits, the floral organs, and sometimes the entire plant. The consequences caused by watermelon pests and/or diseases include yield reduction, post-harvest losses, a decrease in the market value of harvested watermelons, a deterioration in the nutritional and medicinal quality of harvested products, disruptions to the growth cycles of production, and the inability to sell on local or export markets. The areas planted and yields obtained over the past five (05) years by the responding watermelon producers are shown in Table 7. The fight against watermelon pests and diseases in southern Benin is based primarily on the use of chemicals. These pesticides are mostly purchased on the market. Commonly used chemicals are presented in Table 9. Regarding the fertilizers used by watermelon producers in southern Benin, most use chemical fertilizers. It should be noted that poultry droppings are specifically used by some producers in Fonsa, in the commune of Ouidah, in addition to other fertilizers.



The fruit fly Beetles

Cladosporium leaf spot Anthracnose Root-knot nematodes

Mildew Bacteriosis Mosaic virus Gummy canker

Photo 1. Some watermelon pests and diseases.

Source: Field surveys, March 2024

Table 7. Areas and Yields Obtained Over the Past Five Years.

Year	Area (m^2)	Yield (fruits)
2018	83270	35123
2019	107170	45322
2020	127220	53477
2021	159220	68066
2022	155500	65117

Source : Field surveys, March 2024

The analysis of Table 7 shows an increase in sown areas from 83,270 to 159,220 m2 between 2018 and 2021, reflecting a continued increase in yields, rising from 35,123 to 68,066 m2 over the same period before falling slightly in 2022. Table 8 presents the average, minimum, maximum and standard deviation of sown areas and yields obtained over the last five years.

Table 8. Average sown area and average yield obtained over the last five years.

Designation	Average	Minimum	Maximum	Standard deviation
Sup18	1205,846	0,0000	4362,50	1328,004
Sup19	1522,702	0,0000	5975,00	1672,662

Sup20	1711,263	50,0000	6125,00	1412,301
Sup21	2226,187	666,6667	10000,00	2027,325
Sup22	2121,869	700,0000	5000,00	1240,645
Rend18	503,784	0,0000	1999,00	569,245
Rend19	634,518	0,0000	2683,75	709,176
Rend20	714,191	21,0000	2762,50	621,534
Rend21	935,652	273,3333	4000,00	828,110
Rend22	1008,405	209,0000	4600,00	961,642

Source : Field surveys, March 2024

Table 8 shows an increasing trend from 2018 to 2022 in all the parameters indicated, namely means, minimums, maximums, and standard deviations. The average trend in watermelon production in southern Benin over the past five years is shown in Figure 3.

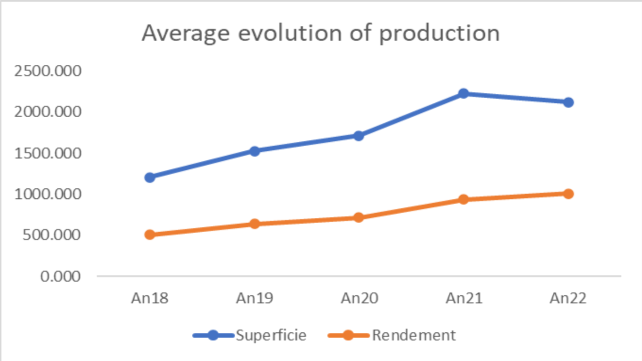


Figure 3. Average evolution of production.

Source : Field surveys, March 2024

Table 9. Commonly used chemicals against watermelon pests and diseases in southern Benin.

Designation	Chemical fertilizer	Organic fertilizer	Chemical control	Biological control	Integrated control
Proportion(%)	99.986	0.014	100	00	00
Elements used	NPK, UREE, K2SO4, SUPER GROS	Les fientes	Pacha 25Ec, Acarius 018Ec, Emacot 019Ec, Kaobtimal, Lambda	-	-

Source : Field surveys, March 2024

Chemical fertilizers (NPK; UREA: K2SO4; SUPER GROS) and chemical control (Pacha 25Ec; Acarius 018Ec; Emacot 019Ec; Kaobtimal; Lambda) are widely used in proportions of 99.99% and 100%, respectively, while organic fertilizers made from droppings are used very sparingly, at 0.014%.

The survey allowed us to gather watermelon producers' impressions of the impacts of chemicals used to control watermelon pests and diseases on the environment and the fruit produced. The responses obtained are presented in Table 10 and the graph below**.**

Table 10. Effects of the use of plant protection products on the environment.

Consequence	Rate (%)
Depletion of production land	1,389
Groundwater pollution	2,778
None	95,833

Source : Field surveys, March 2024.

The consequences of the use of phytosanitary products on the environment are extremely widely declared without major negative impacts at 95.833% (Table XV). The graph in Figure 4 is the schematic representation of Table 10.

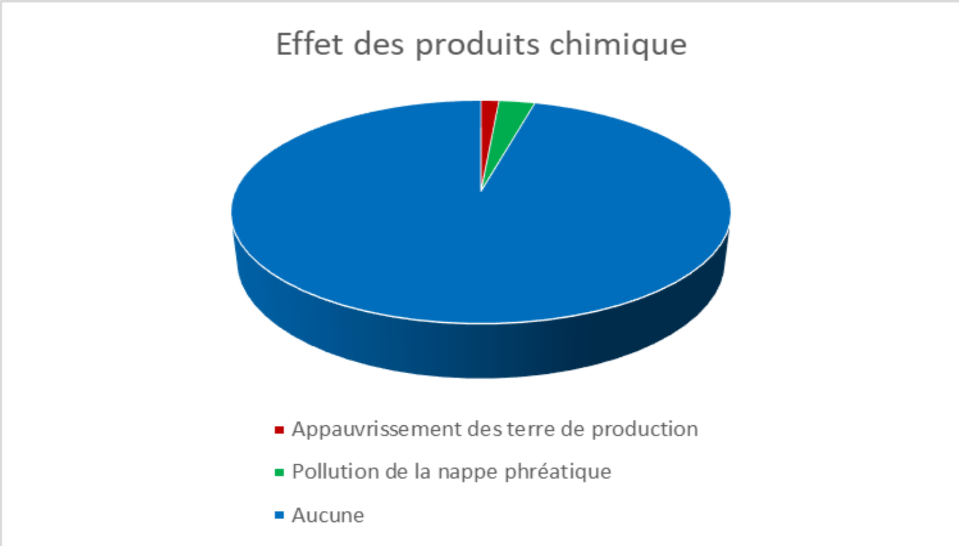


Figure 4. Effect of Chemicals Used on the Environment.

Source. Field Surveys, March 2024

Graph 5 above describes the effect of chemicals according to watermelon producers. It shows that 1.389% of watermelon producers acknowledged that the pesticides used contribute to the depletion of production land, 2.778% stated that these chemicals pollute the water table and according to the remaining 95.833%, these chemicals used have no impact on the environment and watermelon fruits. The control of watermelon pests and diseases in southern Benin is based primarily on the use of chemicals. However, limiting pest populations can be achieved through natural biological control using beneficial insects: this is the case for thrips, whiteflies, leaf miners, aphids, etc. No mass release of beneficial insects is carried out for technical and economic reasons. Only introductory releases of new species can be considered. Sometimes, for other pests, biological control is still insufficient (few or no beneficial insects reach them), and it is necessary to treat them specifically and preventively according to a schedule: this is the case for cucurbit moth caterpillars. It is necessary to support this biological control with specific chemical treatments when beneficial insects are insufficient in number, for example, against leaf miners or aphids. In this case, curative treatments are used with products that preserve beneficial insects. Finally, it is important to note that new pests and diseases appear regularly. Therefore, the use of an effective control method must be considered. In a comparative approach, these results show that chemical control remains the primary method used by watermelon producers in southern Benin to deal with pests and diseases. This observation is largely confirmed by James *et al.* (2010), who emphasize that in tropical market gardening systems, the intensive use of insecticides remains a direct response to the economic losses caused by pests, despite the deleterious effects on biodiversity and health. However, more sustainable alternatives exist. In this regard, Van Lenteren (2000) points out that biological control, particularly through the conservation or increase of natural beneficial insects, constitutes an ecologically viable solution. Several beneficial insects are known to effectively control populations of thrips, whiteflies, leafminers, and aphids (Hassan, 1993; Bale *et al.*, 2008). In Benin, the lack of mass releases of beneficials is often due to technical and economic constraints, which limits the effectiveness of this method on a large scale (Kéita *et al.*, 2017).

Furthermore, some pests, such as cucurbit moth caterpillars (Diaphania spp.), remain relatively unresponsive to locally available beneficials, necessitating the use of specific chemical treatments. In this vein, the work of Kogan (1998) and Ehler (2006) argues that, in an integrated pest management approach, chemical treatments can be compatible with the protection of natural enemies, provided they are selective and applied in a targeted manner. It is also crucial to note the regular emergence of new pests linked to factors of mutation and climate change, and the globalization of trade, without ignoring the evolution of agricultural practices. In their research, Altieri and Nicholls (2003) emphasize that the resilience of agroecosystems depends in part on their ability to integrate different control methods (biological, cultural, mechanical, and rational chemical). The watermelon pest control strategy in southern Benin must evolve toward an integrated approach, combining technical effectiveness, reasonable costs, and environmental protection.

Integrated pest management offers an alternative to traditional chemical control by keeping pest populations low, preventing them from causing economic damage. (Ryckewaert, 1998). It also applies to disease control. Thus, controlling fungal diseases in watermelon is based on the application of preventive and cultural measures such as: Use of healthy seeds and the use of disease-free plant material; Proper management of factors influencing greenhouse climatic conditions, namely irrigation; Avoiding the presence of free water on the crop; Rationalizing fertilization and limiting excessive nitrogen inputs; The plot must be well-drained to avoid water stagnation and excess humidity; 6- Implementing crop rotations. Removing and destroying plant debris and anything left over from pruning the crop. Furthermore, it is essential to follow certain rules regarding chemical treatments: Wetting, i.e., the amount of water used per unit area, must be sufficient: from approximately 400 liters per hectare for a young plantation to 1,200 liters per hectare for a high-yield crop (e.g., tomatoes); for a sprayer, the wetting rate must be halved. Comply with the prescribed doses (i.e., the amount of product per 10 liters of water, for example). Remember to double the dose when using a sprayer because the wetting rate is halved (the amount of product per area, however, always remains the same). Too high a dose risks causing phytotoxicity. • Products should be alternated whenever possible to avoid habituation or resistance among insects and diseases. Products from different chemical families should be chosen. Respect the pre-harvest application intervals for each crop, otherwise there is a risk of residues in the parts consumed (Ryckewaert, 1998). It should be noted that when using integrated pest management, other benefits are also obtained, such as improved air, water, soil, and plant and animal quality in cultivated and non-cultivated environments. The comparative study of watermelon pest management approaches in southern Benin highlights the growing importance of integrated pest management as a sustainable alternative to conventional chemical control. The latter, although still largely dominant among producers, has limitations from both environmental and health perspectives. According to Ryckewaert (1998), integrated pest management aims to maintain pest populations below the threshold of economic harm through a combination of preventive, cultural, biological and, as a last resort, chemical practices.

One of the main advantages of integrated pest management lies in its ability to reduce dependence on pesticides, the excessive use of which is often observed in horticultural production systems in West Africa (James *et al.*, 2010). This systematic use, without strict adherence to doses, safety intervals, or active ingredient rotation principles, creates risks of phytotoxicity, pest resistance, and harmful residues on fruits, as Ryckewaert also points out. In terms of fungal disease management, the integrated approach is essentially based on prevention, through the adoption of good agricultural practices: use of healthy seeds, humidity control (through rational irrigation and drainage), crop rotation, and removal of plant debris, among others. These measures are widely recommended in the work of Elad and Pertot (2014), who demonstrate that prophylaxis is often more effective and less costly than curative treatments, particularly in tropical environments where conditions favor the development of pathogenic fungi. Furthermore, the rational application of plant protection products as part of integrated pest management involves strict adherence to application procedures, particularly with regard to wetting, dosage, and alternating chemical families, in order to limit the resistance of pests and pathogens. This principle is supported by Kogan's (1998) recommendations on the importance of preserving beneficials and reducing environmental impacts. Another fundamental aspect of integrated pest management is its positive impact on the environment. By reducing chemical inputs, it promotes better soil, water, and air quality, while preserving biodiversity, particularly the natural enemies of pests. This agroecological approach is in line with the principles defended by Altieri and Nicholls (2003) who emphasize the increased resilience of diversified and ecologically managed crop systems.

CONCLUSION

This research is part of the characterization of watermelon (*Citrullus lanatus*) insect pests and diseases and the various control methods used in southern Benin. The study covered the municipalities of Missérété, Covè, Za-kpota, Comè, Dangbo, Dogbo, Lokossa, Tori-Bossito, Allada, Adjohoun, Kétou, Granp-Popo, and Ouidah. It made it possible to identify watermelon pests and diseases in southern Benin. These include: flies, beetles, root-knot nematodes, downy mildew, leaf spot, anthracnose, fusarium wilt, and mosaic viruses. Indeed, the fight against watermelon (*Citrullus lanatus*) pests and diseases in southern Benin is based primarily on the use of chemical products such as Pacha 25EC, Acarius 018EC, Emacot019EC, Kaobtimal, Lambda, etc. However, some particularly harmful pests or diseases, such as root-knot nematodes (Meloidogyne sp.), fusarium wilt (Oxysporum sp., Oxysporum niveum), and bacterial fruit spot (*Acidovorax avenaesub*, *Acidovorax sp.*, *Acidovorax citrulli*), can be avoided through long crop rotation, good drainage, and the use of tolerant or resistant cultivars. Similarly, polyethylene mulch, especially when coated with a layer of reflective aluminum paint, repels thrips and aphids. We suggest that officials from the Ministry of Agriculture, Livestock, and Fisheries (MAEP), particularly those from the Territorial Agency for Agricultural Development (ATDA), educate watermelon producers through Field Schools (FS) on integrated pest management, which is an alternative to conventional chemical control and also helps keep pest populations low, preventing them from causing economic damage.

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CONFLICT OF INTERESTS

The authors declare no conflict of interest

ETHICS APPROVAL

Not applicable

AI TOOL DECLARATION

The authors declares that no AI and related tools are used to write the scientific content of this manuscript.

DATA AVAILABILITY

Data will be available on request

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