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Assessment of the incidence and intensity of major cocoa insect pest and Disease in southwest region of Nigeria

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Abstract
A field survey was conducted in the cocoa growing states in Southwest Nigeria in the 2017/2018 year with the objective of assessing the incidence and intensity of diseases and pests affecting cocoa farms in the region. Data were collected by random sampling of 100 trees on three farms in three local government areas of each state. The trees were screened for the presence or absence of insect pests, disease symptoms, parasitic and saprophytic weeds. All the data generated were analyzed using simple descriptive statistics of their various means and reported in percentages. Black pod and the cocoa swollen shoot virus (CSSV) are the primary disease affecting the region with black pod being very severe (51.56%). Major insect pests in the region are cocoa mirid (11.44%), termites (13.16%) and the pod husk borer (7.46%). Mistletoes and moss weed pests were recorded in the region. Management strategies to control the pest and to prevent the transportation of the pest and/or disease material into a state of low incidence should be developed.

Keywords: Cocoa, mirids, black pod, insect pests, diseases, incidence, infestation

Introduction
The cocoa tree (*Theobroma cacao*) belongs to the family Malvaceae and the genus *Theobroma* [1, 2]. Cocoa was introduced to Nigeria in 1874 from the Latin American continent and was first cultivated in Bonny Island in present-day Rivers State [3, 4]. Cocoa production is an important source of livelihood for thousands of people in Nigeria's cocoa-growing communities. Cocoa is grown in 14 states (Ondo, Osun, Ogun, Oyo, Ekiti (South-West), Abia, Akwa-Ibom, Cross River, Delta, Edo (South-East), Kwara, Kogi, Taraba and Adamawa (Northern) in Nigeria [5]. Cross Rivers State is the second-largest producer (19%), next to Ondo state with 21% production [6].

The cocoa production in Nigeria has been fluctuating with Nigeria going from being the second world's largest producer in 1965 to the fourth-largest producer in 2006 [6] and fifth in the world and third in Africa [7, 8]. Côte d'Ivoire and Ghana are the highest producers followed by Cameroon and Nigeria [9]. A significant issue in cocoa production amongst others is the challenge of controlling insect pests [10, 11]. Several pests and diseases attack the Cocoa plant with losses estimated to be over 30% [12]. Insect pests of the cocoa tree include stink bugs (*Bathycoelia thalassina)*, grasshopper, (*Zonocerus. Variegatus),* psyllids (*Ttyora tessmanni*), cocoa mirids/capsids (*Sahlbergella singularis)* and (*Distantiella theobroma)*, pod husk borers (*Characoma Stictigrapta*), shoot feeders (*Anomis leona* Schaus), (*Earias biplaga*) and (*Sylepta retractalis*), cocoa stem borer (*Eulophonotus myrmeleon* (Fldr) and the mealybugs [13, 14]. Insect pests and diseases have largely contributed to the declining productivity of cocoa in Nigeria. A yield loss of 25 - 30% cocoa has been attributed to the cocoa mirid, *Sahlbergella singularis,* 17% is lost through the feeding of the cocoa pod borer *Characoma strictigrapta*, while losses attributable to the major disease of cocoa (the black pod disease caused by *Phytophtora* species) range from 30 – 90% [15, 16].

Although cocoa is widely grown in Nigeria, there have been no recent report updates on the insect pest and diseases affecting cocoa and their adopted damage patterns in the region. This study aims at surveying and assessing the severity of pests and diseases associated with cocoa farms in the Southwest region of Nigeria.

Materials and Methods

Study site

The study was carried out in all the cocoa producing areas of the Southwest region of Nigeria (Oyo, Osun, Ondo, Ekiti, and Ogun states) (Fig 1) during the 2017 to 2018 production seasons.

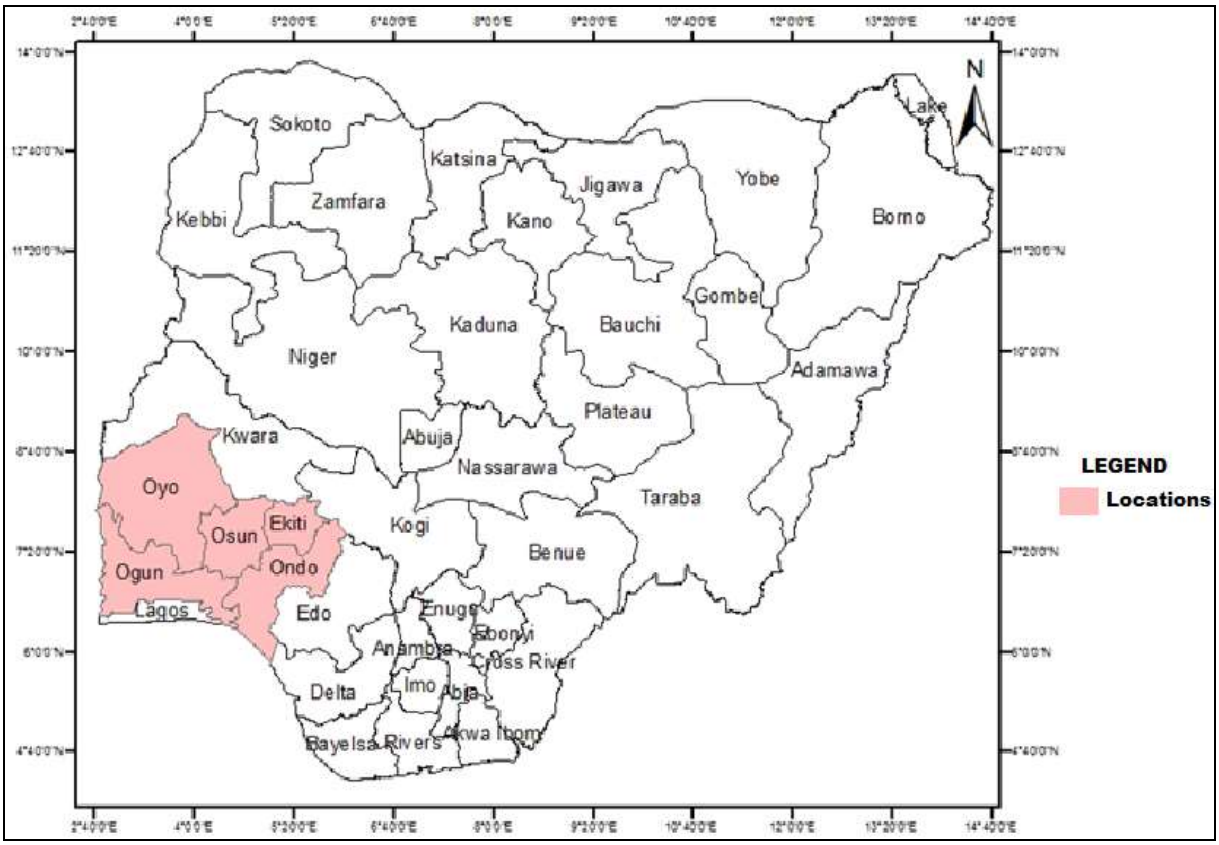

Fig 1: Map of Nigeria showing the study locations

Survey and sampling techniques

The sampling was carried out in three different Local Government Areas (LGAs) of each state above where cocoa is grown in commercial quantities. In each LGA, three 2ha commercial cocoa farms were sampled. On each farm, a total of 100 randomly selected stands of cocoa trees were sampled by systematically traversing the farms at both diagonals and longitudinal ends.

Each selected cocoa plant was closely observed for diseases and insect pest species and their symptoms on the leaves, twigs, stems, flowers, pods and cherelles and their presence or absence are noted and scored. Scoring is done by using 100 pebbles kept as counters; one counter is kept in the pocket for every infested/infected tree and the uninfected tree counter is discarded. The number of counters kept gives a sensitive measure of damage, which determines the percentage of damage.

Insect pest and disease incidence mapping

The percentages of insect and weed pest infestation and disease infections of the farms were assessed, and the pest mapping of the areas was carried out using three points scale below:

1. + (≤ 5% trees affected) - Low pest incidence
2. ++ (6 - 25% trees affected) - Moderately spread
3. +++ (≥ 30% trees affected) - Widely spread

Finally, field pictures were taken with a digital camera and all the farms sampled were geo-referenced using the GPS (Table. 1).

Table 1: Geo-reference locations of representative cocoa plots in each state

Location	Latitude	Longitude	Altitude	Farm area
Oyo state	N 07.22382^{O}	E 003.86965^{O}	141m	2 ha
Osun state	N 07.49980^{O}	E 004.69841^{O}	142M	2 ha
Ondo state	N 07.16667^{O}	E 004.97712^{O}	131M	2 ha
Ekiti state	N 07.85733^{O}	E 005.57132^{O}	541m	2 ha
Ogun state	N 07.22197^{O}	E 003.71672^{O}	153 m	2 ha

Data Analysis

All data generated from this study were analyzed using simple descriptive statistics of their various means and reported in percentages.

Results

Disease incidence and intensity across the states

Diseases of cocoa were found to be widely distributed across the Southwest cocoa agro-ecologies/ states. The black pod disease was found to be widely distributed across the five Western states of Nigeria sampled. The pest mapping using the three-point scale in this study showed that there was a widely spread incidence (+++) of black pod disease in all the cocoa plantations in the Southwestern region (Table 2). The highest rate of 58.3% infection was recorded in Oyo state. Mild infection of Cocoa Swollen Shoot Virus Disease (CSSVD) (0.58%) was recorded across the Southwest region (Fig. 2). However, there was no infection of CSSVD noticed at Ekiti cocoa plantations sampled, although the vector of the virus (mealybug) was found in the state.

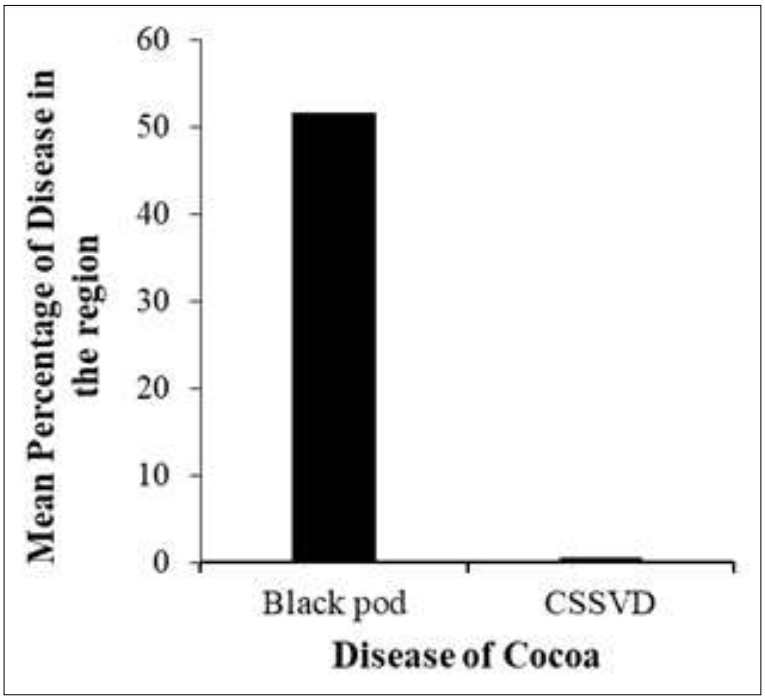

Fig 2: Mean percentage of diseases affecting cocoa farms across Southwest region, Nigeria

Table 2: Incidence and intensity of major diseases, insects and weed pests of the cocoa farm in the Southwest cocoa-producing States of Nigeria

Pest	Pest incidence percentage (%) in all States				
	Oyo	Osun	Ondo	Ekiti	Ogun
Diseases					
Black pod	58.3^{+++}	51.9^{+++}	45.7^{+++}	53^{+++}	48.9^{+++}
CSSVD	1.1^{+}	0.6^{+}	0.4^{+}	0	0.8^{+}
Insect pests					
Mirids	19.2^{++}	8.2^{++}	7.7^{++}	10.9^{++}	11.2^{++}
Cocoa Stem borer (*Eulophonotus myrmeleon* [Fldr])	3^{+}	1.4^{+}	1.3^{+}	1^{+}	2.1^{+}
Termites	14.9^{++}	15.1^{++}	6.4^{++}	12.1^{++}	17.3^{++}
Shield bug	1.7^{+}	1.4^{+}	**1.3^{+}**	1.6^{+}	0.9^{+}
Pod husk borer *Characoma stictigrapta)*	13.2^{++}	5.2	4.6	6^{++}	8.3^{++}
Psyllid	3.1^{+}	3.3^{+}	2.7^{+}	1.3^{+}	1.6^{+}
Grasshopper	3.5^{+}	4.7^{+}	3.3^{+}	3.9^{+}	2.4^{+}
Mealybugs	2.6^{++}	2.2^{++}	2.0^{++}	1.2^{++}	1.4^{++}
Weed pests					
Mistletoes	13.2^{++}	13.2^{++}	14.1^{++}	8.2^{++}	12.7^{++}
Mosses	28.6^{++}	26.3^{++}	26.9^{++}	25.3^{++}	25.7^{++}
Other pests					
Squirrels	4.8^{+}	4.6^{+}	4.8^{+}	3^{+}	2.1^{+}

Insect pest incidence and intensity across the states

Major insect pests recorded in the region include mirid, stem borer and termite. The mirid infestation levels across the states ranged from 7.7% to 19.2% with the highest incidence found in Oyo state. The cocoa stem borers *Eulophonotus myrmeleon* had a low infestation rate ranging from 1% to 3%. The termite infestation was at an alarming rate in all the states ranging from 6.4% to 14.9% damage levels (Table. 2; Fig. 3).

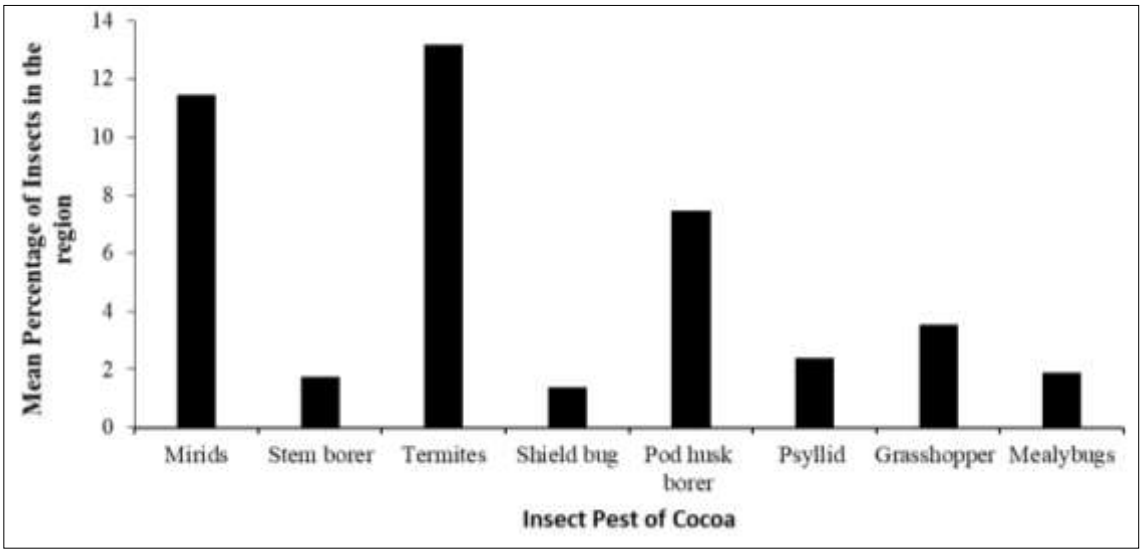

Fig 3: Mean percentage of insect pests affecting cocoa farms across Southwest region, Nigeria

Weed pests such as mistletoes and mosses were found devastating most cocoa plantations in the region. The parasitism level of mistletoes ranged from 8.2% in Ekiti state to 13.2% in Oyo and Osun states respectively. The devastating effects of mosses were at a very high rate in all the states ranging from 25.3% to 28.6% (Table. 2; Fig. 4). Squirrels were recorded in all states in the study area, although in low intensity.

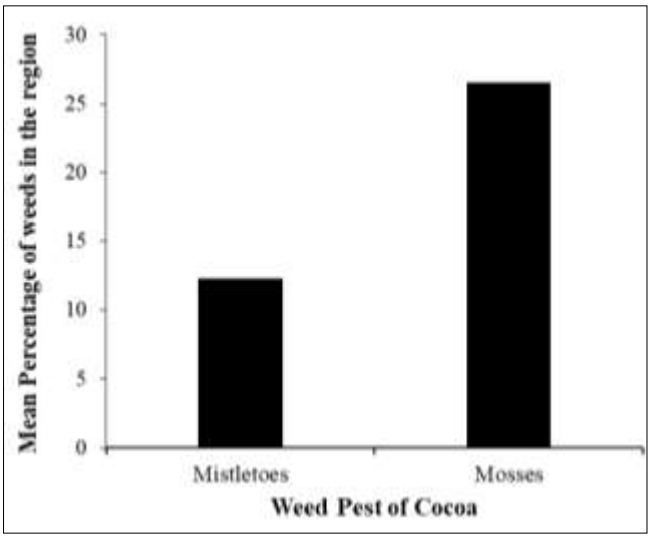

Fig 4: Mean percentage of parasite & saprophyte weeds affecting cocoa farms across Southwest region, Nigeria.

Discussion and Conclusion

Pests and diseases are widely distributed across the Southwest cocoa-producing states. The findings from this study show that black pod disease is widely distributed across cocoa-producing states and causes serious setbacks to pod setting and formation. It is the most prevalent disease and is known to cause a reduction in cocoa production [17]. The highest black pod disease infection rate of 58.3% recorded for Oyo state in this study could be attributed to the general non-maintenance of their farms as all the cocoa farms visited were partially abandoned. However, the disease prevalence could also be attributed to the high humidity nature of the study areas especially during the rainy season. Etaware *et al*., [18] reported that relative humidity of 75% and above favors the establishment of black pod disease and the study locations have that most time of the year. There is a positive correlation between rainfall and black pod disease [19] and the study area has a high amount of rainfall.

Although CSSVD is considered a significant disease in most cocoa-producing regions in West Africa [20, 21], this study further confirms the findings of Dongo and Orisajo [22] about the presence of CSSVD in the regions and effort should be made to suppress the re-establishment of the disease. The Cocoa Swollen Shoot Virus (CSSV) is gradually coming back to the Southwestern cocoa-producing states in Nigeria. The outbreak of CSSV disease was the main reason for establishing the West African Cocoa Research Institute (WACRI) in the mid 60's to contain the menace. Unfortunately, the disease (CSSVD), which hitherto before now has been contained in Nigeria, is gradually returning to the cocoa producing states. However, it is not widely spread in the study locations. Notably, there were no symptoms of CSSV reported in Ekiti state. This should be taken seriously and the movement of cocoa material into other states should be thoroughly screened to prevent the introduction of the disease into the state.

Mirid has been reported as the most important pest that attacks cocoa [23]. This is similar to the finding of this study, where our findings suggest it to be a msignificantinsect pest problem in the Southwest states of Nigeria. The highest mirid infestation rate of 19.2% recorded for Oyo state in this study could also be attributed to the general non-maintenance of their farms as all the cocoa farms visited were partially abandoned. The cocoa pod husk borer *Characoma stictigrapta* (Lepidoptera: Gracillariidae) is an economically important pest of cocoa in West Africa [24, 25].

Termite is a major pest of cocoa in the study location. It has been reported to be a major emerging pest of cocoa farms [26]. Termites cause direct damage by feeding on the roots and stems or by tunneling into the planted seedlings leading to the death of plants. They may also feed on young pods [27, 28]. Although its presence is obvious and well recorded, its damages to cocoa production is not well documented and should be studied.

Mistletoes are parasitic weeds affecting cocoa plants and have been reported to cause low productivity [29, 30, 31]. High levels of mistletoes found parasitizing most cocoa plantations in Nigeria due to the old status of the cocoa farms. Mosses were found to be a parasitic weed of cocoa production in the study

region. Mosses block spaces for developing the cocoa flower cushions on the stem and trunks, which drastically reduces pods productivity.

The squirrels were found mainly in unkept farms with interlocking branches, which facilitates their movement from one tree to the other unhindered. They are not new to cocoa farms and have been reported to cause damage to cocoa trees since the late 1990s (Han, 1982). Not only do they cause direct damage by chewing the pod, but they have also been reported to carry the spore of black pod around the cocoa tree [33].

It is therefore recommended planting materials should not be moved from states with high pest incidences to other cocoa growing states in Nigeria with lower incidences. For instance, movement of bud wood, seedlings, pod, or seeds from states where *Phytophthora megakarya* or CSSVD pose very high risk to states where the incidence is minimal should be prohibited to avoid rapid spread of insect pests and diseases.

To minimize potential risks associated with the movement of cocoa planting materials, it is vital that appropriate quarantine procedures are applied. Document on the safe movement of cocoa planting materials should serve as a reference point to guide researchers, breeders and curators when moving cocoa materials.

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