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Assessment of the Insect pests of flowers and fruits diseases impact on the Solo papaya in a field of Meyomessala locality, South region Cameroon

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Abstract- Insects are among the pests that cause damage to crops. They attack the underground and above-ground parts of the plant, thus reducing its yield. The aim of our study was to investigate insect pests of Solo papaya flowers and fruits and diseases in an experimental plot in the locality of Meyomessala in Southern Cameroon. After three months of collecting pests and papaya fruits, the samples were identified by the symptom observation method on the fruits for diseases and by electron microscope observation for insects. The results reveal 17 insect species in our experimental plot. These species belong to five orders or groups and three of them have the highest number of individuals (22 for Zonocerus variegatus, 18 for Rhaphigaster nebulosa, 17 for Nezara virudula). These results subsequently reveal the high presence (3 out of 4 samples) of insects on flowers compared to fruits. Samples Ei4 and Ei2 had the highest abundance of parasites on these organs (flowers) respectively 95.6 and 4.3% for sample 4, and 51; 48.6% for sample 2. Concerning diseases we found the black spot disease of papaya as the one that attacks all fruits. It is caused by the PRSV-P virus. 04 out of 10 fruit samples showed a high rate of attack (90% of black spots on the fruit surface).

Keys words: Insects, diseases, flowers, fruits, Solo papaya, Meyomessala.

I. Introduction

Fruits are cultivated in Cameroon as in other countries. Insects are invertebrates and arthropods with tracheal respiration whose body is divided into three distinct segments: head, thorax and abdomen. They are divided into four orders. Diptera, Phtiraptera, Aphaniptera and Hemiptera. These organisms inflict major damage to crops. Solitary and gregarious insect outbreaks on fruits have been observed in Meyomessala as in other agricultural production areas of Cameroon. These insect pest attacks were localized on mangoes, lemons, grapefruits, mandarins and papaya in farmers' fields and in the propagation plots of the Institute of Agricultural Research for Development (IRAD). They were characterized by black spots, rust, rot, white spots and localised pitting. This damage also affected flowers that fell before fruit production. Lebegin, described Oidium, anthracnose, black spot and Phytophtora as fungal diseases and virus diseases of papaya (Carica papaya)[1]. These parasites were also studied by Frossard, who described the stem, trunk and crown diseases (damping-off, root, crown and trunk rots caused by Phytophthora and Pythium rots)[2]. Ascochytacaricae. Botryo diplodiafis and Corynespora cassiicola dieback); Erysiphaceae leaf diseases ("Powdery mildew".) Oidium indicum and Oidium caricae-papayae. Ovulariopsis papayae. Sphaerothecahrzrrutli and Oïdio psistaurica. Corynespora cassiicola. Fruit diseases (Anthracnose, Ascochytacaricae, Rhizopus stolonifer, Cercospora papayae, Cladosporium) [11][15].

In this process of fruit parasitism, the insects behave in a polyphonic manner. They can then move from a "solitary" phase or behavior to a "gregarious" phase or behavior[11]. The behavior of gregarious individual’s results in a concentration of individuals, and in this way directly affects the population dynamics [12][13][14]. Numerical population increases at the beginning of outbreaks are associated with heavy rainfall, providing abundant vegetation and moist soil for the development of several generations. Groups can form, outbreed and cause significant crop damage. For example, agricultural losses to communities affected by the last Desert Locust invasion of 2003-2005 in West Africa were estimated at US$2.5 billion [3]. The high dispersal capacity of some insects like the Desert Locust makes it even more devastating.

During periods of major outbreaks (density greater than 300 individuals/ha), the area occupied by the pest is very large (29 million km2 in some 60 countries) compared with 16 million km2 (in some 30 countries) during its period of remission. This study therefore undertakes to study insect pests of flowers and fruits on papaya crops in an experimental plot of the Agricultural Research Institute for Development in the Meyomessala locality in Cameroon and to identify diseases. The general objective of this research is to study insect pests of fruits and flowers of papaya crop in an experimental site of IRAD locality of

Meyomessala, to achieve it we will follow the specific objectives below:

Make an inventory of insect pests of fruit and flowers

2. Study the abundance of each bio-aggressor

3. Study the harmfulness of the pests

4. To identify the diseases of papaya in this experimental site

II-MATERIALS AND METHODS

1. Collection and identification of insects on flowers and fruits

In the experimental field where 120 papaya trees were sown, a sample of 50 papaya trees is selected for insect collection using a collection form. This is done once a month for three months (June, July and August 2022) in sunny weather. The experimental field under study is a pawpaw plot in the first fruit production phase (first fruits) that was established in April 2021. Three (03) flowers and three(03) fruits are taken at random from each papaya tree. The first phase of insect collection is done on first cycle fruits in June and July and the second phase on second cycle fruits in August. A correction of the data from the first collection due to heavy rains is made during the second collection on three-month-old plants in a new field that was created in May 2022. Inspections of flowers and fruits for insect pests are visual. The insects found are captured by hand, counted, photographed with an android phone and preserved in 70ºc alcohol. The collected insect samples are taken to the entomology laboratory of IRAD for identification of species and developmental stages of pests.

2. Identification of diseases

Fruits with a variety of spots (black spots, brown spots, white spots, rust) and rots or moulds were picked (three (02) fruits in each case) and taken to the phytopathology laboratory of IRAD in Yaoundé for disease identification. The identification method is based on the observation of symptoms (spots) on the surface of the diseased fruits and their estimation on a scale from 0 to 100%. The cutting of the fruit is not taken into account when looking for disease symptoms inside. Pictures are taken with an android phone for some diseased fruits. During the search for disease on the fruits, a distinction is made between diseased and healthy papaya plants, which makes it possible to calculate the pest coefficient.

3. Evaluation of yield and financial contribution

The non-diseased fruits are picked every week, weighed with an electronic scale, and then sold in the markets in 5L tubs of 8 fruits at 500fcfa. A structured sheet (month, weight of fruit harvested, sum of weekly sales, and sum of monthly sales) documents the yield and income from sales.

4. Data processing

It is done in Excel and allows:

- Plot the histogram of the diversity of insect species and their numbers

The diversity of species represents the different species in a community.

- The calculation of the abundance of each insect species.

Abundance represents the percentage of a species in a community. It is calculated according to the following formulas to obtain the abundance or frequency according to Dajoz 1985.

$$\text{Abundance} = \frac{\text{number of individuals of the species(Na)}}{\text{total number of all species in the sample (Na + Nb...)}}$$

This data allows the interpretation of the harmfulness of insects on a crop.

Calculation of the harmfulness coefficient

Defined the relationship between the population density of a given pest and the damage it causes[4]. This "economic threshold" is defined as the abundance or population density of the pest at which control measures must be determined and applied to prevent the increasing pest population from reaching the population level causing economic damage. Again, this is referred to as the amount of pest at which control measures must be taken to avoid monetary losses. The calculation of the coefficient will therefore follow the formulas below:

Harmfulness coefficient of pests

$$C\% = \frac{(a-b)\times 100}{a}$$

The percentage of economic loss is also calculated

$$PE = \frac{(a-b)\times p}{a}$$

With,
a: number of healthy papaya plants (picture 3)
b: number of diseased papaya plants (pictures 1 and 2)
p: percentage of attacked plants

- when the coefficient is less than 25% the nuisance coefficient is low

- when it is equal to 50% it is the economic threshold where it is necessary to intervene to avoid considerable losses

- When it is higher than 75%, the nuisance coefficient is high. Intervention by phytosanitary measures has no influence on the pests' nusibility. The economic losses are considerable and irreversible.

III-RESULTS

3.1. Disease on Solo papaya fruits and disease stages

The figure below represents the result of the psychopathological analysis of Solo papaya fruits. It can be seen that all these fruits have black spot disease caused by PRSV-P. Samples E2, E3, E5 and E8 have the highest number of spots (90% of the fruit surface) and are similar.

3.2. Specific diversity of insect pests on Solo papaya plants

Table 1 shows the different pest species of Solo papaya fruits in the study area. A total of 17 insect species were found. Samples Ei1 and Ei3 had the highest species richness (8 species for Ei1) and (5 species for Ei3). Orthoptera and Hemiptera are the two main groups of insects found.

Table 1: Different species on the aerial organs of Solo papaya plants

Sample	Order	Familly	Species et Genders	Organe
	Coléoptèra	Staphylinidae	Alceochara bilineata	
	Orthoptèra	Acrididae	Catantops stramenesis	
Ei1	Hyménoptèra	Apidae	Apis milefera	Flowers
	Coleoptera	Chrysomelidae	Timarcha geottingensis	
		Nitudulidae	Thalycra fervida	
		Staphynilidae	Alceochara bilineata	
	Hymenoptera	Halictidae	Agapostemon virescens	
		Formicidae	Solenopsis xyloni	
Ei2	Hemiptera	Pentatomidae	Rhaphigaster nebulosa	Flowers
			Nezara virudula	
Ei3	Dictyoptera	Mantidae	Mantis religiosa	Fruits
	Hemiptera	Pentatomidae	-	
	Orthoptera	Pyrgomorphidae	Zonocerus variegatus	
		Acrididae	Trilophidia anulata	
			Pseudochrorthipus parellelus parellelus	
Ei4	Hemiptera	Rhopalidae	Leptocoris triviattatus	Flowers
	Orthoptera	Pyrgomorphidae	Zonocerus variegatus	

1.3 Structure of species diversity and developmental stages of parasites

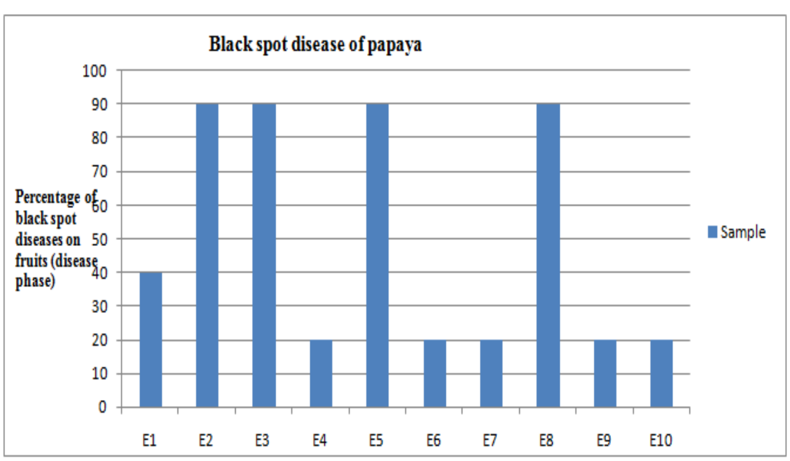

Figure 1: Black spot disease of papaya

In Table 2 the results show Zonocerus variegatus, Rhaphigaster nebulosa, Nezara virudula, as the species with the highest number of individuals (22 for Zonocerus variegatus, 18 for Rhaphigaster nebulosa, 17 for Nezaravirudula). This table also reveals that adults are the dominant developmental stage of the majority of insect species, with only one larva in sample E1. Sample E4 is the only one that has all its individuals as larvae. This is the stink locust Zonocerus variegatus.

Table 2. Number of individuals and developmental stages of the insects

Pests	Number of individuals	development stage
Alceochara bilineata	1	Adult
Catantops stramenesis	1	Adult
Apis milefera	1	Adult
Timarcha geottingensis	1	Adult
Thalycra fervida	1	Adult
Alceochara bilineata	1	Larva
Agapostemon virescens	1	Adult
Solenopsis xyloni	1	Adult
Rhaphigaster nebulosa	18	17 Adults et 1 Larva stage 4
Nezara virudula	17	Larve
Mantis religiosa	1	Adult
Pentatomidae	1	Adult
Zonocerus variegatus	1	Adult
Trilophidia anulata	1	Adult
Pseudochrorthipus parellelus parellelus	1	Adult
Leptocoris triviattatus	1	Adult
Zonocerus variegatus	22	Larva

3.4. Representation of insect abundance on attacked organs

Table 3 below shows the abundance on the organs of Solo papaya trees. It can be seen that sample E1 has the same abundance or density for the different insect species on the flowers. E4 and E2 have the highest abundance on these organs (flowers) and E3 only on fruits.

3.5 Financial returns from the sale of fruit

Table 4 shows that the yield of 50 Solo papaya trees over 500 m2 during the first production cycle is 225kg (4.5 bags of 50kg). This production yielded a revenue of 11,000 CFA francs during the first production cycle. During the second cycle we harvested the same quantity for an income of 15000Fcfa.

Tableau 3. Abondance des insectes sur les organes

Especes et genres	Organes	Abondance
Alceochara bilineata	Fleurs	12,5%
Catantops stramenesis		12,5%
Apis milefera		12,5%
Timarcha geottingensis		12,5%
Thalycra fervida		12,5%
Alceochara bilineata		12,5%
Agapostemon virescens		12,5%
Solenopsis xyloni		12,5%
Rhaphigaster nebulosa	Fleurs	51%
Nezara virudula		48,5%
Mantis religiosa	Fruits	33%
Pentatomidae		16,6%
Zonocerus variegatus		16,6%
Trilophidia anulata		16,6%
Pseudochrorthipus parellelus parellelus		16,6%
Leptocoris triviattatus	Fleurs	4,3%
Zonocerus variegatus		95,6%

Table 4. On the financial contribution from the sale of Solo papaya fruit

Month	Weeks	Weight in Kg	Amounts sold in Fcfa
March 2022	1	25	1500
	2	25	1000
	3	25	1500
	4	25	1500
April 2022	1	25	2000
	2	50	1000
	3	25	1000
	4	25	1500
November 2022	1	50	3000
	2	50	4000
December 2022	1	50	2500
	2	50	5500

3.6.Harmfulness coefficient and percentage of economic loss

For the nuisance coefficient the corresponding formula according to Stern 1959 is as follows

$$C\% = \frac{(a-b)\times 100}{a}$$

a: number of healthy papaya plants which is 40 papaya plants

b: number of diseased papaya plants is 10 feet where diseased fruits were collected

p: percentage of plants attacked, it is obtained by the formula (bx100/total number of plants(50))

Thus we have: $$C\% = \frac{(40-10)\times 100}{40} = 75\%$$

For economic losses according to Stern 1959 we have:

$$PE = \frac{(a-b)\times p}{a}\ ;\ \frac{(40-10)\times 20}{40} = 15\%$$

These results reveal that the Stern coefficient is 75% on our experimental site and the economic loss is 15%.

Picture 1 Fruit attacked at 40%. Picture. 2 Fruit attacked at 90%. Picture. 3 Healthy fruits

Source: Authors from field survey

Picture of some insect species in our study area (pictures of captured species)

Image 4 *Thalycra fervida* **Image 5** *Timarcha goettingensis* **Image 6** *Rhaphigaster nebulosa*

Pictures of papaya black spot disease attacks on fruits in the field

Image 7 *Catantops stramenesis* **Image 8** *Leptocoris triviattatus* **Image 9** *Zonocerus variegatus*

Image 10 *Trilophidia anulata* **Image 11** *Pseudochorthipus p p* **Image 12** *Zonocerus variegates(adulte)*

Image 13 *Nezara viridula* **Image 14** *Apis milefera* **Image 15** *Agaposterman virescens*

Image 16 *Mantis religiosa on the papaya's fruits*

Image 17 *Nezara viridula* and *Rhaphigaster nebulosa on the papaya's flowers*

IV- Interpretation of results

1. Disease on Solo papaya fruits and disease stages

Our study revealed that the black spot disease of papaya is the one that attacks all fruits of all samples in our experimental field at Meyomessala, it is caused by the PRSV-P virus. Four fruit samples showed a high rate of attack (90% of black spots on the surface of the fruits. Picture2). This virus was first described in California 1965. Jensen 1949 also mentioned it and Frossard 1969 grouped it in virus diseases of unknown origin [5]. There are currently three main strains, including PRSV-P in papaya, PRSV-W in watermelon and PRSV-T in melon [6]. It is transmitted by aphids and infects more cucurbits according to the Technisem study "Papaya ring spot virus" [8]. Lebegin, also described this black spot disease as one of the fungal and virus diseases of papaya (Carica papaya) [1]. The presence of this disease in our site is justified by the fact that the land had been left fallow for more than 5 years. Moreover, during the establishment and maintenance of the solo pawpaw field, the parasitic treatments were done with Bastion nematicides and only concerned the phases of whole treatment and 1-month plant recovery. They were not applied during the entire first cycle.

2. Species diversity, structure and developmental stage of the parasites

We found 17 species of insects in our study in Meyomessala. These species belong to five orders or groups and three species have the highest number of individuals (22 for Zonocerus variegatus, 18 for Rhaphigaster nebulosa, 17 for Nezara virudula), image 6; 13 and 17. These results are similar to those of Guerout 1969 for three groups of insects (Coleoptera, Hemiptera and Orthoptera) [7]. Concerning the species, only Nezaravirudula was found in his house, which is different from our study. This species according to its "Papaya animal parasites" is very widespread in the whole tropical zone and attacks many plants among which tobacco, rice, maize, cotton, etc. It measures about 15mm and the adult is emerald green while the larvae are yellow or red. The cycle is completed in 4 or 6 weeks [7]

3 Representation of the abundance of insects on the attacked organs

It was presented that Ei1 has the same abundance (12.5%) for the different insect species on the flowers. Ei4 and Ei2 have the highest abundance on these organs (flowers) respectively 95.6 and 4.3% for survey 4, 51 and 48.6% for survey 2. In Ei3 the insects are found on the fruits. These results of the strong presence of insects on the flowers compared to the fruits could be justified by the beginning of the cycle of the papaya plants; the robustness of the fruits whose skin is difficult to penetrate by the mandibles of these parasites. This is confirmed by the large number of stinkpot larvae (22 larvae) in sample Ei4 which was collected from three month old papaya plants.

4. Nuisance coefficient and percentage of economic loss

Our results revealed that the Stern's coefficient is 75% on our experimental site and the economic losses amount to 15%, which means that this coefficient is higher than the economic damage threshold. In this case its interpretation is that urgent intervention with pest control measures is needed to avoid significant losses. In this case the coefficient is 15%. The control measures we implemented were of two types: systematic clearing of the entire field and sanitary harvesting (removal of all mature and young fruits with black spots and removal of these fruits from the field). This study has different results from those of Samba L et al. 2020 who worked on the differential weediness of Sorghum Bicolor in the Upper Casamance region of Senegal. They revealed that 49 species were potentially harmful to sorghum and belonged to 6 groups and the group of weeds with MPI lower than 500 contained 78% of the flora considered as less harmful [9]. This is also the case of Vilardebo 1973 who worked on the "infestation coefficient - a criterion for evaluating the degree of attack of banana plantations by cosmopolite's sordidus Germ the black weevil of banana". They showed that the average infestation coefficient of 3 plots was 55.4, 21.4 and 1.1%, concluding that there is a close relationship between the distribution of the infestation coefficient and the density of attacks on banana plantations[10].

V-Conclusion

Our study focused on insect pests of Solo papaya flowers and fruits and diseases. Ultimately, our results presented 17 insect species in our study in Meyomessala as the one that constitutes the pest biodiversity. These species belong to five orders or groups and three of them have the highest number of individuals (22 for Zonocerus variegatus, 18 for Rhaphigaster nebulosa, 17 for Nezara virudula). These results further reveal the high presence (3 out of 4 samples) of insects on the flowers compared to the fruits. Concerning diseases, we found the black spot disease of papaya as the one attacking all the fruits of the samples in our experimental field at Meyomessala, it is caused by the PRSV-P virus.

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