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Aspects of the Biology and Variation in Developmental Time of the Spiralling Whitefly, *Aleurodicus dispersus* Russell (Homoptera: Aleyrodidae) on Different Hosts.

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ABSTRACT

Some aspects of the biology of the spiralling whitefly, *Aleurodicus dispersus* Russell (Homoptera: Aleyrodidae), a serious pest of crops in West Africa, was studied on guava seedlings under laboratory conditions as well as in screen house. There were only four larval instars; total larval period was 15-19 days while developmental period from egg to adult was 24.1-28.0 days. At a temperature of 30 $\pm$ 4^{0}C, mortality was 72.2% and at 25 $\pm$ 2^{0}C (in laboratory condition) mortality was 46.9%. Time required by *A. dispersus* to complete development from egg to adult at 25 $\pm$ 2^0 C was influenced by the host plant. Development was completed in 18% less time on cassava (*Manihot utilissimma*), croton (*Codiatum variegatum*), *Acalypha* sp., guava (*Psidium guajava*) and plantain (*Musa paradisiaca*) than on frangipani (*Plumeria rubra*) and mango (*Mangifera indica*).

INTRODUCTION

The spiralling whitefly is a serious pest of guava, pawpaw (*Carica papaya*), banana/ plantain, cassava, many vegetables and ornamentals (Akinlosotu *et al.*, 1993). It was first noticed outside its native area in Hawaii in 1978, and has since spread across the pacific and South East Asia (Martin, 1990). The whitefly occurred in the central Islands Hawaii, Guam Fiji, Cook Islands, the Philippines and Sarawak (Martins 1987). It has also been confirmed in India as a new pest of cassava (Palaniswami *et al.*, 1995). The spiralling whitefly is highly polyphagous having been found on 26 different plant families and over 100 plant species out of which guava, banana, frangipani, mango, sea grape and tropical almond appear to be the most preferred (Mound and Halsey, 1978). The spiralling whitefly has recently been confirmed in Nigeria (Akinlosotu *et al.*, 1993) and in Benin (Neuenschwander, 1994) where it sometimes occurs in large numbers on plant species from at least 32 different families.

The whitefly sucks sap from leaves and where it occurs in large numbers, thei honeydew deposits encourage the growth of sooty mould on the foliage leading to marked reduction in the photosynthetic surfaces of such foliage and consequent drop i fruit production. The whitefly also causes yellowish speckling on the leaves as they suc out the sap, and in severe infestation, the leaves wrinkle and curl (Palaniswami *et al.* 1995). Infestations pose a serious threat to subsistence farmers in areas where fruit cro and vegetables are the most available food for providing energy and vitamins in the diet

Whitefly control methods include pruning and burning of the infested plants anc application of insecticides such as cypermethrin; these however, give short-lived contro (Akinlosotu *et al.*, 1993). Dimethoate and buprofezing have also been reported to be effective against the whiteflies especially the larval forms (Wijesekera and Kudagamage, 1990). In Nigeria, the pest is a cause of great concern because like other exotic pests it has great potential to become widespread especially in the absence of its natural enemies. However, the endo-parasitic wasps, *Encasia haitiensis* Dozier and *E. guadeloupae* Viggiani (Hymenoptera: Encyrtidae), which parasitise the whitefly, were found in the Republic of Benin and some parts of Nigeria together with the whitefly (Akinlosotu *et al.*, 1993; Neuenschwander, 1994). This suggests that since there was no formal release of these parasitoids anywhere in Nigeria, the wasps must have been introduced together with the whitefly from the neighboring countries. Successful biological control of the spiralling whitefly has been reported in Hawaii where the released *E. haitiensis* and the predator, *Nephaspis amnicola* caused a 79.0% and 98.8% reduction in the population of the whitefly in the lowland and highlands of Honolulu respectively (Kumashiro *et al.*, 1995). Similarly, within a year of the release of *E. haitiensis* in South Pacific, Fiji Island, the population of the whitefly crashed so much so that it was no longer a problem (Anon., 1992). The coccinelid beetles, *Menochilus sexmaculatus* and *Seymnus* sp., which prey on the spiralling whitefly has been reported to cause a decline in the population of the whitefly in India (Palaniswami *et al.*, 1995).

The whitefly, since its discovery in West Africa, has been an object of study so as to gather detailed information on its biology and ecology as well as that of its natural enemies. These are very necessary in designing an appropriate and ecologically sound control strategy for the pest. This paper therefore, reports on some aspects of the biology of *A. dispersus* and its comparative life cycle on some of its host plants.

MATERIALS AND METHODS

Environmental conditions

Studies were carried out in two quarantine facilities: (i) In the laboratory condition where temperature was $25^0 \pm 2^0$C and relative humidity, RH, was 70% - 80% while fluorescent tubes provided lighting supplied on a 12:12 (L: D) photoperiod

throughout the study. (ii) In the screen house where temperature ranged between 28^0 C and 32^0 C (mean 30^0 C) with 50-70% RH and the plants received direct sunlight throughout the duration of the experiments.

Culture of *Aleurodicus dispersus*

Aleurodicus dispersus used for the studies were reared and maintained on the foliage of guava plants grown in soil in round plastic pots (5 litres) kept in wooden cages (45 cm x 45 cm x 45 cm). Each cage had a glass top, sides with net and a door with two sleeve openings to facilitate access into the cage. The stock culture of the whiteflies was maintained only in the screen house. There were 3 cages and each cage contained three young guava seedlings. Adults of the spiralling whiteflies were collected from guava plants in the fields by severing the infested leaves from the plants. The whiteflies from the field were then (gently) placed on the leaves of the plants in 3 cages to serve as the culture.

Life Cycle Studies

Twenty rearing cages were used for this experiment. Each cage contained 2 potted guava seedlings and with an aspirator, 25 - 30 pairs of adult whiteflies were transferred onto each potted plant in the cage from the stock culture. After 24 hours of oviposition the adult whiteflies were removed from the plants. A set of 10 cages out of the 20 artificially infested cages was placed in the laboratory condition and the other set was placed in the screen house, and thus represented 10 replicates for each of the experiments. Through the 2 sleeve openings the plants were watered every other day in the screenhouse and 3 times per week in the laboratory. The number of eggs produced and the duration of the first, second, third and fourth instar stages were monitored daily and recorded until the death of the adult. A larva from each of the cages was taken out everyday for description and measurement using a micrometer attached to a stereo-binocular microscope and was later returned to its cage. Freshly emerging adults were transferred into10 different cages; five of the cages were put in the screenhouse while the other five were in the laboratory condition. Pre-oviposition period, fecundity and longevity of *A. dispersus* were then observed under both systems. Data were subjected to the analysis of variance procedure and means were separated using Tukey's Honestly Significant Difference ($P < 0.05$).

Comparative Life Cycle Study

The twelve test plants listed in table 2 were used for the study. Tomato (*Lycopersicum esculentum)* Mill., pepper (*Capsicum anuum)* Linn., pawpaw (*Carica papaya)* Linn. and guava (*Psidium guajava)* Linn. were raised from seeds; fig (*Ficus polita)*Vahl., frangipani (*Plumeria rubra)* Linn., cassava (*Manihot esculenta*) Crantz,

croton (*Codiateum variegatum)* (Linn.) Blume and *Acalypha wilkensiana* Mull. Ar were from cuttings; mango *(Mangifera indica*) Linn. from grafting; sweet orange (*Cit sinensis*) Linn. from budding while plantain (*Musa paradisiaca*) Linn. was raised fi suckers. Ten seedlings of each of the 12 plant species mentioned were grown in diffe round plastic pots (5 litres) and each was transferred to a cage (45 cm x 45 cm x 45 c at early leaf production stage for the study. With an aspirator, 25 - 30 pairs of ac whiteflies were transferred onto each potted plant. After 24 hours of oviposition, adult whiteflies were removed from the plant and the number of days for the eggs develop into adults were monitored and recorded. Data were subjected to the analysis variance procedure and means were separated using Tukey's Honestly Significa Difference ($P < 0.05$).

Table 1: Measurements of the various developmental stages of the spiralling whitefly

Stage	Length (mm)	Width (mm)
Egg	0.32 ± 0.02a	0.24 ± 0.04a
1st instar larva	0.62 ± 0.20b	0.16 ± 0.06b
2nd instar larva	1.00 ± 0.30c	0.20 ± 0.08c
3rd instar larva	1.21 ± 0.40d	0.25 ± 0.07d
4th instar larva	1.40 ± 0.80e	0.85 ± 0.60e
Adult (male)	2.10 ± 0.40f	1.20 ± 0.70f
(female)	2.30 ± 0.30g	1.30 ± 0.40f

Means followed by the same letters in the same column are not significantly ($P \geq 0.05$) different from one another (Tukey's Honestly Significant Difference, HSD).

RESULTS AND DISCUSSION

The eggs were observed to be cylindrical in shape, laid in a spiral manner and were covered with white powdery material. The spiral manner of egg-laying from where it derived the name is because the ovipositing female rotates her ovipositor while she fixes her mouth part in a position during egg laying (Anon., 1992). The eggs are attached to the leaves by short pedicels. Most times, the eggs were laid on the lower surface of the

leaves, though at times they may be found on the upper surface when infestation is heavy. There were no differences in the sizes of eggs produced in the laboratory condition and in the screenhouse. Mean length was 0.32 ± 0.02 mm while the egg width was 0.24 ± 0.04 mm. The length of egg was slight at variance with the reports of 0.2 mm by Gameel (1974) on *Bemisia tabaci* in Sudan; this is probably because most members of the genus *Aleurodicus* are physically larger than *Bemisia tabaci* (Gill, 1990). Duration of the egg stage was 6 – 10 days.

The first-instar larvae were pale yellow in colour but were covered with white wax. They were able to crawl but did not leave the leaves on which they hatched. After a few minutes of crawling they stopped and started feeding. The body sizes from the screenhouse and the laboratory were not significantly different. The mean length was 0.62 ± 0.2 mm while the width was 0.16 ± 0.06 mm.

Table 2: Developmental times and mortality of the immature stages of *A. dispersus* on guava

	Mean developmental times in days ± SD (and Mortality)			
	Laboratory condition		Glasshouse	
Period from egg to 1st instar larva	8.8 ± 1.2a	(0.0)	8.5 ± 1.5a	(0.0)
Period of 1st instar larva	4.6 ± 1.2a	(23.1)	5.0 ± 1.1a	(37.8)
Period of 2nd instar larva	3.5 ± 1.8a	(11.4)	4.3 ± 1.0b	(20.5)
Period of 3rd instar larva	3.2 ± 0.1a	(6.6)	4.9 ± 0.9b	(7.7)
Period of 4th instar larva	4.0 ± 2.4a	(5.8)	5.3 ± 1.2b	(6.2)
Total development time	24.1 ± 1.0a	(46.9)	28.0 ± 2.1b	(72.2)
Pre-oviposition period	1.0 ± 1.9a		2.9 ± 3.6b	
Oviposition period	5.1 ± 4.2a		4.3 ± 2.1a	
Longevity	7.5 ± 4.6a		7.3 ± 4.1a	

Means followed by the same letters in the same row are not significantly ($P \geq 0.05$) different from one another by Tukey's, HSD.

Table 3: Developmental time for *A. dispersus* from egg to adult on different host at 25.0 ± 2°C

Host	Mortality (%)	Developmental time	
	Mean ± SD	Mean ± SD	(Range)
Frangipani (*Plumeria rubra*)	86.2 ± 10.8	31.7±1.9a	(29 - 34)
Mango (*Mangifera indica*)	86.1 ±6.8	30.0±2.1ab	(27 - 34)
Pawpaw (*Carica papaya*)	84.9 ±8.6	29.8±1.0b	(27 - 31)
Tomato (*Lycopersicum esculentum*)	82.7 ±12.2	29.4±2.0b	(27 - 31)
Fig (*Ficus polita*)	82.5 ±9.4	29.2±2.3b	(26 - 32)
Pepper (*Capsicum anuum*)	76.6 ± 6.8	27.2±1.2c	(26 - 29)
Sweet orange (*Citrus sinensis*)	74.1 ±10.2	26.5±0.8cd	(25 - 28)
Cassava (*Manihot esculenta*)	73.9 ±7.2	26.4±1.6d	(24 - 28)
Croton (*Codiatum variegatum*)	73.5 ±12.4	26.1±11.4d	(24 - 28)
Acalypha (*Acalypha wilkesiana*)	73.0 ±8.3	25.8±1.9de	(24 - 29)
Plantain (*Musa paradisiaca*)	72.8 ±4.2	24.3±1.1e	(23 - 26)
Guava (*Pisdium guajava*)	72.2 ±8.6	24.1±1.0e	(22 - 25)

Means followed by the same letters are not significantly (P>0.05) different from one another by Tukey's, HSD.

(Table 1). The mean developmental times and the mean mortality rate of the immature stages of *A. dispersus* are presented in Table 2. Development to the second-instar took about 5 days. The second instars were sessile and were more yellowish than the first instar. Because they were sessile, their legs and antennae were not as developed as in the first instar. They were oval in shape and were also covered by a thick whitish woolen mass; they were of course, longer than the first instar. The mean length was 1.00 ± 0.3 mm while the mean width was 0.20 ± 0.08 mm. The third instar larvae looked very much like the second instars though they were brownish in colour. They were 1.21 ± 0.4 mm in length and 0.25 ± 0.07 mm in width; the stage lasted for about 4 days. The fourth instars were also sessile but were dark brown in colour. Total larval period ranged between 24.1 and 28.0 days.

The adults had four wings and emerged through an opening on the fourth instar case. The adults were covered completely with white wax but their wings were yellowish in colour and covered the entire body length except the head and the ovipositor. The body length was 2.1 ± 0.4 mm and 2.3 ± 0.3 mm for male and female adults respectively. Longevity was 4 -11 days (mean: 7.3 ± 4.1 days) though some of the females in the laboratory condition lived up to 12 days. Total number of eggs laid per individual varied in the screen house and the laboratory: 28.4 ± 8.5 in the former and 30.8 ± 9.6 in the latter. Sex ratio was 1:1 and adult females had a pre-reproductive period of about 3 days in the screen house but only 1 day in the controlled environment. *Aleurodicus dispersus* thus had a life cycle from egg to reproductive adult of around 24 -29 days and each female could produce 26 -31 eggs. These results conform to the reports of Avidov (1956) and Butler *et al.* (1983) who reported 3 - 4 weeks= duration for the life cycle of *Bemisia tabaci*. Wijesekera and Kudagamage (1990) in Sri Lanka and Palaniswami *et al* (1995) in India however, reported 18 – 23 and 25 – 48 days respectively for the life cycle of *A. dispersus*.

In the screen house, larval mortality was around 72.2% during development to adult in both sexes, of this, 37.8% occurred in the first instar while mortality was only 46.9% in the laboratory. The mortality rate of 72.2% was a little less than that reported for *Bemisia gossypiperda (=tabaci)* (Husain and Trehan, 1933). The developmental period and mortality rate may be more under natural condition due to several environmental factors that come into play. Generally, the features revealed in the life cycle study pointed to the short developmental period of the spiralling whitefly and its ability to colonize its host and reproduce at a fast rate. This makes the insect an economic pest, which deserves immediate attention.

The times required for *A. dispersus* to complete development from egg to adult on some selected field vegetable, fruits, tuber crops and ornamental plants in the laboratory are presented in table 3. The minimum developmental time was 22 days on guava making it the most preferred and 34 days on frangipani and mango making them the least preferred. The results of this study confirmed the pest status and the wide level of polyphagy of *A. dispersus* on horticultural plants.

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