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## Role of Insect Pollinators in the Pollination of Coconut: *Cocos Nucifera* at Asante Mampong Municipality in Ashanti Region of Ghana

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### **Abstract**

*This research was conducted in the Asante Mampong Municipality in the Ashanti Region of Ghana from 27th June, 2018 to 16th October, 2019. The core objective of the study was to investigate into the role of insect pollinators in the pollination of three varieties of coconut (*Cocosnucifera*) on Coconut Plantation at Asante Mampong Municipality.*

*A five acre Coconut plantation was established in the year 2008. The major coconut varieties grown are namely; Hybrid Tall (HT), Malayan Yellow Dwarf (MYD) and Equatorial Guinea Dwarf (EGD). These varieties were grown in rows but mixed together with the inter row distance 7.5m X 7.5m for the short varieties and 9.0m X 9.0m for the tall varieties.*

*Six (6) individual coconut plants were selected randomly from each variety, making a total of eighteen (18) coconut plants for the investigation based upon their fruiting requirements using simple random sampling.*

*The results from the study showed that, there were more cross-pollination than self-pollination in Hybrid Tall (HT) and Malayan Yellow Dwarf (MYD). Both cross-pollination than self-pollination took place in Equatorial Guinea Dwarf (EGD).*

*Seven (7) insect species were found as coconut flower visitors. Out of the seven, three (3) species namely honey bees (*Apismellifera*) and stingless bees (*Dactylurina spp.* and *Meliponula spp.*)*

*Were the potential pollinators. Housefly (*Orinidiaspp.*), Wasps are occasional flower visitors foraging for resources for their colony. Ants were numerous but their structure and movement may have no effect on pollination.*

*Observation of foraging insects and pollinator counts were done on the inflorescence of the selected coconut plants. The foraging activities of bees occur at mid-day (11:00am-2:00pm) after which their activities gradually decline drastically (3:00pm-6:00pm). Intense foraging of bees occurs when temperature was between 27°C to 29°C (12:00pm-2:00pm). *Dactylurinaspp* prefers higher temperature than *Apismellifera* and *Meliponula spp.* Abundant *Dactylurinaspp* were observed at the temperature range of 27°C to 29°C between 12:00pm - 2:00pm while *Apismellifera* and *Meliponulaspp* were also in abundant at the temperature 27°C between 12:00pm-1:00pm.*

**Keywords:** *Coconut, pollination, pollinators, temperature, insect species, hybrid tall, Malayan yellow dwarf and Equatorial Guinea dwarf*

### **1. Introduction**

The coconut palm (*Cocosnucifera*) is the most known member of the palm family (Habibullah *et al.*, 2014 and Fan *et al.*, 2013). It is the only species recognized in the genus *Cocos* and belongs to the family *Arecaceae* (Palm family), (Fan *et al.*, 2013 and Freitas *et al.*, 2016). In many cultures around the world the local name for the coconut palm translates to “tree of life”, or “tree of heaven”, because of the numerous uses and products derived from the coconut palm (Rasheed *et al.*, 2016 and Verkley *et al.*, 2014 and Freitas *et al.*, 2016). *C. nucifera* is found throughout the tropics, with different varieties in different locations (Rasheed *et al.*, 2016 and Verkley *et al.*, 2014, Fan *et al.*, 2013 and Freitas *et al.*, 2016). In the southern parts of Ghana, coconut palms of the ‘West African Tall’ variety are common (Loiola *et al.*, 2016 and Lima *et al.* 2015).

The origins of the coconut palm, based on genetic analysis and origination of ‘Dwarf’ cultivars, are in Southeast Asia and the islands around the seas surrounding Indonesia and Malaysia (Habibullah *et al.*, 2014, Verkley *et al.*, 2014 and Fan *et al.*, 2013). From its origin, it naturally spread west to the east coast of Africa and east among the tropical islands of the Pacific (Habibullah *et al.*, 2014). Coconut would not have reached the west coast of Africa without human aid because of its inability to survive the duration of travel and southern climatic conditions that fall outside the coconut temperature tolerance. In addition, the coconut would not be able to compete in a trans-continental spread. Humans aided the spread of the coconut from West Africa to the Caribbean (Rasheed *et al.*, 2016, Loiola *et al.*, 2016 and Verkley *et al.*, 2014).

The introduction of the coconut palm to Ghana occurred about 500 years ago, within 50 years of 1499, when the Portuguese brought the coconut to the Atlantic coast of Africa (Habibullah *et al.*, 2014 and Lima *et al.* 2015). The coconut

palm was important along the coastal region due to the contribution to trade routes, but was not immediately of commercial importance. After World War I, however, large communal coconut plantations were established along the coast, in Ghana, with stimulation for the markets coming from both African and European interests (Ilfie, 2015 and Freund 2016). By the end of 1936, there were at least 5,693.4 hectares (14,076 acres) of coconut plantations located in southern Volta as well as the Eastern, Central, and Western regions.

There two main classifications of varieties which are the 'Tall' and the 'Dwarf'. 'Tall' varieties are more common. The fruit of the coconut is spherical to oblong in shape, and occur in bunches on the palm. They grow slowly and bear fruits 6 to 10 years after planting. As male flowers mature earlier than the female flowers, this type is highly cross-pollinated. 'Dwarf' varieties are generally shorter in stature and have thinner stem, fruit earlier, and have smaller fruits than the 'tall' varieties. Due to overlapping of male and female phases, the dwarf varieties are self-pollinated. (Rasheed *et al.*, 2016 and Loiola *et al.*, 2016).

Coconut provides man with food, drink, fuel oil and many other products. The coconut water is nutrient rich, almost perfectly isotonic, and aseptic enough to be used as an IV fluid and the kernel of the coconut, known for its high-oil content, is rich in saturated fatty acids (Rasheed *et al.*, 2016, and Loiola *et al.*, 2016). Saturated fatty acids are normally considered non-nutritious; however, evidence points to the contrary for fatty acids derived from the coconut (De Souza *et al.*, 2015). In fact, coconut oil is traditionally used medicinally for many illnesses. Some Pacific Islanders view coconut oil as the cure for all illness (Eyreset *et al.*, 2016). The amount and quality of oil in the kernel, however, varies among the variety and age of the coconut (De Souza *et al.*, 2015).

### 1.1. The Objective of This Study Was Therefore:

The main purpose of the study is to investigate into the Role of Insect Pollinators in the Pollination of Three Varieties of Coconut (*Cocos nucifera*) at Asante Mampong Municipality in Ashanti Region of Ghana.

## 2. Materials and Methods

### 2.1. The Study Area

#### 2.1.1. Description of the Study Area

##### 2.1.1.1. Geographical Location

The field experiments were carried out at the Coconut plantation site of the College of Agriculture Education, University of Education, Winneba, Mampong-Ashanti from 17<sup>th</sup> July, 2018 to 16<sup>th</sup> October, 2019. Mampong Municipality is located north -east of Kumasi, the Ashanti regional capital. It is bounded to the north by Atebubu District in the Brong Ahafo Region, east by Sekyere Central, south by Sekyere South and Ejura-Sekyedumasi to the West. The Municipality which covers a total land area of approximately 782km<sup>2</sup> with 69 settlements has geographical location lying between latitudes 7°4'0" North of the Equator and longitudes 1°24'0" West of the Greenwich Meridian. If respect to the plantation site, it covers an area of 14681.1m<sup>2</sup>, distance 450 meters.

### 2.2. Setting of the Study

The study was carried out to investigate the role of insect pollinators in the pollination of three varieties of coconut (*Cocosnucifera*) on CAGRIC coconut plantation. The Coconut plantation was established in the year 2008 with the total acreage of five (5) acres. The major coconut varieties grown are namely; Hybrid Tall (HT), Malayan Yellow Dwarf (MYD) and Equatorial Guinea Dwarf (EGD).

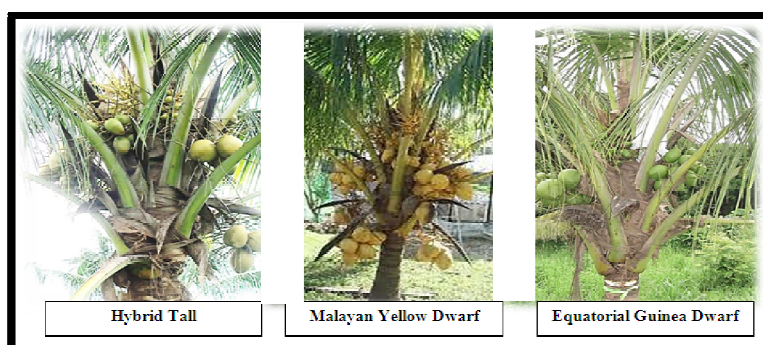


Figure 1.1: The Three Varieties of Coconut on CAGRIC Plantation

These varieties have grown in rows but mixed together with the inter row distance 7.5m X 7.5m for the short varieties and 9.0m X 9.0m for the tall varieties.

### 2.3. Sample Population and Sampling Procedure

Out of the three (3) major varieties of coconut in the plantation, six (6) individual coconut plants were selected randomly from each variety, making a total of eighteen (18) coconut plants for the investigation. That is, Hybrid Tall (HT):

HT1, HT2, HT3, HT4, HT5, HT6, Malayan Yellow Dwarf (MYD): MYD1, MYD2, MYD3, MYD4, MYD5, MYD6 and Equatorial Guinea Dwarf (EGD): EGD1, EGD2, EGD3, EGD4, EGD5, EGD6.

The three (3) main coconut varieties were identified in farm, and in each case, six (6) plants were selected based upon their fruiting requirements using simple random sampling.

## 2.4. Data Collection

### 2.4.1. Testing For Self-Pollination And Cross-Pollination In Coconut

The pollination experiment was conducted between 27<sup>th</sup> June, 2018 to 16<sup>th</sup> October, 2019, approximately 12 weeks. Six plants each from the three varieties of coconut in the plantation were sampled and bagged. The bagging was done on 27<sup>th</sup> June, 1<sup>st</sup> July and 19<sup>th</sup> July 2018. Bagging was done at least 6 days before any of the female flowers in an emasculated inflorescence became receptive. The receptivity of a female flower is denoted by the splitting of the white stigma and the secretion of nectar. The rectangular muslin net (bag) was slipped over the unopened inflorescence with its opening coming down over the peduncle and tied with a copper wire to prevent any flower-visiting insects from entering. The muslin net was of a fine mesh size so as to prevent any foreign pollen and insect from passing through. Daily observation was done on the set-up. Counting and recording of the female flowers was done after the opening of the spadix. As soon as the stigma of all female flowers necroses or turns brownish-black, the bag was removed and the female fruits counted and recorded.

The average number of fruit per plant for six plants per variety were added and divided by six for the mean number of fruits per variety (Malhotra et al, 2017, Abrol, 2015 and JAMATIA, 2016).

### 2.4.2. Sampling and Collection of Pollinators

The survey for pollinators was conducted between 27<sup>th</sup> June, 2018 to 16<sup>th</sup> October, 2019. Sampling was done by the researcher. The method that was used to sample pollinators was similar to Perera et al., 2016, Larekeng et al., 2015 and Pashte and Kulkarni, 2015). A quadrat measuring 1 meter by 1 meter was demarcated (Walters and Hansen, 2013) and six (6) plants 30m apart were sampled and tagged.

Hourly observation begun from 06:00am – 05:00pm for foraging and pollinators counts was done on flowers. Observation of foraging and pollinators counts were done on inflorescence flowering. Observations were made under conditions favourable for insects' flight, sunny or cool weather and weak wind. Sweep net sampling was used to reach pollination in the canopy of coconut. Sampling was done to collect flower visiting insects of the coconut bloom (JASMI, 2017 and Delaplane et al., 2013).

During the hourly observation, insect activities were observed and recorded under the following: insects that visited female flowers, insects that visited male flowers, insects that visited male flowers and moved to female flowers and insects that visited female flowers and moved to the male flowers. An opened spadix was scanned for pollination. Each inflorescence was observed for five minutes. A visit was defined as occurring when an insect touched the anthers or stigmas. Hourly temperature was taken to match with pollinator abundance recorded. This was done by the help of mercury-in-glass thermometer.

The sampled insects were killed by drowning in soapy water, cleaned in clear water by shaking and preserved in 70% alcohol. Samples of preserved insects were sent to taxonomists at the insect museum of the Entomology and Wildlife Development for identification. Dried and pinned specimens of insect pollinators were kept in the insect museum of the Development of Entomology and Wildlife, University of Cape Coast. The number of pollinators encountered per tree was taken as abundance.

## 2.5. Data Analysis

### 2.5.1. Comparison of Cross Pollination to Self-Pollination

The mean number of fruits for cross-pollination and self-pollination of each variety was calculated, significance was tested using ANOVA.

#### 2.5.1.1. Bagging Experiment

Fruits that were formed in each bagged (self-pollination) and unbagged (open-pollination) were recorded. Total number of bagged and unbagged from each tree were added and divided by two for average fruit per tree, the average number of fruits per tree for five trees in the landscape were added and divided by five for the mean number of fruits in the landscapes.

### 2.5.2. Species Composition of Insect Flower Visitors for Three Coconut Varieties

Species composition on total insect abundance was calculated and tabulated. Data on hourly insect visitor abundance per tree for the three varieties were recorded with hourly temperature reading. This information was used to plot graph to display effect of temperature on foraging.



Figure 2: Investigation into the Type of Pollination

2.6. Investigation into the Type of Pollination System

The results indicated different means for the varieties. Fruit formation due to cross-pollination for Hybrid Tall (HT) was higher (10.00) than that for self-pollination (2.67). T-test analysis indicated that cross-pollination is significantly higher ( $p < 0.008$ ) than self-pollination.

Results on Malayan Yellow Dwarf (MYD) indicate that cross-pollination (13.00) is higher than self-pollination (4.00). T-test analysis indicated that cross-pollination is significantly higher ( $p = 0.032$ ) than self-pollination therefore the null hypothesis ( $H_0 = CP = SP$ ) is rejected in both cases and the alternate hypothesis ( $H_A = CP \neq SP$ ) accepted for HT and MYD. There is more cross-pollination than self-pollination in HT and MYD.

For Equatorial Green Dwarf (EGD) field results indicated that, cross-pollination (11.83) was higher than self-pollination (5.00). However, t-test analysis indicated that the difference is not significant therefore the null hypothesis ( $H_0 = CP = SP$ ) is accepted that there is no difference between cross-pollination and self-pollination. The  $H_A = CP \neq SP$  is rejected. Therefore both cross-pollination and self-pollination are taking place.

Coconut variety	Type of Pollination		Mean	Std. Deviation	Std. Error Mean	T	Df	Sig. (2-Tailed)
	Opened Inflorescence	Bagged Inflorescence						
Hybrid Tall	10.00	2.67	7.33	4.18	1.71	4.29	5	0.008
Equatorial Green Dwarf	11.83	5.00	6.83	11.37	4.64	1.47	5	0.201
Malayan Yellow Dwarf	13.00	4.00	9.00	7.48	3.06	2.95	5	0.032

Table 1: Investigation into the Type of Pollination

Means followed by the same letter in superscript are not significantly different based on least significant (LSD) test at 95% significance level.

2.7. Species Composition of Insect Flower Visitors for Three Coconut Varieties

Seven species of insects were collected foraging on the three varieties of coconut and they consist of Ants, Honey Bee (*Apis mellifera*), Housefly (*Orinidiaspp*), Stingless Bee (*Dactylurinaspp* and *Meliponulaspp*), Big Wasp and Medium Wasp.



Figure 3: Species Composition of Insect Flower Visitors for Three Coconut Varieties

Honey bee (*Apis mellifera*), and Stingless Bees (*Dactylurina spp* and *Meliponula spp*), seem to be the major pollinators of coconut because they have special adaptive feature for the collection of pollen grain (the pollen basket on the hind leg). They were seen foraging on flower and storing pollen in their pollen basket and insects moved from male to female flowers, this may result in pollination. There were a lot of ants on all the varieties but their movement does not follow any order and seem not to contribute to coconut pollination. Wasps (Big and Medium) and Housefly are occasional visitors. Number of insect species on types: 6 on EGD and HT, 5 on MYD. Honey bees and ants were dominant on EGD (19.54) while Honey bees were dominant in HT (21.33) and MYD (20.63).

Insect Type	Variety of Coconut					
	Equatorial Green Dwarf (EGD)		Hybrid Tall (HT)		Malayan Yellow Dwarf (MYD)	
	Frequency	(%)	Frequency	(%)	Frequency	(%)
Ants	203	19.54	129	13.83	146	15.45
Honey Bee ( <i>Apis mellifera</i> )	203	19.54	199	21.33	195	20.63
Housefly ( <i>Orinidia spp</i> )	8	0.77	4	0.43	0	0.00
Stingless Bee ( <i>Dactylurina spp</i> )	169	16.27	99	10.61	179	18.94
Stingless Bee ( <i>Meliponula spp</i> )	29	2.79	37	3.97	33	3.49
Wasp (Big)	11	1.06	14	1.50	2	0.21
Wasp (Medium)	8	0.77	6	0.64	8	0.85

Table 2: Species Composition of Insect Flower Visitors for Coconut Variety

The Effects of Environmental Temperature on the Abundance of Foraging Insect Pollinators (*Apis mellifera*, *Dactylurina spp*, *Meliponula spp*).

2.8. The Effects of Temperature on the Abundance of Foraging Insect Pollinators on Hybrid Tall (HT)

Foraging activities of coconut flower visitors seem to be influenced by environmental temperature and time visit.

Inspection started at 6:00am when temperature was low (23°C) and foraging was relatively low. Mean number of *Apis mellifera* foraging by 6:00am at 23°C was 4.0. This increased gradually and peaked to a mean number of 11.0 by 12:00noon when the temperature was 27°C. Foraging deceased gradually after falling to a mean of 9.0 by 5:00pm at 25°C. *Dactylurinaspp* foraging by 6:00am at 23°C was 8.0. By 10:00am 25°C, no *Dactylurinaspp* was encountered. However, mean number of *Dactylurinaspp* peaked to a mean of 13.0 by 12:00noon at 27°C. Number of the insect fluctuated till 5:00pm at 25°C when 4.0 speices was encountered.

Mean number of *Meliponulaspp* countered by 6:00am at 23°C was 1.0. This fluctuated and peaked (8.0) by 1:00pm at 28°C. It gradually declined to 4.0 by 5:00pm at 25°C.

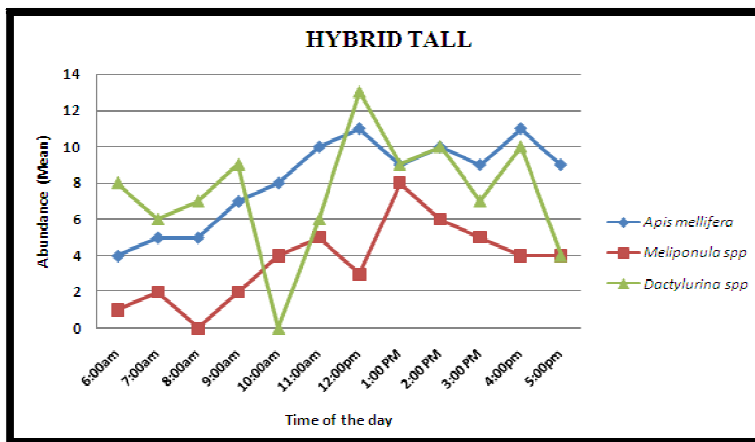


Figure 4: The Effects of Temperature on the Abundance of Insect Pollinators on Hybrid Tall

2.9. The Effects of Temperature on the Abundance of Foraging Insect Pollinators on Equatorial Green Dwarf (EGD)

The environmental temperature and time of the day influenced the foraging activities of coconut flower visitors especially the potential pollinators.

Inspection started at 6:00am when temperature was low (23°C) and foraging was relatively low. Mean number of *Apis mellifera* foraging by 6:00am at 23°C was 2.0. This fluctuated and peaked with a mean number of 20.0 by 12:00noon when the temperature was 27°C. Foraging deceased gradually after falling to a mean of 15.0 by 5:00pm at 25°C.

No *Dactylurinaspp* foraging was recorded by 6:00am at 23°C till 8:00am at 24°C. By 9:00am at 24°C, the number of insects started increasing gradually from 1.0 and peaked with a mean number of 27.0 by 2:00pm when the temperature was 29°C. Foraging deceased gradually after falling to a mean of 5.0 by 5:00pm at 25°C.

There was no foraging of *Meliponulaspp* by 6:00am at 23°C. This fluctuated and peaked (8.0) by 12:00pm at 27°C and gradually declined to 7.0 by 4:00pm at 27°C and the same mean was recorded 5:00pm at 25°C.

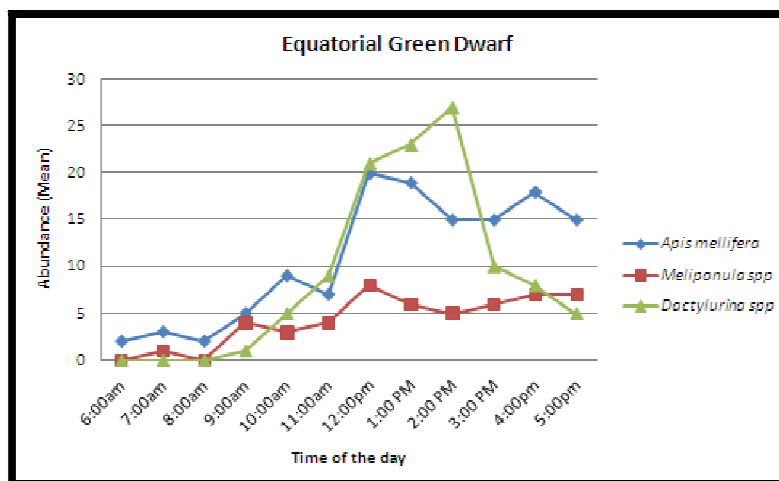


Figure 5: The Effects of Temperature on the Abundance of Insect Pollinators on Equatorial Green Dwarf (EGD)

2.10. The Effects of Temperature on the Abundance of Foraging Insect Pollinators on Malayan Yellow Dwarf (MYD)

The environmental temperature and time of the day influenced the foraging activities of coconut flower visitors especially the potential pollinators.

At 6:00am when temperature was low (23°C), the inspection started and foraging was relatively low. The mean number of *Apis mellifera* foraging by 6:00am and 7:00am at 23°C was 5.0. This fluctuated and peaked with a mean number of 20.0 by 2:00noon at 29°C being the highest temperature. Foraging deceased gradually to a mean of 15.0 at 3:00pm and 4:00pm with temperature 28°C and 27°C. However, by 5:00pm at 25°C the mean was 17.0.

No *Dactylurinaspp* foraging recorded by 6:00am and 7:00am at 23°C. However, by 8:00am at 24°C, the number of insects started increasing gradually from 2.0 and peaked to a mean number of 25.0 by 2:00pm when the temperature was 29°C. Foraging decreased gradually after falling to a mean of 7.0 by 5:00pm at 25°C.

There was 1.0 *Meliponulaspp* foraging by 6:00am at 23°C. This fluctuated and peaked (10.0) by 12:00pm and 4:00pm at 27°C respectively and declined to 9.0 by 5:00pm at 25°C.

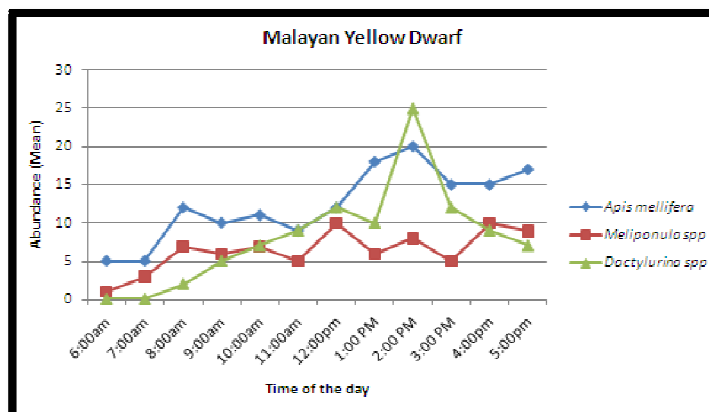


Figure 6: The Effects of Temperature on the Abundance of Insect Pollinators on Malayan Yellow Dwarf

### 3. Discussion

#### 3.1. Investigation into the Type of Pollination System

The results indicated that more cross-pollination than self-pollination took place in Hybrid Tall (HT) and Malayan Yellow Dwarf (MYD). This result confirms that of Thomaset *al.*, 2015, Gunn *et al.*, 2015 and Dinesh and Vasug (2016) who reported that, Tall variety has greater genetic variability as it is usually cross pollinated.

The field observation also indicated that, for Equatorial Guinea Dwarf (EGD), both cross-pollination and self-pollination occurred. These results are in consistent with Chan and Rasheed *et al.*, 2016, and Loiola *et al.*, 2016 who reported that, the male and female flowers of dwarf varieties of coconut mature at different times, encouraging cross pollination; however, self-pollination is possible.

#### 3.2. Species Composition of Insect Flower Visitors for Three Coconut Varieties

Among other insects, bees appear to attain highest abundance and species richness in the tropics, as well as the temperate regions (Edwardset *al.*, 2014 and Pardee *et al.*, 2014). In the tropics, honey bees and stingless bees are dominant. Honey bees have been recorded as potential pollinators (Goulsonet *al.*, 2015 and Fürs *et al.*, 2014). Certain groups of flies such as fruit flies are omnipresent on palm inflorescence in the tropics, but probably have less consequence for pollination (Buchmann, 2016, Martin 2014 and Thiessen, 2016).

The results of the study in Table 4.2 indicate that, Seven (7) insect species were found as coconut flower visitors. This is in line with Henderson, (2002) and Sholdt, (1966) who reported that a number of insects visit the coconut inflorescence. Out of the seven, three (3) species; honey bees (*Apismellifera*) and stingless bees (*Dactylurina spp.* and *Meliponula spp.*) may be potential pollinators. The present result is consistent with those that indicate that honey bees (*Apismellifera*) are the dominant flower visitors. This is consistent with (Edwardset *al.*, 2014 and Pardeeet *al.*, 2014). Honey bees are probably the most important pollinators (Goulsonet *al.*, 2015 and Fürs *et al.*, 2014.) Followed by stingless bees. This is because they presented the most appropriate foraging strategy of moving from the staminate flowers to the pistillate flower and cause accidental pollination (Abrol 2015 and Lok *et al.*, 2013). They are also equipped with adaptive structures with which they carry pollen grain and also carry pollen on their ventral surfaces which cause pollination as they move from the anthers to the stigma (Loket *al.*, 2013) Housefly (*Orinidiaspp*), wasp are occasional flower visitors foraging for resources for their colony. In addition, wasps have been reported to deter bees from foraging temporarily when present (Mattila and Seeley2014, Groulx, 2016).Ants were numerous during the study period but their structure and movement may have no effect on pollination.

#### 3.3. The Effects of Environmental Temperature on the Abundance of Insect Pollinators

The time of day when honeybees start and finish foraging often depends on ambient temperature, humidity and/or light levels, as well as the availability of floral resources the specific combination of factors is species-specific (Abrol 2015 and Lok *et al.*, 2013). Studies have shown that foraging and pollination are influenced by temperature ((Lok *et al.*, 2013 and Goulsonet *al.*, 2015).

From the results in figure 4.3, it can be deduced that most of the foraging activities of bees often occur mid-day (11:00pm-2:00pm) but from (3:00pm-6:00pm) their activities gradually decline drastically. Intense foraging of honey bees occur when temperature is between 27°C to 29°C. *Dactylurinaspp* prefers higher temperature than *Apismellifera* and *Meliponula spp.* Abundant *Dactylurinaspp* were observed at the temperature range from 27°C to 29°C (12:00pm-2:00pm) whiles *Apismellifera* and *Meliponulaspp* were also in abundant at the temperature 27°C (12:00pm-1:00pm). These

observations were encountered among the three varieties of coconut. This is consistent with Houdegbe et al., 2016 and Hamisi 2016), that *Dactylurina* spp prefers higher temperature for their foraging activities than *Apis mellifera* and *Meliponula* spp.

#### 4. Conclusion

From the study, it was concluded that more cross-pollination than self-pollination took place in Hybrid Tall (HT) and Malayan Yellow Dwarf (MYD). This result confirms that of Thomas et al., 2015, Gunn et al., 2015 and Dinesh and Vasug (2016) who reported that, Tall variety has greater genetic variability as it is usually cross pollinated. The field observation also indicated that, for Equatorial Guinea Dwarf (EGD), both cross-pollination and self-pollination occurred. These results are in consistent with Chan and Rasheed et al., 2016, and Loiola et al., 2016 who reported that, the male and female flowers of dwarf varieties of coconut mature at different times, encouraging cross pollination; however, self-pollination is possible.

Seven species of insects were collected foraging on the three varieties of coconut and they consist of Ants, Honey Bee (*Apis mellifera*), Housefly (*Orinidia* spp), Stingless Bee (*Dactylurina* spp and *Meliponula* spp), Big Wasp and Medium Wasp. Honey bee (*Apis mellifera*), and Stingless Bees (*Dactylurina* spp and *Meliponula* spp), seem to be the major pollinators of coconut because they have special adaptive feature for the collection of pollen grain (the pollen basket on the hind leg). They were seen foraging on flower and storing pollen in their pollen basket and insects moved from male to female flowers, this may result in pollination. There were a lot of ants on all the varieties but their movement does not follow any order and seem not to contribute to coconut pollination.

The environmental temperature and time of the day influences the foraging activities of coconut flower visitors especially the potential pollinators. For Hybrid Tall variety, Mean number of *Apis mellifera* foraging by 6:00am at 23°C was 4.0. This increased gradually and peaked to a mean number of 11.0 by 12.00noon when the temperature was 27°C. Foraging deceased gradually after falling to a mean of 9.0 by 5.00pm at 25°C. *Dactylurina* spp foraging by 6:00am at 23°C was 8.0. By 10.00am 25°C, no *Dactylurina* spp was encountered. However, mean number of *Dactylurina* spp peaked to a mean of 13.0 by 12:00noon at 27°C. Number of the insect fluctuated till 5:00pm at 25°C when 4.0 speices was encountered. Mean number of *Meliponula* spp encountered by 6:00am at 23°C was 1.0. This fluctuated and peaked (8.0) by 1.00pm at 28°C. It gradually declined to 4.0 by 5.00pm at 25°C.

For Equatorial Green Dwarf, Inspection started at 6:00am when temperature was low (23°C) and foraging was relatively low. Mean number of *Apis mellifera* foraging by 6:00am at 23°C was 2.0. This fluctuated and peaked with a mean number of 20.0 by 12.00noon when the temperature was 27°C. Foraging deceased gradually after falling to a mean of 15.0 by 5.00pm at 25°C. No *Dactylurina* spp foraging was recorded by 6:00am at 23°C till 8:00am at 24°C. By 9.00am at 24°C, the number of insects started increasing gradually from 1.0 and peaked with a mean number of 27.0 by 2.00pm when the temperature was 29°C. Foraging deceased gradually after falling to a mean of 5.0 by 5.00pm at 25°C. There was no foraging of *Meliponula* spp by 6:00am at 23°C. This fluctuated and peaked (8.0) by 12.00pm at 27°C and gradually declined to 7.0 by 4.00pm at 27°C and the same mean was recorded 5:00pm at 25°C.

For the Malayan Yellow Dwarf, At 6:00am when temperature was low (23°C), the inspection started and foraging was relatively low. The mean number of *Apis mellifera* foraging by 6:00am and 7:00am at 23°C was 5.0. This fluctuated and peaked with a mean number of 20.0 by 2.00 pm at 29°C being the highest temperature. Foraging deceased gradually to a mean of 15.0 at 3:00pm and 4:00pm with temperature 28°C and 27°C. However, by 5.00pm at 25°C the mean was 17.0. No *Dactylurina* spp foraging recorded by 6:00am and 7:00am at 23°C. However, by 8.00am at 24°C, the number of insects started increasing gradually from 2.0 and peaked to a mean number of 25.0 by 2.00pm when the temperature was 29°C. Foraging deceased gradually after falling to a mean of 7.0 by 5.00pm at 25°C. There was 1.0 *Meliponula* spp foraging by 6:00am at 23°C. This fluctuated and peaked (10.0) by 12.00pm and 4:00pm at 27°C respectively and declined to 9.0 by 5.00pm at 25°C.

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