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THE INSECT PESTS OF COFFEE AND THEIR DISTRIBUTION IN KENYA

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ABSTRACT
Coffee insect pests constrain the production of anticipated high coffee yield and quality. Knowledge of common insect pests on coffee is important to facilitate the designing of effective control strategies that are likely to vary from one coffee growing region to the other because of possible variation in their distribution. To ascertain the insect pests infesting coffee in Kenya, their distribution in different coffee growing agro-ecological zones and the common control strategies being applied, an extensive field survey was conducted in all coffee growing regions. The survey established a total of 20 insect pests as a constraint to coffee production as recorded from the respondents. Only nine (9) were common with over 20% of the surveyed coffee farms reporting their infestation. The Green Scales, *Coccus alpinus* De Lotto dominated in all the surveyed coffee farms, as was reported by 61.7% of the respondents. The insect pests reported varied in their distribution across the coffee growing agro ecological zones. Coffee thrips, *Diarthrothrips coffeae* Williams was major in UM1 where 52.8% of the farms reported thrips infestation. Both *C. alpinus* and *D. coffeae* equally dominated in UM2 with 61.5% of the farms reporting the infestation. In UM3, *C. alpinus* at 78.1% was most prevalent insect pest. The findings from the survey established that coffee suffers heavily from a complex of insect pests' infestation that constraint its productivity. Among these pests, *C. alpinus* was dominant in most coffee farms and agro ecological zones.

KEY WORDS: Agro-ecological zones, Insect pests, *Coccus alpinus* ,*Diarthrothrips coffeae* ,Infestation

INTRODUCTION

Coffee plays an important role in the global economy (FAO, 2002). The value added coffee industry is worth about US$ 70 billion worldwide, making it the second most important legally traded commodity in the world after oil (1CO, 2009). The crop is a major export earner in about 80 tropical and sub tropical countries in Africa, Asia and Latin America where it supports livelihoods for over 120 million people worldwide (Osorio, 2002). In Africa, it is a primary export crop with 33 million people growing it mainly on their subsistence farms (Kotecha, 2002). In Kenya, coffee is of economic importance where it contributes to about 11% of total export earning and with more than 10% of Kenyans deriving their income from this crop (Masaba *et al*., 1990). It is grown in the upper midland (UM) agro-ecological zone (agro-ecozone) which is subdivided into three sub-zones namely coffee–tea zone (UM_1), main coffee zone (UM_2) and marginal coffee zone (UM_3). The climatic conditions of these sub-zones differ especially in altitude, annual mean temperature and rainfall.

The UM_1 has an altitude of 1570-1810 m a.s.l, annual mean temperature of 18.4^{0}C and rainfall of 1650mm. The UM_2 lies between 1395-1675m a.s.l with an annual mean temperature and rainfall of 19.4^{0}C and 1465mm, respectively. The UM_3 lies between an altitude of 1330-1560m a.s.l., with annual mean temperature of 19.9^{0}C and low rainfall of 1270mm (Ralph and Helmut, 1983). A number of factors prevent coffee farming in some of these agro-ecozones. Growing of coffee at altitudes below 1400m a.s.l. is limited by drought, infestation by Coffee Berry Borer, *Hypothenemus hampei* (Ferri) among other insect pests and severe infection by Coffee Leaf Rust (CLR). At altitudes of 2000m a.s.l., growing of coffee is limited by low temperatures and the destructive Coffee Berry Disease (CBD) (Anonymous, 1989). Today, declining coffee production in Kenya has been a main challenge. The production has declined from 130,000 metric tonnes in 1988/89 to around 50,000 metric tonnes today. The decline is attributed to a number of reasons; Low international coffee market price following the collapse of the price support mechanism under the International Coffee Agreement (ICA) in 1989 (Anonymous, 2007), high cost of farm inputs, unfavorable weather conditions (droughts) and increased incidences of coffee pests. Pests have been a problem since mankind embarked on growing plants. The increasing incidences of coffee pests and their consequent control and management have significantly constrained economical production of coffee in Kenya. These coffee pests mainly include arthropods (insect pests), pathogenic micro-organisms (diseases) and weeds. Oeke *et al.*, (1995) estimated that from the total attainable production of eight crops (coffee included) worth US$580 billion, about 42% or US$ 240 billion was lost due to insect pests (15%) followed by pathogens (13%) and weeds (13%). In 1998, a total of US$ 34 billion worldwide was spent by farmers on protecting plants from insect pests and diseases (Yudelmon *et al*., 1998).Known key insect pests of coffee include the Coffee Berry Borer (CBB), *Hypothenemus hampei* (Ferrari); Antestia bugs, *Antestiopsis* spp.; Green scales, *Coccus alpinus* De Lotto and Leaf miners, *Leucoptera* spp. However, in Kenya other insect pests prevail and could be of economic importance or their status could have changed from minor pests to major ones. The distribution of insect pests depends primarily on the host plant and climatic conditions (Hubert, 1959). But temperature, solar radiation and relative humidity have

influence on physiological processes of coffee tree thereby playing an important role in defining its potential yield or ecological limitations (Camargo, 2008).

This study aimed to establish the common insect pests of coffee and their distribution in coffee growing agro-ecological zones that could be contributing towards the decline in coffee productivity. There was an assumption that Coffee is infested by many insect pests, and their distribution and management in coffee agro-ecological zones varies. The findings of this study focused towards future development of effective pest control strategies for various agro-ecozones.

MATERIALS AND METHODS

To establish the common insect pests of coffee, their distribution and management, an extensive survey was carried out that covered six of the eight coffee growing provinces and thirteen major coffee growing districts in Kenya (Table 1). Coffee farmers/respondents from the thirteen coffee growing districts were interviewed, with the UM-subzones (UM1, UM2, and UM3) taken into consideration in the random selection of farmers. The coffee growing districts surveyed per province were selected based on mean national coffee production (About 82% of the Kenyan coffee comes from the Central and Eastern provinces)

The sampling design

A sample size of N=120 (where N was the number of farms) was allocated to the six provinces in a proportionate stratified sampling design with $n=N.p_i$, where p_i was the proportion of coffee produced in each province. The allocated sample sizes for each province were distributed randomly among the subzones present in the selected districts. A total of 36, 52 and 32 farms/farmers were sampled or interviewed in UM1, UM2 and UM3, respectively (Fig. 1). In each UM-subzone, four farms were selected for the survey of insect pests (Table 1). Following the principle of disproportionate, most of the sampled farms (70%) were located in eastern and central provinces, which are the main coffee-growing regions in Kenya (Table 1).

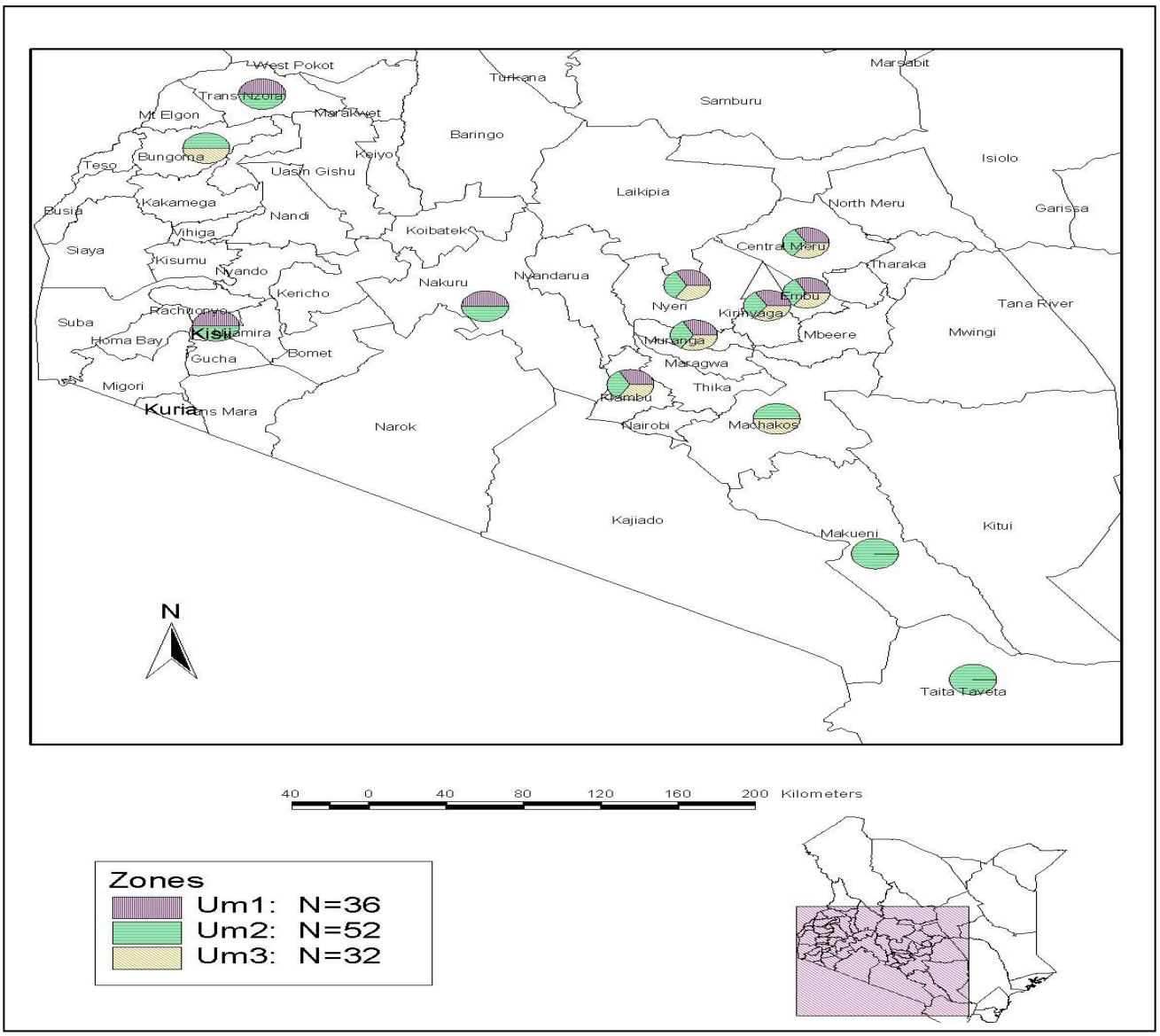

FIGURE 1: Distribution of surveyed coffee growing districts and their agroecozones in Kenya
***Source**: Regional Centre for Mapping of resources for development*

Distribution of coffee insect pests

A face to face home interview using a structured questionnaire was used to determine common insect pests, their distribution and management practices exercised by the farmers. Farm owners (respondents) from the randomly selected farms in each agroecozone per district were interviewed. Details of coffee management practices and the common pests known by the farmers were acquired from the respondents and their farm records. The coffee insect pests mentioned by the farmer were confirmed by randomly selecting 10 coffee trees from each farm. The tree parts (flowers, leaves, berries, stems, branches and roots) were visually examined for the infestation and the actual presence of the coffee insect pests. The insect pests mentioned and known by the respondents were confirmed to be present and recorded on site, whereas the unknown ones were preserved in labeled specimen tubes and later identified at Coffee Research Station (CRS).

TABLE 1: Distribution of the surveyed coffee farms in the coffee-growing districts and their respective agro-ecological zones

Coffee district	Agroecozone	No of farms sampled / surveyed in each province					
		Coast	Eastern	Central	Rift Valley	Western	Nyanza
Taita Taveta	UM2	4					
Makueni	UM2		4				
Machakos	UM2,UM3		8				
Meru Central	UM1, UM2, UM3		12				
Embu	UM1, UM2, UM3		12				
Thika	UM1, UM2, UM3			12			
Muranga	UM1, UM2, UM3			12			
Nyeri	UM1, UM2, UM3			12			
Kirinyaga	UM1, UM2, UM3			12			
Nakuru	UM1, UM2				8		
Trans Nzoia	UM1, UM2				8		
Bungoma	UM2, UM3					8	
Kisii	UM1, UM2						8
TOTAL		4	36	48	16	8	8

TABLE 2: Insect pests established from the surveyed coffee farms and agroecozones

Common Name	Scientific Name	% farms attacked	Agroecozone
Coffee Berry Borer	*Hypothenemus hampei* (Ferrari)	25.0	UM1, UM2, UM3
Berry Moth	*Prophantis smaragdina* (Butler)	21.7	UM1, UM2, UM3
Thrips	*Diarthrothrips coffeae* Williams	55.8	UM1, UM2, UM3
Capsid bugs	*Lygus coffeae* (China)	30.8	UM1, UM2, UM3
Leaf miners	*Leucoptera* spp	33.3	UM1, UM2, UM3
Jassids	*Coloborrhis bellicose* Distant	18.3	UM1, UM2, UM3
Antestia	*Antestiopsis spp*	40.8	UM1, UM2, UM3
Yellow Headed Borer	*Dirphya nigricornis* (Olivier)	28.3	UM1, UM2, UM3
White Borer	*Anthores leuconotus* Pascoe	21.7	UM1, UM2, UM3
Green scales	*Coccus alpinus* De Lotto	61.7	UM1, UM2, UM3
Kenya Meallybugs	*Planococcus kenyae* (Le Pelley)	16.7	UM1, UM2, UM3
Fruit flies	*Ceratitis capitata* (Wiedemann)	4.2	UM1, UM2, UM3
Lace bugs	*Habrochila ghesquierei* Schouteden	11.7	UM1, UM2, UM3
Fried egg scales	*Aspidiotus sp*	1.7	UM1, UM3
Termites	*Odontotermes badius* Haviland	9.2	UM1, UM2, UM3
Aphids	*Aphis coffeae* Nietner	10.0	UM1, UM2, UM3
Stinging caterpillar	*Parasa vivida* (Walker)	5.0	UM1, UM2, UM3
Leaf skeletonizer	*Epiplema dohertyi* (Warren)	9.2	UM1, UM2, UM3
Systate weevils	*Systates spp*	3.3	UM1, UM2, UM3
Giant loopers	*Ascotis selenaria reciprocaria* (Walker)	4.2	UM1, UM2, UM3

RESULTS

The survey realized a complex of coffee insect pests. The insect pests occurred under various coffee varieties that have been under production for many years. During the survey the Scots Lab (SL-28 and SL-34), the improved Hybrid cultivar Ruiru- 11(R11), Kent 7 (K7) and Blue Mountain (BM) were the main commercial coffee varieties grown by the farmers, either singly or combined. The SLs and R11 were the common varieties grown in 41% and 22% of all the farms sampled, respectively. A combination

of SL/R11 followed with 18% of the farms whereas the rest either purely grown or combined only represented less than 10% each.

Distribution of coffee insect Pests

Twenty (20) coffee insect pests were established and found to constrain coffee productivity in the farms surveyed (Table 2). Ninety five (95 % (n=19)) were widely spread and occurred in all the three coffee agroecozones. The distribution of Fried egg scales, *Aspidiotus* sp. which constituted 5% (n=1) of the total insect pests occurred only across two agroecozones (UM1 and UM3) (Table 2). Nine (45% (n=9)) insect pests recorded were common with over 20% of the farms surveyed recording the infestion (Tables 2 and 3). The *C. alpinus* was the most common insect pest according to the survey where 61.7% (n=74) of the farms experienced the infestation (Table 3).

The pests' distribution and dominancy in the agro ecological zones differed. Thrips, *Diarthrothrips coffeae* Williams dominated in 52.8% of the surveyed farms in the UMI agroecozone. *Coccus alpinus* and *D. coffeae* were common in UM2 with equal distribution of 61.5%. In UM3, the occurrence of Green scales was 78.1% (Table 3).

TABLE 3: Percentage of common Insect pests in coffee growing agroecozones

Insect Pests	% infested	% attacked farms per agro- ecozone		
		UM1	UM2	UM3
Coccus alpinus	61.7	47.2	61.5	78.1
Diarthrothrips coffeae	55.8	52.8	61.5	50.0
Antestiopsis spp	40.8	33.3	40.4	50.0
Leucoptera spp	33.3	36.1	36.5	25.0
Lygus coffeae	30.8	38.9	19.2	40.6
Dirphya nigricornis	28.3	22.2	36.5	21.9
Hypothenemus hampei	25.0	8.3	28.9	37.5
Prophantis smaragdina	21.7	27.8	9.6	34.4
Anthores leuconotus	21.7	2.8	23.1	40.6

Table 4: Percentage levels of insecticides usage in coffee farms surveyed

Insecticide /Active ingredient	Trade name(s)	% No farms
Chlorpyrifos	Dursban	
Cabosulfan	Marshal	
Profenofos	Selecron	
Beta-Cyflutrin	Bulldock	
Lambdacyhalotrin	Karate	
Dimethoate	Folimat	42.5
Diazinon	Basudin	
Fenitrothion	Sumithion	
Malathion	Malathion	
Fenithion	Lebaycid	
Alphacypermetrin	Fastac	
Pyrethroid	Decis, Pyrene,	

TABLE 5: Percentage use of common insecticides in coffee growing agroecozones

Insecticide	% farms	% farms per agroecozone		
		UM1	UM2	UM3
Chlorpyrifos	17.5	17	23	9.4
Fenitrothion	14.2	19	12	13
Diazinon	5.8	8.3	3.8	13
Dimethoate	5.8	5.6	7.7	3.1

Management of coffee insect Pests

Use of insecticides was the most common pest control strategy applied in most of the coffee farms surveyed. The farmers used 13 insecticides to manage coffee insect pests. Approximately 42.5% of the farms surveyed applied insecticides (Table 4). Among the insecticides recorded, four (4) were common, each with over 5% of the farms surveyed using any of the products (Table 5). Chlorpyrifos (Dursban 480EC) was the commonly used insecticide among the farmers. At least 17.5% of the farmers interviewed applied Chlorpyrifos to control insect pests (Table 5).

The use of insecticides across the agro ecological zones varied but not significantly different (P>0.05) from each other (Fig. 2). They were mainly used in UM2 (44.2%) followed by UM1 and UM3 at 41.7% and 40.6%, respectively (Fig. 2). Fenitrothion (Sumithion) was commonly used in UM1 where 19.0% of coffee farmers used the product. In UM2, Chlorpyrifos was the common insecticide used (23.0%). Fenitrothion and Diazinon

(Basudin) were equally common in UM3 at 13.0% each (Table 5).

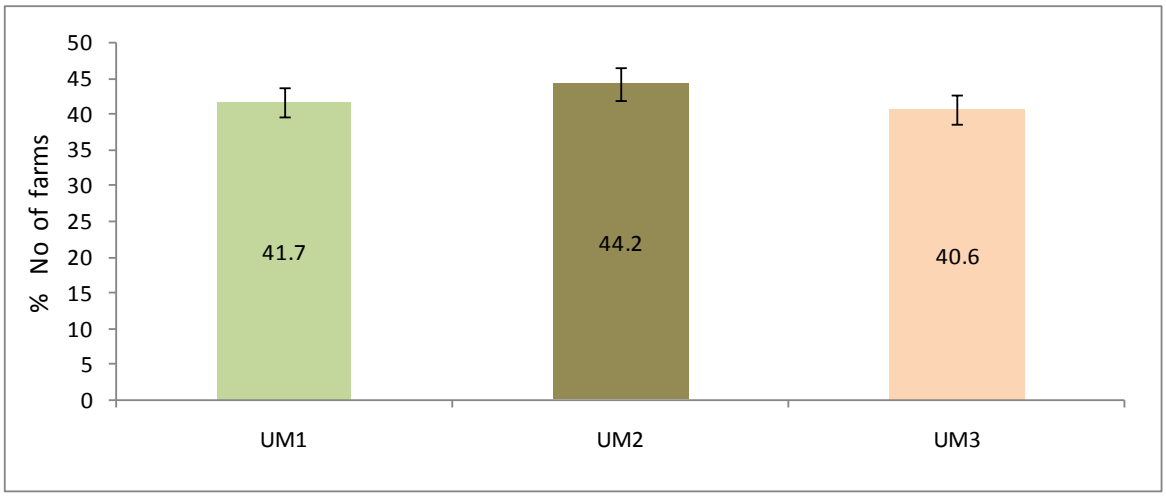

FIGURE 2: Percentage of coffee farmers using insecticides in different agroecozones

DISCUSSION

In Kenya, the mean coffee production per tree varies between the smallholder (2.8kg/tree/year) and estate (5-6kg/tree/year) coffee farmers. This variation is attributed to a number of reasons such as coffee varieties grown, pest attack and their management, farm management practices among others. The survey conducted indicated that insect pests of coffee are several and farmers have knowledge of their presence and occasionally the damage they cause. For instance it was realized that Coffee Berry Borer, a major pest of coffee infests the crop mostly without the knowledge of the farmer and may only be realized when the damage has occurred. Similar situations applied to other coffee insect pests such as Berry Moth and Antestia bugs. Under such a situation, heavy losses and expenditure are likely to be incurred leading to excessive application of insecticides that not only pollute the environment but also lead to imbalanced biological equilibrium.

The coffee varieties grown in various coffee growing regions ranged from those that are susceptible to common diseases; Coffee Berry Disease and Coffee Leaf Rust, to those that are resistant to the same diseases such as Ruiru 11. However, among all the coffee varieties none was resistant to the several insect pests that were established. When commercial farming of coffee started in Kenya, Antestia bug was the only common pest problem. But as coffee expanded to various growing regions more pests were realized to attack this crop. From what was established under this study, the number of insect pests has increased with time, an indication that they have coevolved together with coffee since its commercialization. As land cultivation for agricultural food production intensified, this could have also contributed to the increased establishment of coffee insect pests because some alternative host plants were cleared to pave way for food crops leaving coffee as the only or among other host plants to be infested. It was evident from the survey that coffee hosts a number of insect pests. Twenty (20) of them were observed, an indication that insects are major problems in coffee farming, although not all are key pests. In Kenya according to Mugo (1994) as many as 36 insect pests attack this crop. However, nine of these namely *A. leuconotus, Antestiopsis spp, C. alpinus, D. coffeae, D. nigricornis, H. hampei, L. coffeae, Leucoptera spp* and *P. smaragdina* were considered by farmers as most common. They were widely spread and occurred in all the coffee growing agroecozones. Thus their effect on coffee production is across all the coffee growing regions hence effective pest management practices need to be put in place.

It was observed that with changes in climate or global warming, different pests were suited to different agroecozones. For instance *D. coffeae* and *C. alpinus* dominated the UM1 and UM3, respectively meaning that the two pests prefer different climatic conditions more than the others. Both *D. coffeae* and *C. alpinus* were equally distributed in UM2.For high coffee yield and quality to be sustained, farmers need to employ good agricultural practices. Cultural practices for instance Pruning, fertilization, intercropping (leading to shading), buni stripping and mulching, are some of the strategies that contribute to the management of coffee insect pests. The practices as found to be carried out by the farmers could, therefore, be associated with farmer's knowledge on how to manage some major coffee pests. Alongside use of cultural practices, pesticides particularly insecticides were used by 42.5% of the farmers to manage coffee insect pests. It is well known that coffee farmers depend heavily on pesticides to control coffee pests despite this being associated with upsurge of new pests as a result of elimination of their associated biological control agents (Masaba and Waller, 1992; Mugo and Ndoiru, 1997; Vega *et al*., 2006).The coffee pests' complex established in this study requires effective and sustainable pest management strategies. Twelve (12) insecticides were used to control insects. With many insect pests infesting coffee, Chlorpyrifos with broad spectrum effect was found to be the most commonly used insecticide by farmers. The farmers in the three agroecozones were found to commonly and equally use insecticides, an indication that insect pests are a major constraint in coffee production in all the agroecozones. The distribution of coffee insect pests in coffee growing agroecozones varied widely. Some coffee producing regions e.g. Rift Valley and Western Provinces unlike those in Eastern and Central had low pest pressure. The variation in distribution of these pests in

different coffee growing regions could be due to the age and history of where coffee farming started in Kenya, the natural topographical barriers, heavy usage of pesticides, rainfall and temperature patterns, coffee farming systems and conserved biocontrol agents.

CONCLUSION

Based on the survey, coffee farming in Kenya is constrained by an attack from several insect pests among other factors that require a well designed Integrated Pest Management strategy aimed at managing the major insect pests to below economical injury levels.

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