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Abscission of Pepper Fruits By Dipterous Pest, *Atherigona orientalis* [Schiner] In Traditional and Mono-Crop Farms in Port Harcourt, Niger Delta, Nigeria.

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Abstract: *Pepper fruits grown in traditional farms of Rivers State, Nigeria showed lower infestations of dipterous pests both at dry and rainy seasons than those grown at mono-crop farms [students' t -test, P< 0.05]. Abscission of pepper fruits was significantly higher in Nsukka Yellow variety than other varieties sampled. Generally both infestation and abscission were significantly higher in Capsicum annum than in C. frutescens which showed the lowest infestation and subsequent abscission in both seasons. The relationship between depths of cuticle cracks on pepper fruits and number of eggs laid showed a positive correlation [r=0.71]. A strong correlation also existed between number of larvae and percentage fruit loss [r=0.88].*

Keywords: *Abscission, pepper fruits, fruit flies, traditional, mono crop farms, Port Harcourt, Nigeria.*

I. Introduction

Different authors in their own ways view abscission simply as the shedding of lateral organs in plants [Kaufman et al., 1985., Reid, et al 1974]. Abscission implies the immature loss of fruits prior to full maturity. According to Dorais et al., 2004 research has been directed toward improving the internal and external quality of tomato fruit produced in greenhouses (Dorais et al. 2001). One of the major problems encountered by greenhouse tomato growers is fruit cuticle cracking (CC), also called russeting, hair cracking, swell cracking, shrink cracking, rain check, crazing, and cuticle blotch. In contrast to concentric and radial fruit cracking where large (one or more cm long by a few mm wide) and deep (a few mm) cracks occur in circles around the stem scar or radiating from the stem scar. CC are very fine hair-like cracks (0.1 to 2 mm in length) limited to the cuticle and first layers of cells of the epidermis. The impact and roles of insects' feeding activities have not been determined to relate it as one of the major factors that could influence abscission of solanaceous fruits. According to Kaufman et al [1985] the principles dictating at which stage of maturity a fruit or vegetable should be harvested are crucial to its subsequent storage and marketable life and quality.

Atherigona orientalis [Schiner] and *Ceratitis capitata* [Wiedman] are major fruit flies that have been found damaging peppers, tomatoes, soursops, local apples, guava, melons apart from fish and fish products in Nigeria [Ogbalu et al., 2014]. The impact of their feeding activities affected the germinability of pepper seeds [Ogbalu, 1986].During the rains pepper fruit loss was up to 73.7% loss especially in *Capsicum annum* var Nsukka Yellow [Ogbalu, 2013]. This variety sustained the highest larval population of *A. orientalis* in pepper fruits. The pepper fruit fly, *A. orientalis* deposits eggs under the calyces of pepper fruits and tomatoes; at the apical portion of the fruits from where the emerging larval instars make entry into pepper and tomato fruits. Feeding activities commence at the apical portion down into the fruits and detachment is initiated. *Ceratitis capitata* females penetrate ripe pepper and tomato fruits with the aid of their ovipositor although they both utilize sites of cuticle cracks for egg deposition.

Nitrogen toxicity is most typical under hot, dry conditions and plants turn an overly-deep shade of green. Lesions often occur on the stems of annual seedlings and these can be confused with canker diseases. Similarly, twisting and distorting of mature tomato plants that experience ammonium toxicity may appear similar to symptoms caused by viruses. Ammonium toxicity can be a problem in greenhouse soils because of the lack of specific microorganisms that convert ammonium to nitrite and then to nitrate. This factor is commonly applied to fruits, since skin colour changes as fruit ripens or matures. Some fruits exhibit no perceptible colour change during maturation, depending on the type of fruit or vegetable. Assessment of harvest maturity by skin colour depends on the judgment of the harvester, but colour charts are available for cultivars, such as apples, tomatoes, peaches, chilli peppers, etc. Thompson, 1998 listed in a chart different options in post harvest handling.. Most fruits synthesize volatile chemicals as they ripen. Such chemicals give fruit its characteristic odour and can be used to determine whether it is ripe or not. The odours may only be detectable by humans when a fruit is completely ripe, and therefore has limited use in commercial situations. Some fruits may develop

toxic compounds during ripening, such as Ackee tree fruit, which contains toxic levels of hypoglycine [Thompson, 1998].

In this paper we attempt to evaluate abscission of pepper fruits in traditional and monocrop farms and also to evaluate the role of fruit fly feeding as a source of abscission in different pepper varieties grown in Niger Delta of Nigeria.

II. Materials and Methods

Experimental Site and Design:

[a] Traditional Farms

We selected four traditional farms in Port Harcourt, Rivers State, Nigeria where they adopted mixed cropping system of growing vegetables that include peppers for our study. We selected four farms from different parts of Port Harcourt. In the traditional farms, sources of nutrients were animal manures; chicken manure, cow dung, goat dung and decayed agricultural matters. There was no fertilizer application in the traditional farms.

Sample collections: We took our samples during the rainy season of 2013 [between the months of May and September] and also during the dry season of 2013/2014 [between the months of December 2013 and February 2014]. We picked the pepper fruits that dropped per plant and took them to the laboratory in covered plastic plates to estimate the number of larvae in each fruit.

[b] Mono-crop Farms

We maintained four mono-crop experimental farms in the Research farm of the Department of Applied and Environmental Biology, Rivers State University of Science and Technology, Port Harcourt, Nigeria. In the mono crop farms we applied NPK fertilizer at the standard rate at 2 weeks after planting [Ogbalu, 1989, 1999]. We planted four varieties of pepper namely, Nsukka yellow [[NSY], Atarugu [ATR], [both are of *Capsicum annum*] Local medium red [LMR] and Bird's eye chilli [BEC] [both are of C. frutescens] varieties.

Four plots were maintained for each of the pepper varieties. Each plot had four rows for a particular variety per plot having 30 pepper plants per row at a spacing of 100cm in between plants and a spacing of 1 metre between rows, giving a total of 120 plants per plot replicated four times. Control plots were maintained for each replicate/plot and control plots did not receive fertilizer treatments. All pepper plants received water during the dry season. Data were collected during the rainy season and dry seasons of 2013 -2014 for the assessments of abscission in pepper. We adopted the same method of collection of samples as in above, the only difference being that we picked abscised pepper fruits per row. In the traditional setting there was no organized planting of crops however we still collected data from the four traditional farms on abscised fruits.

Statistical Analysis. Data were subjected to Analysis of variance and means were separated using SNK test, a furtherance of Duncan Multiple range test [DMRT]. We also used standard error to assess percentage number of fruit fly larvae / plot and percentage abscission. Students' t-test was used to compare both infestation and abscission in traditional and mono-crop farms in Port Harcourt.

III. Results

In most traditional farm settings there was no consistent farming method of what to plant and there was also no organized pattern of planting of any crop. Most farms contained whichever crops the farmer has opted to grow for the season. Fig. 1 showed that in the dry season of 2013, there was a general low infestation and low abscission of pepper fruits in the four traditional farms [I-IV]. However, abscission was significantly highest in the local medium red [LMR] variety and Nsukka Yellow [NSY] variety than other varieties [DMRT, $P< 0.05$]. The Bird's eye chilli [BEC] variety had significantly lowest abscission in the data collected in the dry season of 2013. From the data collected in the rainy season of 2013, a relatively low infestation and abscission of fruits occurred in traditional farms in Port Harcourt during the rainy season of 2013 depending on the variety of pepper [Fig.2].

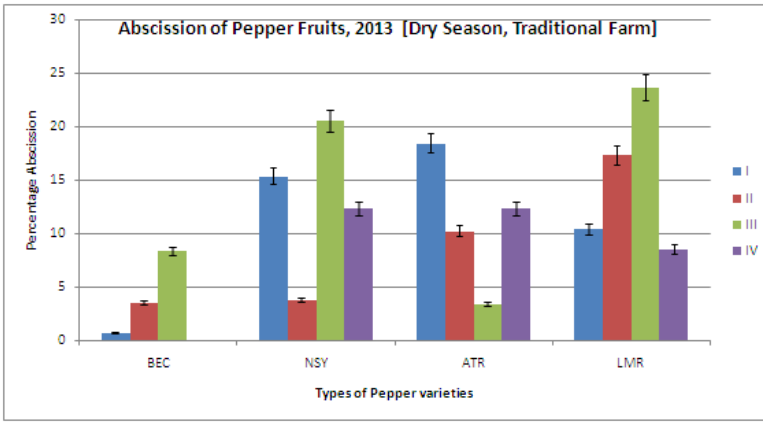


Fig. 1. Abscission of pepper fruits in Traditional Farm during the dry season of 2013 [December to February][I-IV represents the number of farms in the particular traditional or mono-crop setting]. NSY=Nsukka Yellow; ATR= Atarugu variety; BEC= Bird's eye chilli; LMR= Local medium red variety.

Peppers grown in the four traditional farms during the dry season of 2013 had a relatively low infestation of dipterous flies [Fig. 1]. The local medium red [LMR] variety had the highest abscission of 23.7% followed by Nsukka Yellow [NSY] with 20.6% abscission in Farm II. There was significant difference in percentage abscission in Farm I between NSY [15.4] and ATR [18.5] and BEC had the lowest percentage abscission.

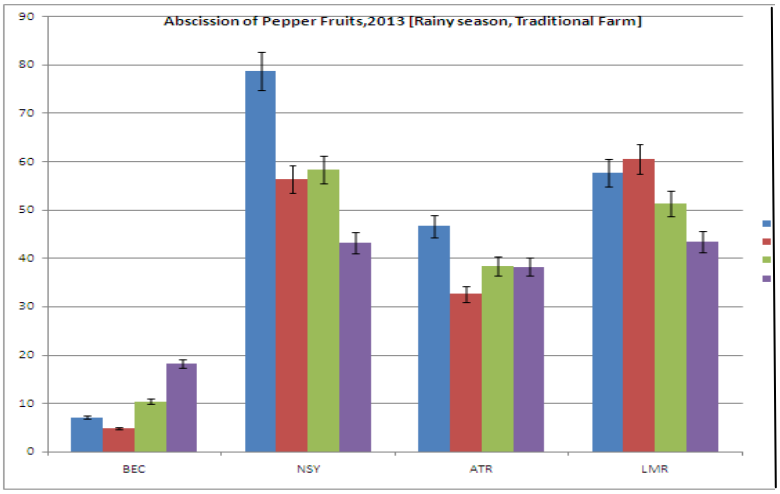


Fig.2. Abscission of Pepper Fruits in Traditional Farm during the Rainy season of 2013 [June – September]

During the rains of 2013, there was higher infestation of pepper fruits by dipterous pests and this subsequently resulted in higher abscission of pepper fruits. However, in all the four farms it was only the BEC variety that consistently showed the lowest infestation and abscission. NSY had the highest infestation and abscission in the rains of 2013[88.4%]; LMR had 60.6%; ATR 46.7%; BEC, 18.2%. We assessed percentage abscission in the most susceptible variety, Nsukka Yellow [NSY] during the rains of 2013 [Fig. 3]. It was established that the rate of abscission of pepper fruits was high in all the four farms of the mono-crop farms of the variety. The control plot which consisted of all the varieties of pepper plants attracted high infestations along with the NSY variety [Fig. 4]. Data collected from the monocrop farms still showed NSY and control plots with relatively high infestation and abscission during the rains of 2013 [Fig. 4]. Percentage abscission was lower than 35% in all the mono-crop farms during the dry season of 2013/2014 [Fig. 5]. A strong correlation existed between depth of cuticle crack and number of eggs the gravid females deposited [r=0.52] in Fig. 6. There was a strong correlation between number of fruits of Nsukka Yellow variety abscised and number of fruits per pepper plant [r= 0.71] [Fig. 7]. Most of the fruits abscised were in their fully ripe state. There was a significant difference in the t-test analysis between abscission and infestation levels in traditional and mono-crop farms [t-test; $P < 0.05$].

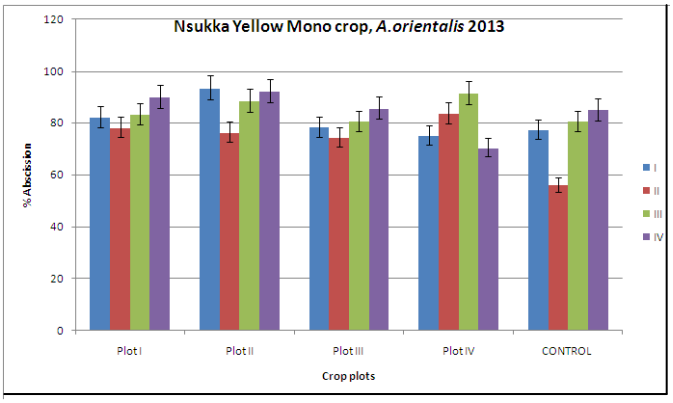
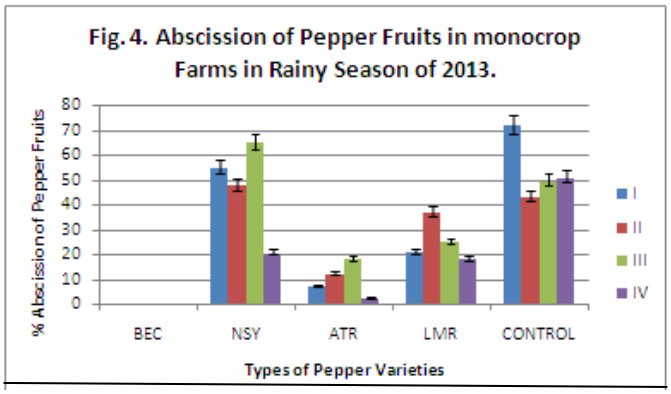
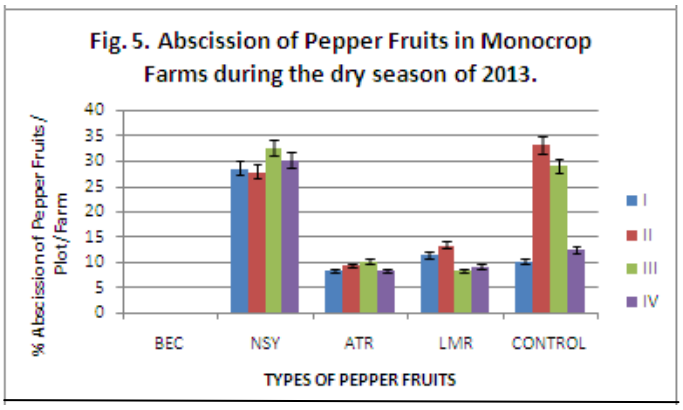


Fig. 3. Percentage Abscission caused by Atherigona orientalis in monocrop Farms [Nsukka Yellow, Capsicum annum] during the rainy season of 2013.





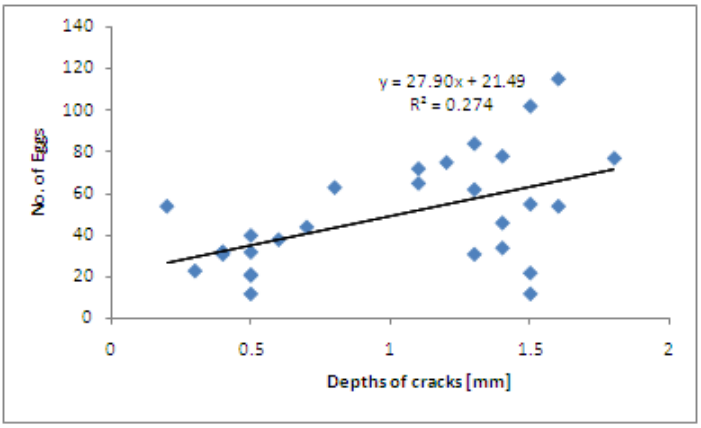


Fig. 6. Relationship between number of eggs and depth of cuticle cracks [r=0.52].

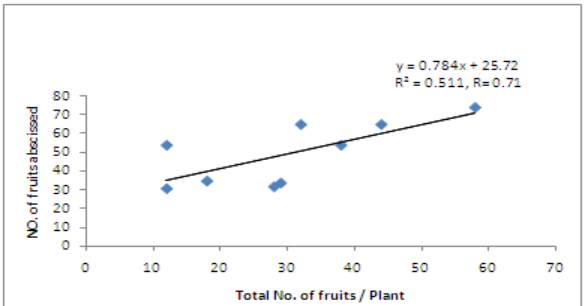


Fig. 7. Relationship between Number of fruits abcised and total number of fruits per pepper plant

IV. Discussion

Plants can be damaged by insects including infectious microbes such as fungi, bacteria, viruses, and nematodes. They can also be damaged by non infectious factors, causing problems that can collectively be termed "abiotic diseases" or "abiotic disorders". Furthermore, many of these abiotic disorders can predispose plants to diseases caused by infectious microbes [Kennelly, 2012]. Many a times the main causes of plant infection is neglected; the insects initiate plant diseases as direct or indirect carriers of microbes, apart from their role as carriers, their feeding activities contribute to abscission of pepper fruits. Other factors that can affect abscission of fruits include unfavourable soil properties, fertility imbalances, moisture extremes, temperature extremes, chemical toxicity and physical injuries. The aforementioned factors can reduce plant health and even kill plants especially those grown in the Niger Delta and humid zones of Nigeria. Pepper fruits generally harvested during the dry season escaped infestation by pepper pests both in traditional farms and mono-crop farms. Abscission was lower during the dry seasons at both farms.

Abscission of peppers occurred mostly during the rainy seasons of the two years in study. The present study confirmed the earlier reports of Ogbalu [1989] and Ogbalu et al., 2005 on possible roles of *A. orientalis* in pepper fruits abscission in Nigeria. Pepper fruits including bell peppers grown during the rainy seasons within the humid tropics of Nigeria are predisposed to dipterous pests' infestation. The general farm practices are the traditional types that encourage multiple planting of agricultural grains, legumes and vegetables along with other cash crops. In this study abscission of pepper fruits occurred mostly in mono-crop farms than in the traditional farms that adopted mixed farming system of having multiple planting of crops that promoted alternate hosts for the pests and this enabled the main host plant to avoid much infestation. The dipterous pests were found also on other crops such as melon, and on border crops such as guava and sour sops and cucumber which Ogbalu et al [2014] reported as other host plants of frugivorous pests in the Niger Delta.

Ethylene production increases in many abscising organs prior to abscission and also the presence and the feeding activities of the dipterous larvae in pepper fruits also contributed to abscission. Ethylene is known to be the causal factor in shedding of leaves and a common problem in the post harvest handling of vegetables [Kays et al., 1980], fruits and ornamentals [Armitage et al., 1980]. Some earlier workers had attributed percentage fruit loss to polygalacturonase activity for semi-ripe fruits and also for fully ripe fruits [Reid, 1985]. Production of ethylene by flowers has been rather extensively studied, primarily in association with petal fading and abscission (Armitage et al 1980), and there is a presumptive association of ethylene with the natural separation of fruits from plants following ripening. Ethylene is now implicated as a natural regulator of leaf abscission [Beyer and Morgan, 1971; Jackson and Osborne, 1970. Young fruit abscission was not a common phenomenon in this study as young, unripe fruits were not infested and hence did not abscise.

The important role of ethylene production in fruits notwithstanding, the roles of the larval stages of dipterous flies in this study should be considered; their number per fruit and their feeding effects at the apical region of pepper fruits predispose fruits to abscission. Apart from this, the eggs are deposited by the gravid females under the calyces of pepper fruits from where the emerging larvae gain entry into pepper fruits. The apical region serves as immediate feeding foci for the larvae and the larvae remain within the fruits throughout its larval and pupal stages feeding and inducing or contributing to abscission along with ethylene production, fungal and other micro organism infections. There was also a strong correlation between percentage fruit loss and number of larvae [r=0.88] implying that apart from other factors that the presence of dipterous larvae in ripening fruits can induce abscission in pepper fruits. Previous studies had shown that as they feed on the mesocarp, placentae, seeds and ovules they affect the germinability of pepper seeds. Cuticle cracks are also utilized by the dipterous gravid females for egg deposition [Ogbalu, et al., 2005b] and their presence serving as breeding sites will add to abscission as emerging larvae will add to the feeding impact on pepper fruits and subsequent abscission. Ogbalu [1999] listed other factors that will attract fruit flies to pepper plants in traditional

farm settings. We conclude that the presence and feeding activities of *A. orientalis* contribute to abscission of pepper fruits in the humid Niger Delta.

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