ISSN : 0974 - 7532 *Volume 6 Issue 4,5*

Trade Science Inc.

Research & Reviews in

BioSciences

Regular Paper

RRBS, 6(4,5), 2012 [142-147]

Field observations of the populations, morphology, behaviour and natural enemies of a very important pest, cassava mealy bug

Luke C.Nwosu*[1], Mark C.Eluwa[2]

[1]Department of Science Laboratory Technology, The Federal Polytechnic EDE, P.M.B. 231, Osun State, (NIGERIA)

[2]Department of Biological Sciences, Michael Okpara University of Agriculture Umudike, Abia State, (NIGERIA)

E-mail : luke2007ambition@yahoo.com

Received: 17th April, 2012 ; Accepted: 17th May, 2012

ABSTRACT

Biological studies on the cassava mealy bug were carried out in mono – cropped cassava fields in Mbaitoli Local Government Area, Imo State, Nigeria during the dry seasons of 2006 and 2007. Population surveys of the mealy bug in the nine towns of the L.G.A. were conducted with the aid of a tally counter while behavioural, morphological and other biological studies of this notorious pest were achieved by thorough observations in the field. Even though 41% of the farms surveyed were infested with the cassava mealy bug, current mean mealy bug populations were relatively high (about 38 bugs per cassava shoot) compared with populations of less than 20 bugs per shoot observed in most fields after the establishment of the biological control programme in the late 1980s. High mealy bug populations recorded in the study stands to pose a serious threat to food availability, at least in the area. The study established *Ferrisia virgata* and *Phenacoccus manihoti* as the predominant mealy bug species in the area. The victims of *F. virgata* were observed to suffer general symptoms of weakening but not conspicuous distorted growth while *P. manihoti* was found to specialize in the infliction of distorted growth on the cassava host. Investigations in the origin, nature and significance of the mealy bug wax among others, showed that the wax is adaptive in function. Observations on the activities of predators and other enemies encountered amidst bug's populations and the nature of bug's interactions with other pests showed that the coccinellid beetles and wingless ants made impact on the mealy bugs and bugs coexisted with the cassava green spider mite. Morphological studies on the different stages of the mealy bug showed differences in size, colour, mobility and shape. The study recommends regular release of the proven natural enemy of the mealy bug (*Epidinocarsis lopezi*) as a pest management strategy.

KEYWORDS

Biological studies;
Fields;
Tally counter;
Predominant;
Coexisted;
Strategy.

Regular Paper

INTRODUCTION

The cassava mealy bug has become an important pest in Nigeria and its damage seems to be increasing in areas where it had not previously been found[1,2]. It was accidentally introduced into Africa in the early 1970s[15,16,21], and it subsequently spread over most of the continent[5].

Through its feeding damage and stunting of shoot tips, it dramatically reduced tuber yields[5,14] and thus probably became the most important pest of cassava (*Manihot esculenta* Crantz) ever recorded in the continent.

Cassava tuber is a staple food for over 300 million people in tropical regions of the world[1,2,10,18]. In addition, cassava tuber is used in the production of livestock feed and industrial starch, beside being of use in the pharmaceutical industry[18,20].

The activities and impact of the mealy bug on this very important plant, cassava, moved the learned world into search for a sustainable control. Control of the mealy bug with natural enemies was attempted following its recognition as an immigrant species[3] in the sense that it is not native to Africa. Extensive explorations for natural enemies were conducted in South America between 1977 and 1981 by the Common Wealth Institute of Biological Control in collaboration with International Institute for Tropical Agriculture[11,12].

Indeed, the Biological Control Programme of the International Institute of Tropical Agriculture (IITA), in collaboration with numerous international agencies, was established, in part to combat this new pest. Low yield in cassava tubers, as evidenced from widespread scarcity of its products in the market culminating in prohibitive prices, reached its peak in Nigeria, for instance, in 1983. This unexpected development alarmed the learned world and gingered concerned groups into action. The result of this concern was that following extensive exploration in South America[22] and quarantine at the International Institute of Biological Control (IIBC) in the United Kingdom, the solitary and host – specific wasp, *Epidinocarsis lopezi* (De Santis) (Hymenoptera, Encyrtidae) was imported into Africa, reared and first released in Nigeria in 1981[8]. Cassava mealy bug populations declined after the release and have remained low since[6,7].

Much as this effective biological control measure remains operational, efforts should be continued towards augmenting/improving on its efficacy through further biological studies. In other words, all additional environmental/ biological information from anywhere on the said pest, should be explored and harnessed. This is part of the aim of the present study. Therefore, this study concentrates on investigating into the population, species types, morphology, behaviour and natural enemies of the pest in the area. This work will undoubtedly serve as a good reference material for Biologists and other researchers working in the field of Entomology.

MATERIALS AND METHODS

Site description

This study was done in selected farms in Mbaitoli Local Government Area of Imo State of Nigeria. Mbaitoli is located in South Eastern Nigeria on latitude 060 3' N and longitude 070 36' E. Although this area has mixed population of diverse occupations of civil servants, students and other workers, it is not much different from the typical Nigerian rural to semi – rural setting in which members are largely farmers. Villages are practically sandwiched between extensive cassava plots grown as monocultures. These are mainly small – holder plots that are seemingly contiguous. The native farmers quite rural grow various cassava cultivars for their subsistence usually devoid of insecticidal treatments. The only modern input may be chemical fertilizer.

Population survey

A total number of 100 cassava farms ranging from 0.25 to 2.5 hectares each, were selected for the study using the household random selection method. Their areas in square meters were determined with the aid of measuring tape (10,000 metre squre 2 = 1 hectare).

Then, species of cassava mealy bug (adult and crawlers) on virtually all infested cassava stands were visually counted, using a tally counter/ register. The exercise also determined the number of infested stands. Average number of cassava mealy bugs on infested stands per farm was determined by dividing the total number of mealy bugs counted in single farm by number of infested stands present. In each town of the L.G.A., the percentage infestation of the farms was computed

Regular Paper

using the formula:

$$\frac{\text{Number of infested farms}}{\text{Total number of farms studied}} \times 100\%$$

The worked out percentages were pooled between farms near human habitations and those farther from living homes. At the conclusion of the study, the percent average of all the infested farms was worked out.

Morphological studies on the cassava mealy bug

Morphological study of the pest was achieved by strong visual observations, use of hand lens and simple microscope. To achieve a better microscope focus, the collected adult and especially, crawlers of mealy bug specimens were kept on slide (that was oiled on the surface) to restrict movement. On observations, the size, colour, shape and other body features of both mounted mealy bugs and unmounted ones on host stands were recorded. All stages of the pest (egg, nymph and adult) were morphologically studied. At the conclusion of the study, average/modal observations were simply worked out and pooled/ segregated according to species.

Behaviourial study of the cassava mealy bug and survey for natural enemies and their impact on the mealy bug

The feeding habits of mealy bug species and nature of damage caused, concentration points of attack, nature of association formed with other pests, mealy bug wax production/nature/ significance and types/impact of natural enemies amidst bug's populations were studied employing strong visual observations, hand lens and taxonomic features.

Other field observations

In course of the study, any other factor or feature, known to be related to cassava mealy bug was critically observed and documented.

Identification of species of casava meay bug

Mealy bug species encountered were identified in the field and representative samples/ specimens collected were further subjected to detailed taxanomic analysis/identification in the laboratory using guides provided by Cox and Williams[3].

Statistical analysis

Counts were recorded in numbers and infestation rate expressed in percentage, modal observations of qualitative data were taken to be representative mean observation and simple averages were employed in working out final population and infestation status of the pest in the area.

RESULTS AND DISCUSSION

Results of this study are presented and discussed along these lines/in this form for clarity purposes.

Population survey

A total number of 191,394 cassava mealy bugs (about 38 per cassava shoot) were recorded in 100 sampled plots (with mean age of nine months) covering all towns of Mbiatoli L.G.A, Imo State, Nigeria. Forty – one out of 100 sampled crop plots (41%) had varying degrees of mealy bug infection (TABLE 1). This observation and assessment were corroborated by Hammond and Neuenschwander[7]; Umeh[21]; Nweke and Haggblade[18] that encountered mealy bug populations amidst cassava crop. However, this result differed markedly from the spectacular mealy bug epidemic of 1979 to early 1980s[7,11,21]. From the findings of the present study, no similar alarming infestation reoccurred in Mbaitoli, an Eastern part of Nigeria, even though cassava mealy bug still persisted and caused varying degrees of damage to the crop in the area. This observed state of affairs may suggest possibilities of serious economic damage.

TABLE 1 : Population and infestation data of cassava mealy bug in Mbaitoli local government area, Imo State, Nigeria during 2006/2007.

Type of Site	No of Farms Studied	No of Farms Infested	% of Farms Infested	Population %Ofbugs Recorded	Population ofBugs Recorded	Noof Stands Infested	Average Bugs Pershoot
Near Living Home	50	30	30	131,130	68.5	2,919	45
Far form Living Home	50	11	11	60,264	31.5	1,944	31
Total	100	41	41	191,394	100	4,858	38

NOTE: Percentages were worked out in terms of the 100 farms studied and total number of bugs encountered in the study.

That current mean cassava mealy bugs population were relatively high (about 38 bugs per shoot) simply suggests that the major control agent seemed not to be in equilibrium with the cassava mealy bug in the study area. This is because, in regions of successful colonization of the natural enemy of the mealy bug, populations of the pest fall within 10 – 20 per cassava shoot[17,21]. It is now obvious why conspicuous stunting of cassava shoot tip reoccurred in the study area.

Morphological description of the species encountered in the field

The adult stage

According to Fields *et al.* (1985), three species of mealy bugs attack cassava crop. Of these three, *Phenacoccus manihoti* and *Ferrisia virgata* were encountered in cassava farms in Mbaitoli Local Government Area, Imo State, Nigeria while *Phenacoccus madeirensis* was not encountered in the study.

Live adult females of *P. manihoti* were observed to be pinkish and covered with a fine coating of mealy wax. Its lateral and caudal filaments are very short that if observation is not thorough, lateral and especially caudal filaments may not be visible to the naked eyes. Adult female when mounted measured 0.1 to 0.3 cm; 0.1 to 0.15 cm in length and width respectively.

Contrastingly, *F. virgata* had been observed to be typical whitish mealy bugs. Size is 0.4 and 0.2 cm in length and width respectively when mounted. It was found to be characterized by a pair of longitudinal dark strips (which may or may not run through the entire body length), long glossy wax threads and a pair of long tail filaments. However, the presence of the pair of long tail/caudal filaments is most diagnostic.

Nymphal stage

The nymphal stages of the cassava mealy bugs are also known as "crawlers". This name may have arisen in association with their observed high degree of mobility. This stage of mealy bugs was found to be highly susceptible to wind and therefore plays crucial role in the spread of mealy bugs. They measured smaller than the adults (about 0.05 cm in length and width), showing varying colouration such as yellow, blurred white and faint pink, perhaps depending on the species and the stage. These nymphs were found to be frequently housed in the calyx of the tender shoot tips. This behaviour may also be adaptive in function since they are hidden away from enemies.

Egg: Field work showed that eggs of mealy bugs are small, whitish and roughly cylindrical in shape.

Comparative assessment of mechanism of attack and nature of damage done to the cassava crop by *P. manihoti* and *F. virgata* mealy bugs

According to Fields *et al*., (1985) and[21], different species of cassava mealy bugs cause varying types and degrees of attack. In this study, *P. manihoti* was observed to suck sap from terminal shoots and leaf bases of infested cassava crops. This resulted in strong growth disturbances, which were manisfested in the stunting and deformation of terminal shoots. There was reduction in internode length, which caused twisted stems. When number of bugs at shoot tips became much, infestation gradually spread to bases of tender leaves and thence to their blades proper, especially abaxially. Preponderance of bugs on leaf bases caused folding and therefore reduction in sizes of affected leaves. Advanced sucking at leaf bases resulted in death and drying of such leaves. Severe and prolonged sucking subsequently caused death of shoot tips. Infestation and corresponding damage seemed/appeared more complex when *P. manihoti* coexisted with the cassava green mite. Attacked cassava crop, with more wax coverings of mealy bug, showed more stunting of shoot tips. Thus, number of bugs present on the cassava crop seemed directly proportional to damage caused.

Meanwhile, *F. virgata* (stripped mealy bug) was found to also suck saps from cassava crop. The victims (sapped cassava crops) suffer general symptoms of weakening and do not really exhibit distorted growth. Contrastingly, *P. manihoti* was observed to specialise in infliction of distorted growth on the cassava host. Furthermore, other severe damage inflicted by *F. virgata* were drying up and wilting of leaves. At heavy infestation, *F. virgata* spreads to the leaves. Undoubtedly and as determined, *F. virgata* unlike *P. manihoti* attacks the cassava crop only occasionally.

Origin, nature and significance of mealy bug wax

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It has been recorded that the cassava mealy bug secrets wax or fine coating called the mealy bug wax[3]. However, in this study, when fresh, the mealy bug wax appeared like droplet (s) of liquid with partial or slight slimy nature. When it dried, it hardened lightly into fine, foamy, wax coverings. The web – like, dry coverings must be adaptive in function in that it absorbs or at least reduced impact made by natural enemies, predators and other opportunistic visitors of mealy bug. This was a significant observation. Additionally, to the adults (especially settled ones), the dried, sticking and sometimes enveloping coverings prevent air – borne action produced by wind on bugs and consequently preventing or at least reducing spread by adult mealy bugs. It is now obvious why the crawlers (nymphs) not the adult mealy bugs have been seriously incriminated in the spread of mealy bug infestation[6]. Therefore, it can be inferred that the cottony wax secretions have caused mealy bugs and farmers both harm and good.

Natural enemies, predators and other opportunistic visitors of the cassava mealy bug encountered in the study

The wingless ants were encountered singly and in numbers as much as four, pulling and eating the secreted, foamy, dry wax coverings of *P. manihoti*. In the process, they used their antennae to knock on (the body of) the bug's coverings repeatedly and interestingly lick their antennae after about eight to ten knocks. The ants smaller in size preferred fresh secretions to dry coverings. The study has listed the wingless ants as a predator or at least an opportunistic visitor of the cassava mealy bug. Coccinellid beetles and *Epidinocarsis lopezi* were found in association with mealy bugs present on cassava shoot. That *E. lopezi* and Coccinellid beetles are the major natural enemy and predator of the mealy bugs respectively have been documented[5,8].

Commonest strategy adopted by rural cassava farmers for (immediate) control of mealy bugs

As a means of control, the local farmers cut off infested parts of the cassava crop. This was also a significant observation. The demerit of this quick method of riding off the pest is that even when properly disposed, eggs, which persist on buds and shoot generally, hatch into crawlers and infestation continues.

CONCLUSION

Looking at the cassava mealy bug from the international point of view, this pest constituted about the most economic disaster affecting a major staple crop, cassava[9,14,15,21]. However, in this study, no similar mealy bug epidemic reoccurred and therefore, it can be concluded that biological control by *E.lopezi* (at least in Mbaitoli) is successful in preventing alarming infestation of cassava crop by the mealy bugs. Meanwhile, since cassava mealy bug still persisted and caused varying degrees of damage, man's economy stands to be impinged on, at least in the area.

To that effect, if one must recommend control or pest management strategy, it should be regular release of the proven natural enemy of cassava mealy bug.

From the findings of this study, the species of cassava mealy bug (*P. manihoti* and *F. virgata*) predominantly established in the area markedly differed in terms of morphology, mechanism of attack and nature of damage done to the cassava crop. Damage caused by the mealy bugs to the cassava crop was intensified when bugs coexisted with the cassava green mite. The mealy bug wax and frequent housing of the crawlers in the calyx of the tender cassava shoots were found to be functionally adaptive. The study also confirmed the activities of the known natural enemies of the mealy bug in the field and listed the wingless ants as predators or at least opportunistic visitors of the cassava mealy bug. The cultural means of the pest control in the area was observed not to be sustainable. This work can always serve as a useful material to reckon with.

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