Journal Homepage: -www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI:10.21474/IJAR01/19428
DOI URL: http://dx.doi.org/10.21474/IJAR01/19428

ISSN NO. 2320-5407

RESEARCH ARTICLE

INVENTORY OF PHYTOSANITARY CONSTRAINTS AND CHEMICAL PRODUCTS ENCOUNTERED IN PAPAYA CULTIVATION IN THE NIAYES AREA (SENEGAL)

Awa Marie Coll Cissé[1,3], Papa Madiallacké Diedhiou[2], Cheikh Dieye[4] and Ibrahima Diedhiou[3]

1. Iba Der Thiam University (UIDT) BP: A967, Doctoral School Sustainable Development and Society (ED2DS) Thies, Senegal.
2. Gaston Berger University (UGB) BP 234, UFR of Agronomic Sciences, Aquaculture and Food Technologies (UFR S2ATA) Ngallele Road Saint-Louis, Senegal.
3. National Higher School of Agriculture (ENSA) BP 296 Km 7, Khombole Road Thies, Senegal.
4. Cheikh Anta Diop University of Dakar (UCAD), Department of Plant Biology, BP 5005 Dakar Fann, Senegal.

Manuscript Info

Manuscript History
Received: 05 July 2024
Final Accepted: 09 August 2024
Published: September 2024

Key words:-
Carica Papaya, Niayes, Phytosanitary Constraints, Pesticides, Active Ingredient, Carbofuran

Abstract

Fruit growing faces several obstacles. Phytosanitary constraints are at the top of the list. Papaya growing in the Niayes area is no exception to the rule. This study aims to draw up an inventory of the phytosanitary constraints affecting papaya and the products used for chemical control of this crop in the Niayes area. Fifty (50) farms were visited, and a list was drawn up of the pests encountered, namely insects, arachnids, nematodes, diseases, and the active ingredients most commonly used. The survey showed that mealybugs were the most common insect pests and that red spider mites were the most common arachnid pests. Fungal and viral diseases were predominant, with trunk/collar rot and papaya ringspot virus. Thirty (30) active ingredients were listed for phytosanitary treatments. A total of forty-seven (47) synthetic pesticides were found. Of these, only fifteen (15) appeared on the list of products approved by the Sahelian Pesticides Committee. Carbofuran, which is a prohibited active ingredient, was used by 28% of the growers we met. Mancozeb, Thiofanate methyl, and Zineb, which are among the most widely used fungicides, have been banned in Europe.To our knowledge, this is the first article to deal with the issue in Senegal.

Introduction:-

Senegal is divided into several agroecological zones. One of these is the Niayes zone, which is of major importance as a niche for the country's horticultural production. This makes it important both economically and in terms of food security. Agriculture has always been a pillar of local development. Urban agriculture is an alternative to the poor performance of rural production systems and responds by improving food security for city dwellers. The Niayes area accounts for almost 80% of national horticultural production (Fall and Fall, 2001; Cissé and*al*., 2003; Ngom and*al*., 2012).

Among the many species grown here is papaya, one of the main tropical fruits. It is being studied more and more because of its growing interest, the small size of its genome, which was sequenced recently, its relatively short life

Corresponding Author:-Awa Marie Coll Cissé
Address:-Iba Der Thiam University (UIDT) BP: A967, Doctoral School Sustainable Development and Society (ED2DS) Thies, Senegal.

cycle compared with other tropical fruits, and its nutritional value (Yu and*al*., 2009; Krishnan and*al*., 2012; Ming and*al*., 2012; Jiménez and*al*. 2014). Papaya has culinary, medical, and industrial uses (Pantoja and*al*., 2002; Ming and*al*., 2012; Palei and Rout, 2018).

It is a fast-growing crop, but it is not immune to the various constraints that plague the agricultural sector. Phytosanitary constraints are among the most important, in addition to water management, high investment costs, seed quality, and soil type. These include the various biotic problems encountered by growers, such as insects, mites, nematodes, and fungal, viral, or bacterial diseases. Diseases remain a significant limiting factor to papaya productivity and marketing (Hine and*al*., 1965; Ventura and*al*., 2004).

Various control methods are used to limit losses, based on synthetic pesticides or biopesticides. The use of these products requires several precautions to be taken, which are not always respected by growers. As a result, there is a risk of pollution or contamination. Their impact on the environment and the quality of harvested produce is often underestimated. Given the diversity of both the constraints and the chemicals used, it is necessary to list them.

This study aims to draw up an inventory of the phytosanitary constraints linked to papaya production in the Niayes area and to identify the different active ingredients used during phytosanitary treatments.

Materials and Methods:-

Study site:

The surveys were carried out on papaya-producing farms located in the Niayes area, which comprises four (4) administrative regions of Senegal (Dakar, Thies, Louga, and Saint-Louis) and forms the main coast (Fall and*al*. ,2001; Ngom and*al*., 2012).

The farms visited are located in the communes of Fandene, Darou Khoudoss, Keur Moussa, Tivaouane Peulh Niaga, Bambilor, Notto Gouy Diama, Notto Diobass, Diender Guedj (**Fig 1**).

Fig1:-Location of sampling sites.

Canvassing and survey:
The snowball method was used for this study. Fifty (50) orchards were visited. The data were obtained after observations and analysis of the results of the surveys, which focused mainly on insects, arachnids, fungal, viral, and bacterial diseases, nematodes, and the plant protection products used.

During the interviews, the interviewees were shown photos to make it easier to answer their questions.

Data analysis:
The data were recorded using an Excel spreadsheet.

Results:-

Symptomology:
The symptoms observed during the survey are recorded below (**Table 1**).

Table 1:- Symptoms observed in the orchards visited.

Description	**Illustration**	**Pest / Disease**
Nodules on the roots		Nematodes
Black soot covering the fruit and accompanied by the presence of a slightly sticky substance		Fumaginia / mealybugs
Deformation of leaf blades		Tarsonema

Drying out of leaves, which also lose their green colour		Red spider mite
Lower trunk rot and weakening leading to plant fall		Trunk / collar rot (*Pythiumsp.*;*Phytophthorasp.*)
Slightly depressive blackish spots on fruit		Anthracnose (*Colletotrichum sp.*)
Plants that lose most of their foliage and die back		Bacteriosis
Ring-shaped spots on fruit		Papaya Ringspot Virus

No symptoms		Fruit fly

In addition to the pests and diseases listed in this table, other pests and diseases were reported by growers. These include downy mildew, powdery mildew, whitefly, termites and caterpillars.

Appearance of bio-aggressors depending on the farms visited :
In the fifty (50) farms visited, the insect species encountered were: whitefly, fruit fly, termites, caterpillars and mealybugs. The latter are the most common. Mealybugs were found on twenty-four (24) of the farms visited, whiteflies were found on twenty (20) of the farms.Fruit flies, termites, and caterpillars were found on twelve (12) of the farms for the first two and one (1) farm for caterpillars.

As far as arachnids are concerned, the tarsonema and the red spider were found in the orchards. The red spider was found on thirty-six (36) farms. Tarsonema was less common, with twelve (12) farms affected.

Nematodes were found on thirty-five (35) farms.

Figure 2Shows the number of farms where each bio-aggressor was encountered.

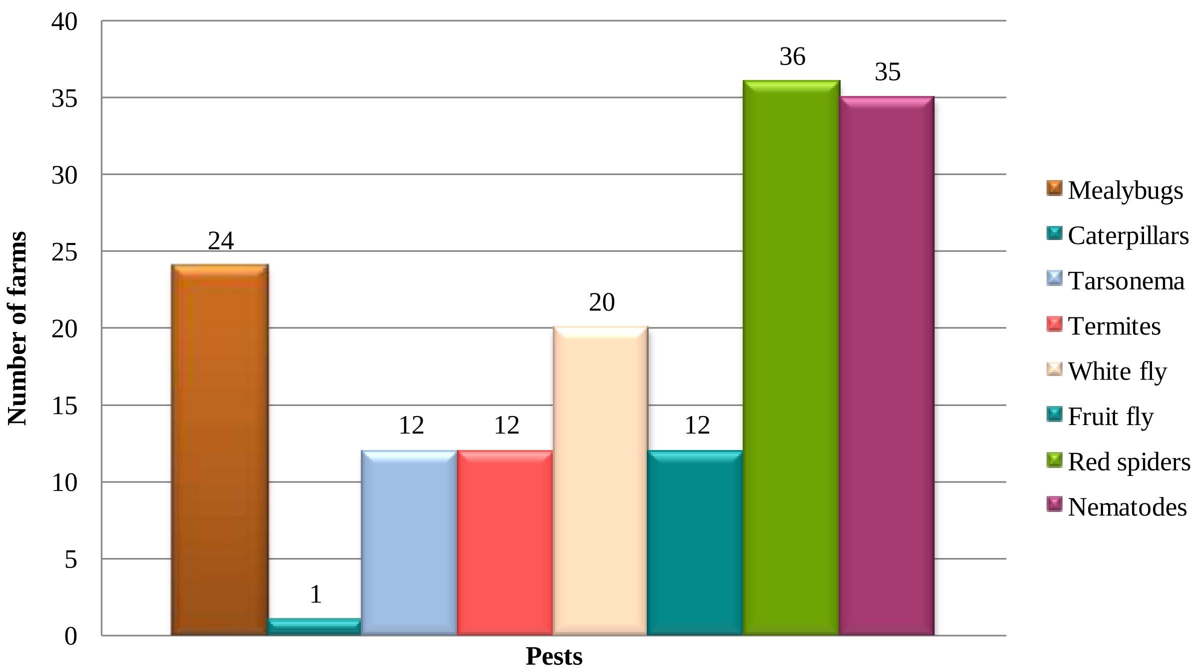

Fig 2:- Appearance of pests on different farms.

Appearance of diseases on the farms visited:
On the fifty (50) farms visited, the diseases encountered were fungal, bacterial or viral.They were: downy mildew, trunk/collar rot, anthracnose, fumaginia, powdery mildew, papaya bacterial blight, and papaya ringspot virus. Fungal and viral diseases were the most common, with trunk and collar rot and papaya ringspot virus found on forty (40) and twenty-nine (29) farms respectively. Figure 3 shows the number of farms for each disease.

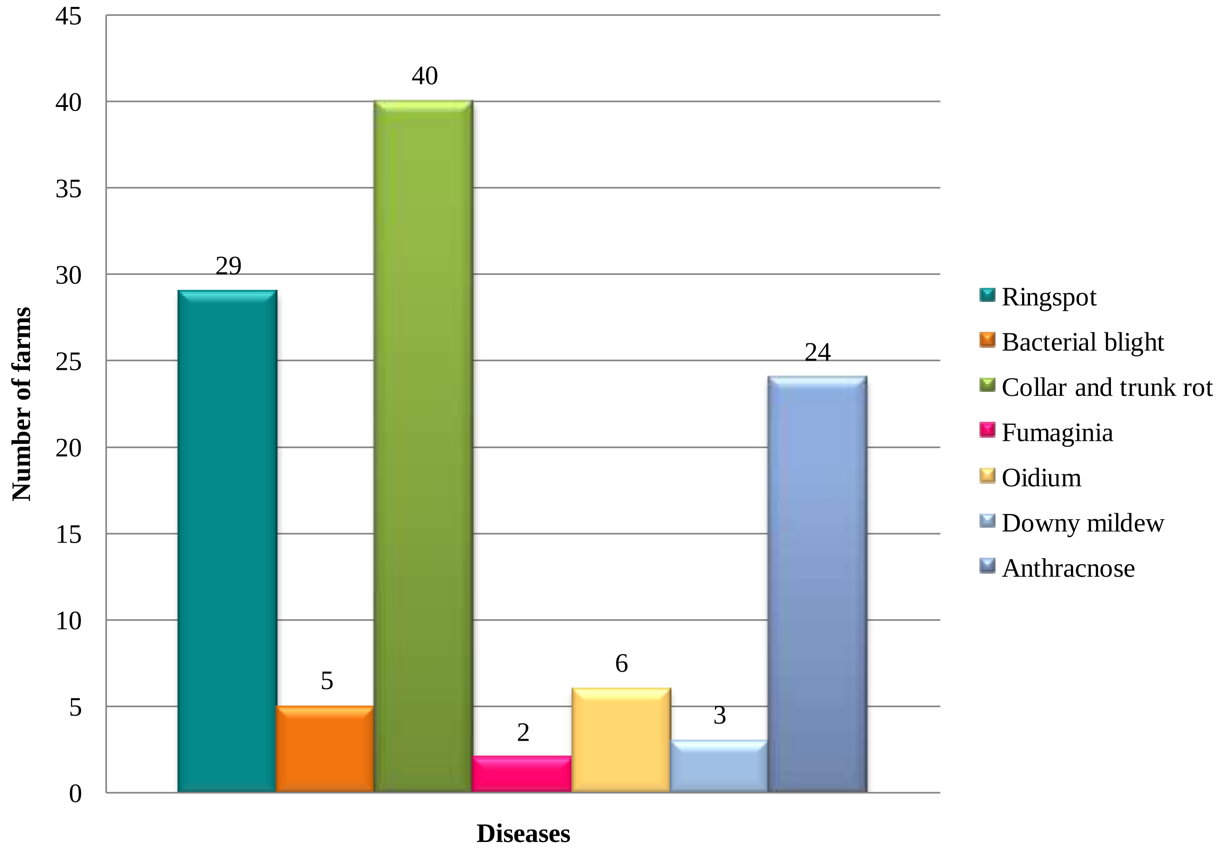

Fig 3:- Appearance of diseases on different farms.

Trunk/collar rot is cited by growers as the most common disease encountered during cultivation, followed by papaya ringspot virus.

Phytosanitary treatment:
A very wide range of pesticides is used by growers. A list of forty-seven (47) chemical products has been drawn up. Of these, only fifteen (15) appear on the list of pesticides approved by the Sahelian Committee of Pesticides (SCP). Table 1 lists the chemicals encountered based on their trade names. MOCAP is the most widely used product.

Table 1:- Synthetic pesticides used on the farms visited.

Trade names	Firm holding the authorization	Number of farms
1. ABALONE	Arista Lifescience	2
2. ABAMECTINE*		1
3. ABEMEC*		2
4. ACARIUS	Savana	4
5. ALLIETTE*		1
6. ARMADA*		1
7. ARSENAL*		11
8. BENJI	Savana	1
9. BOMEC	Solevo Suisse SA	5
10. BULDOZERE*		1
11. CALLIFAN	Arista Lifescience	2
12. CLORSBAN	Agropharm	4
13. CONFIDOR*		4
14. DECIS	Bayer West Central Africa SA	2

15. DICOFOL*		8
16. DIMETHOATE*		7
17. DIMETO	Agropharm	1
18. DOUBLE ATTACK*		1
19. DRAGON*		1
20. ENDOSULFAN*		1
21. FONGIMAX*		7
22. FURADAN*		14
23. IDEFIX	Savana	3
24. IMAMEX*		5
25. K OPTIMAL	Solevo Suisse SA	12
26. LANNATE*		2
27. MANCOZEBE*		8
28. MANGA +*		3
29. METHOX*		4
30. MOCAP*		19
31. NEMA B2	Savana	2
32. NEMATOX*		4
33. PACHA	Savana	2
34. PIRIMOR*		1
35. PROMOCARB*		4
36. PYRICAL	Arista Lifescience	2
37. SOUFRE*		6
38. SOUFRE 800*		1
39. SOUFRE MICRONISE*		2
40. SULFUS 80*		3
41. SUPER ABAM	Agropharm	1
42. SUPER DRAGON*		1
43. SUPER MANCO*		1
44. TERPRID*		1
45. THIOMEX*		9
46. VELUM	Bayer West Central Africa SA	3
47. VYDATE*		2

N.B.: in black: pesticides registered by the Sahelian Pesticides Committee; *: pesticides not registered by the Sahelian Committee of Pesticides(CSP, 2023).

Thirty (30) active ingredients and combinations of active ingredients were listed. Table 2 lists the various active ingredients and combinations of active ingredients encountered.

Table 2:- Active ingredients and combinations of active ingredients found on papaya farms.

1. Abamectin	17
2. Acetamiprid	1
3. Acetamiprid + lambda-cyhalothrin	14
4. Acetamiprid, bifenthrin	2
5. Carbofuran*	14
6. Chlorothalonil + pyrimenthanil	1
7. Chlorpyrifos ethyl	6
8. Cypermethrin	1
9. Deltaméthrin	2
10. Dicofol	8
11. Dimethoate	8
12. Emamectine benzoate	6
13. Ethoprophos	19
14. Fluopyram	3

15. Fosetyl al	1
16. Copper hydroxide	3
17. Imidacloprid	4
18. Mancozeb*	12
19. Methomyl	6
20. Oxamyl	6
21. Profenofos	11
22. Profenofos + cypermethrin	1
23. Propamocarb	4
24. Pyrimicarb	1
25. Sulfur	12
26. Thiamethoxam + lambda cyhalothrin	1
27. Thiofanate methyl	9
28. Trifloxystrobin + triadimefon	1
29. Zineb*, copper oxychloride, thiofanate methyl*	7
30. Endosulfan	1

N.B.: in black: authorized active ingredients; *: prohibited active ingredients.

Several prohibited active ingredients were found in the fields, including Carbofuran, which is found in FURADAN and is still used by fourteen (14) of the growers, i.e. 28% of the sample, and Mancozeb, Thiofanate methyl, and Zineb, which are banned in the European Union.

By pesticide group, we found: nineteen (19) insecticides, nine (9) fungicides, six (6) acaricides, five (5) nematicides, and one (1) bactericide. Some active ingredients combine several functions (**Fig 4**).

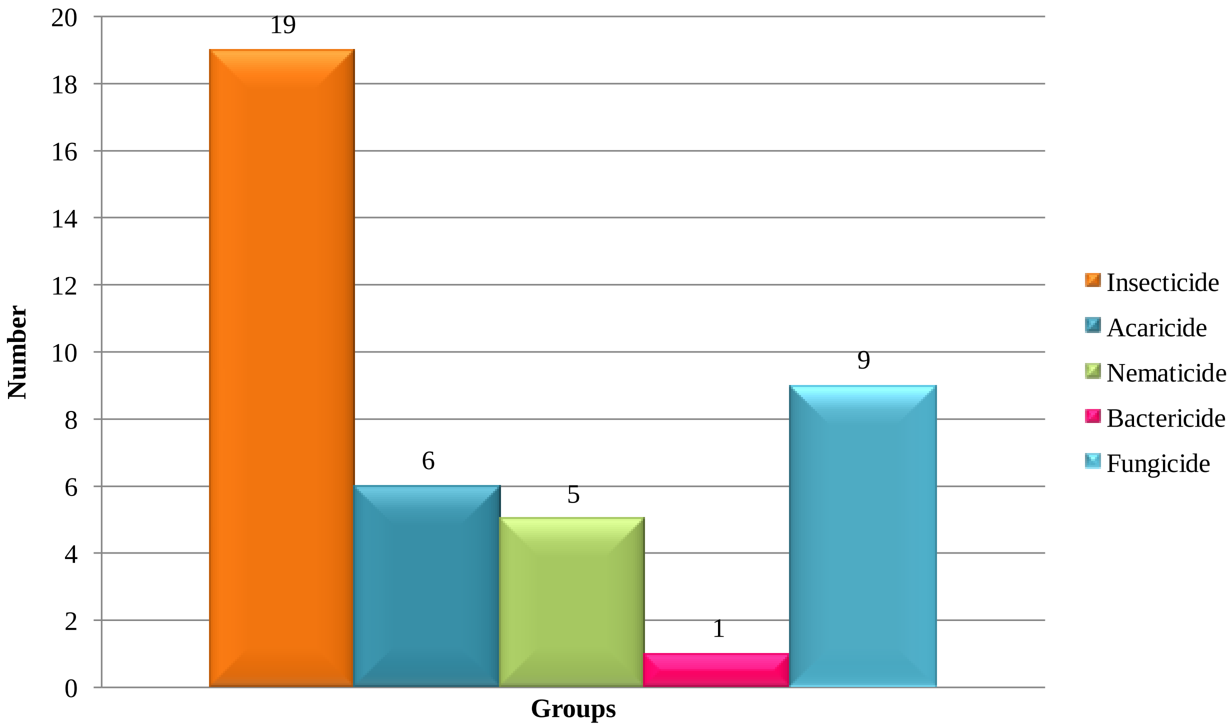

Fig 4:- Distribution of pesticides by group.

Ethoprophos is the most commonly used active ingredient for nematicides, while Mancozeb, Sulfur, and Thiofanate methyl are the most commonly used active ingredients for fungicides. For insecticides and acaricides, Abamectin is the most common active ingredient. For bactericides, Copper hydroxide is the most commonly used active ingredient.

Few growers use biopesticides, of which there are six (6) out of fifty (50). Those found in the field are neem cake, neem oil, black soap, soap combined with oil, MYCO'SOL, and MYCICLEAN, which are based on microorganisms.

It was difficult to obtain answers on doses. A systematic treatment was noted on the majority of farms, with a frequency varying from one week to ten (10) days. This is an insecticide- and fungicide-based treatment. Nematicides and other fungicides against soil-borne diseases are applied at the time of planting.

The management of waste from phytosanitary products also poses a problem. Empty or opened/pirated bottles and sachets are piled up on some of the farms visited (**Fig 5**).

Fig 5 :- Waste from plant protection products.

Growing constraints:

The main constraints cited by growers are water control, diseases, particularly fungal diseases, red spider mites, especially in dry periods or when there is a lack of water, the high cost of investment, and the need for maintenance compared with other tree species, the quality of the seeds used by nurserymen and the type of soil. Phytosanitary constraints, in this case, diseases, were the most important. They were mentioned by twenty-five (25) growers, i.e. 50%. Figure 6 shows the various constraints linked to papaya growing according to the growers surveyed.

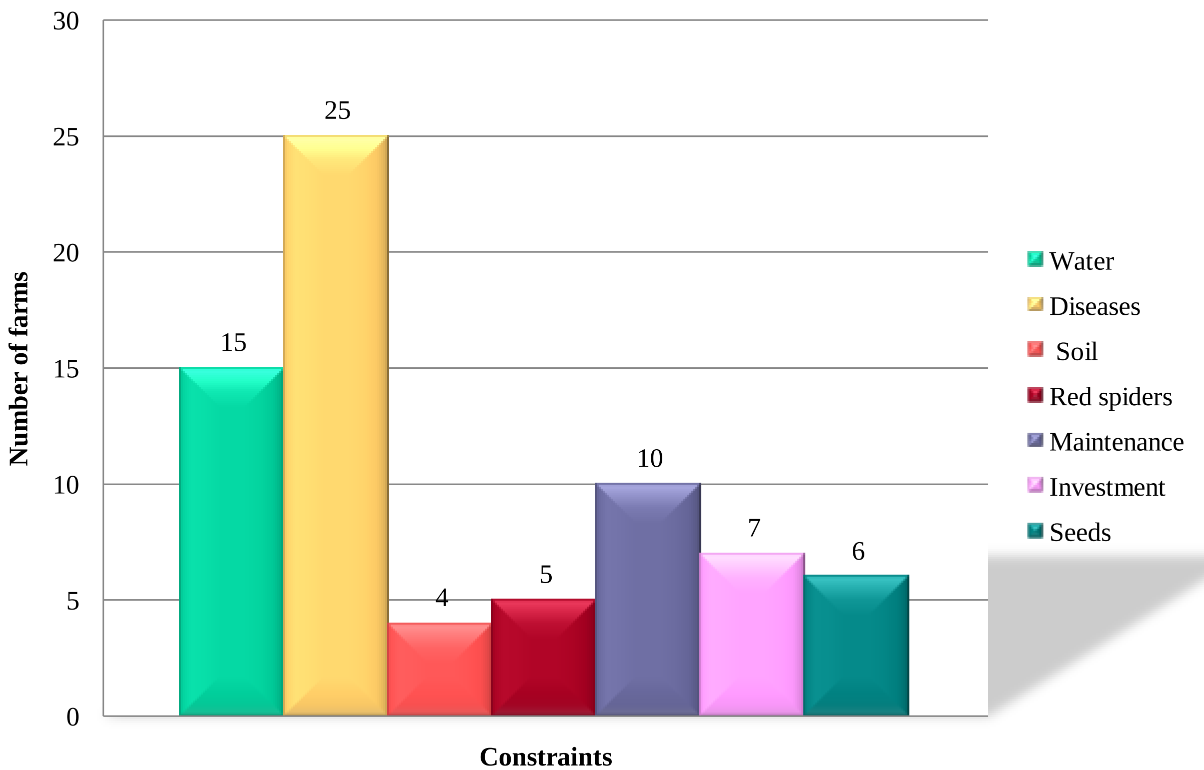

Fig 6:- Main constraints during cultivation.

Discussion:-

The results of the survey show that phytosanitary constraints predominate among those hindering papaya cultivation. This confirms the work of Porter and*al*., 2014 and Office of the Gene Technology Regulator, 2008,which highlights the fragility of the *Carica papaya* species due to the size of its genome and the low genetic diversity of the *Carica* genus.

The presence of nematodes is especially noted on soils dominated by sand. This justifies the heavy use of MOCAP compared with other products, as soils in the Niayes are predominantly sandy. Red spider mites, on the other hand, are found mainly during a dry phase linked to the time of year when the harmattan blows or to a lack of irrigation. The red spider is singled out as the mite most to be feared, because of its extensive and rapid damage, as mentioned in the work of Guéroutback in 1969. The author mentions the climatic conditions which remain favorable to the development of insects, mites, and nematodes in tropical zones throughout the year. It is worth highlighting the resistance phenomena noted in the red spider despite the treatments carried out. This explains the use of neem oil combined with black soap mentioned by one of the growers. The use of sulfur is also found on farms, as stated in the work of Guérout, 1969, for the control of mites. The outbreak of red spider mites can also be explained by the elimination of beneficial insects during repeated spraying with insecticides. Among them is *Stethorus sp*. a species of the *Coccinellidae* family, observed in Ivory Coast, as mentioned in the work of Touréand *al*.,2020.Insects are highly prevalent but do not have time to cause significant damage due to the frequent insecticide treatments in orchards. This is confirmed by the wide variety of active ingredients used against insects on the farms surveyed.

Papaya Ringspot Virus is difficult for growers to identify and is confused with symptoms caused by nematode attacks. Moreover, as it does not necessarily affect the quantities harvested, it does not attract the attention of growers. When plants are regularly watered and fertilized, they manage to produce despite the presence of the disease (Hine and*al*., 1965). Nevertheless, the aesthetic appearance of the fruit is marred.

Anthracnose is not cited as one of the most common diseases by growers, which can be explained by the fact that it is more visible in the post-harvest period (Rahman and*al*., 2008).Growers selling on the field are therefore not greatly affected by its impact on the harvest, as they do not have to preserve the fruit.

Trunk and/or collar rot occurs mainly in clay soils, which retain more water, and in low-lying areas. Damage due to rot is most severe in the Mboro area. This is due to the steep slopes in the orchards. Plants located in low-lying areas are most often devastated. The soil is poorly drained. This confirms the work of Zhu and*al*., 2004 and Venturaand*al*., 2004. The predominance of rot confirms that of fungal diseases in papaya (Biratu, 2022).

The very wide range of active ingredients and the application of systematic treatments confirm the Niayes area's reputation for abusive pesticide use (Ngom and*al*., 2012; Ngom and*al*., 2013). Dimethoate, used to control insects, is one of the active ingredients responsible for major contamination of agricultural produce, according to the work of Ngom and *al*., 2012. The risks of polluting the environment, harvested produce, and the water table are real and are evidenced by the use of prohibited active ingredients on some farms and the poor management of waste from plant protection products. Carbofuran is still used. Mancozeb, Thiofanate methyl, and Zineb, which are among the most widely used fungicides, are banned in Europe (INRS, 2023). Added to this, the high prevalence of pesticides not approved by the Sahelian Committee of Pesticides (SCP) raises the question of the pesticide market's control in Niayes. None of the growers we met used biopesticides exclusively, which confirms the work of Boinahadji and Kébé, 2018.

Setting up an irrigation system is cited as one of the reasons for the high level of investment required to grow papaya. Water remains one of the main limiting factors, as confirmed by the high proportion of wells and boreholes, on the one hand, because papaya growing requires a lot of water and on the other because of the quest for a degree of autonomy about the water supply system, which is not always functional and whose rates drain producers' resources.

The constraints linked to seeds can be explained by the fact that growers buy young plants from nurserymen. They therefore do not know the exact origin of the seed and whether the seedlings purchased are really of the variety advertised.

Conclusion:-

This study aimed to draw up an inventory of the phytosanitary constraints encountered in papaya orchards in the Niayes area and to list the various active ingredients used during phytosanitary treatments. It also revealed the various factors limiting papaya cultivation. Phytosanitary constraints are the most frequently cited; with stem and collar rot being the most common disease. The use of prohibited or unregistered products should be highlighted, with Carbofuran, Mancozeb, Tiofanate methyl, and Zineb.

References:-

1. Biratu, W. (2022) : Papaya Fruit Pests and Development of Integrated Pest Management: Critical Review . Journal of Biology, 10.
2. Boinahadji, A.K., and Kébé, B. (2018) : Rapport d'enquête sur la reconnaissance et la gestion des insectes ravageurs des cultures maraîchères par les producteurs de la zone des Niayes. Eclosio.
3. Cissé, I., TandiaA.A., FallS.T., and DiopE.S. (2003) : Usage incontrôlé des pesticides en agriculture périurbaine : cas de la zone des Niayes au Sénégal. 12: 181-86.
4. CSP. (2023): Liste globale des pesticides autorisés par le Comité Sahélien des Pesticides.
5. Fall, A.S, FallS.T., CisséI., BadianeA.N., DiaoM.B., andFall,C.A. (2001) : Typologie des systèmes de production agricoles urbains. In Cités horticoles en sursis - L'agriculture urbaine dans les grandes Niayes au Sénégal, 11-18. Canada: Centre de recherches pour le developpement international.
6. Fall, S.T., and FallA.S. (2001). Cités horticoles en sursis - L'agriculture urbaine dans les grandes Niayes au Sénégal. Centre de recherches pour le developpement international. Ottawa (Ontario), Canada K1G 3H9.
7. Guérout, R(1969) : Le papayer : les parasites animaux.24 (6): 325-36.
8. Hine, R.B., HoltzmannO.V., and Rabbe. R.D. (1965) : Diseases of papaya (Carica papaya) in Hawaï , no 136.
9. INRS(2023) :Fiche toxicologique : Mancozebe. www.inrs.fr/fichetox.

10. Jiménez, V.M., Mora-NewcomerE., and Gutiérrez-SotoM.V. (2014) :Biology of the Papaya Plant. In Genetics and Genomics of Papaya, editedby Ray Ming and Paul H. Moore, 17-33. New York, NY: Springer New York. https://doi.org/10.1007/978-1-4614-8087-7_2.
11. Krishnan, P., BhatR., KushA., and RavikumarP. (2012) : Isolation and functional characterization of bacterial endophytes from Carica papaya fruits. no 113: 308--317. https://doi.org/10.1111/j.1365-2672.2012.05340.x.
12. Ming, R., YuQ., MooreP., PaullR., ChenN., WangM.-L., ZhuY., SchulerM., JiangJ., and PatersonA. (2012) : Genome of papaya, a fast-growing tropical fruit tree. Tree Genetics & Genomes 8 (juin). https://doi.org/10.1007/s11295-012-0490-y.
13. Ngom, S., MangaA., DiopM., ThiamM.B., RousseauJ., CisséI., and TraoréS.(2013): Étude de l'évolution des résidus de pesticides dans les produits horticoles de grande consommation au Sénégal. no 21 & 22: 31-44.
14. Ngom, S., Traore S., ThiamM.B., and Manga A. (2012): Contamination des produits agricoles et de la nappe phréatique par les pesticides dans la zone des Niayes au Sénégal. 12.
15. Office of the Gene Technology Regulator (2008) : The biology of Carica papaya (papaya, papaw, paw paw). Version 2. Department of Health and Ageing Office of the Gene Technology Regulator.
16. Palei, S., Dash D.K, and RoutG. (2018) : Biology and Biotechnology of Papaya, an important fruit crop of tropics: A Review. Vegetos- An International Journal of Plant Research 31 (décembre): 1. https://doi.org/10.5958/2229-4473.2018.00086.1.
17. Pantoja, A, FolletP. A., and Villanueva-JiménezJ. A.(2002) :Pests of papaya. In Tropical Fruit Pests and Pollinators, CAB International, 131-56.
18. Porter, B.W., ChristopherD.A., and ZhuY.J. (2014) : Genomics of Papaya Disease Resistance. In Genetics and Genomics of Papaya, edited by Ray Ming and Paul H. Moore, 277-307. New York, NY: Springer New York. https://doi.org/10.1007/978-1-4614-8087-7_15.
19. Rahman, M.A., MahmudT.M.M., KadirJ., Abdul RahmanR., and Begum,M.M. (2008) : Major Postharvest Fungal Diseases of Papaya cv. 'Sekaki' in Selangor, Malaysia. 31 (1): 27-34.
20. Toure, M., KoffiE., KwadjoE., DoumbiaM., KreiterS., and Kouadio K. (2020) : Diversité des coccinelles (Coléoptères : Coccinellidae) prédatrices dans les vergers de papayer (*Carica papaya L.*) en Côte d'Ivoire. Afrique Science Revue Internationale des Sciences et Technologie 16 (janvier): 271-78.
21. Ventura, J. A., CostaH., and TatagibaJ. S. (2004) : Papaya Diseases and Integrated Control. In Diseases of Fruits and Vegetables: Volume II, édité par S. A. M. H. Naqvi, 201-68. Dordrecht: Kluwer Academic Publishers. https://doi.org/10.1007/1-4020-2607-2_7.
22. Yu, Q., TongE., SkeltonR.L., Bowers J.E., JonesM.R., MurrayJ.E., HouS., andal. (2009) : A Physical Map of the Papaya Genome with Integrated Genetic Map and Genome Sequence. BMC Genomics 10 (1): 371. https://doi.org/10.1186/1471-2164-10-371.
23. Zhu, Y., AgbayaniR., JacksonM., TangC.S., and MooreP. (2004) : Expression of the grapevine stilbene synthase gene VST1 in papaya provides increased resistance against diseases caused by *Phytophthora palmivora*. Planta 220: 241-50. https://doi.org/10.1007/s00425-004-1343-1.