Journal of Plant Protection Research ISSN 1427-4345

ORIGINAL ARTICLE

Farmers' knowledge and perception of cocoa insect pests and damage and the implications for pest management on cocoa in Ghana

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Vol. 61, No. 2: 145–155, 2021

DOI: 10.24425/jppr.2021.137022

Received: November 13, 2020
Accepted: December 23, 2020

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Abstract

Annual losses of cocoa in Ghana to insect pests are significant. The use of integrated pest management (IPM) tools is critical for effective pest management. Previous studies on the subject have considered how farmers perceive the economic impact of insect pests on cocoa. These studies however did not investigate farmers' ability to identify pests, associated damage symptoms and their implications for pest management. The current study, therefore, assessed farmers' ability to correctly associate insect damage with the pest species that caused it. A total of 600 farmers were interviewed in the Eastern, Ashanti, Western, Brong Ahafo and Central Regions of Ghana with a structured open and closed-ended questionnaire. Most farmers (>85%) were unable to correctly identify and associate pests to their damage. The majority (>80%) of farmers also could not link the immature stages of insect pests to their adult stages. Wrong identification of the major pests (>85%) led to a wide variation in the timing of insecticide application amongst farmers. The majority of the farmers (60%) interviewed had not received training in insect pest identification. The study shows that 90% of the farmers, who had received some training, got it from the Cocoa Health and Extension Division (CHED) of the Ghana Cocoa Board (COCOBOD). Almost all respondents (98%) agreed that correct pest identification is critical for effective pest control. The importance of pest identification and monitoring as a component of IPM is discussed.

Keywords: cocoa, farmer groups, insect pest identification, insecticides, IPM

Introduction

Cocoa provides foreign exchange and a source of livelihood for over half a million farmers and their dependants in Ghana (Baah 2008). However, cocoa cultivation is saddled with many problems, including the incidence of pests and diseases. A number of insects are listed as occurring on cocoa, but only a few, such as mirids (Miridae) have been described as causing substantial damage (Entwistle 1985; Padi and Owusu 1998) and the shield or stink bug (Awudzi *et al*. 2018). The main mirid species in West Africa are *Sahlbergella singularis* Haglund, *Distantiella theobroma* (Distant), *Helopeltis* spp. and *Bryocoropsis* spp. (Hemiptera: Miridae), but

only the former two (*S. singularis* and *D. theobroma*) are economically important in cocoa production and are responsible for about 25–30% yield loss annually (Padi and Owusu 1998; Anikwe *et al.* 2009b). The shield or stink bug, *Bathycoelia thalassina* (Herrich-Schaeffer), (Hemiptera: Pentatomidae) has been reported as an important insect pest of cocoa in Ghana. It is estimated to cause about 18% of crop losses (Owusu--Manu 1971; Owusu-Manu 1976; Awudzi *et al.* 2018). *Bathycoelia thalassina* causes premature pod ripening and clumping of beans in pods. Recently, *Pseudotheraptus devastans* Distant (Hemiptera: Coreidae) has been observed to cause significant crop losses of cocoa across the entire cocoa landscape in Ghana. This insect pest was considered to be of limited distribution in the Eastern Region (Lodos 1965). The nymphs and adults of *P. devastans* feed on pods by inserting their stylets through the husk into the beans, resulting in extensive pod deformation, agglutination or clumping of beans inside the pods, and eventually, reduction in yields (Lodos 1965). The feeding lesions on the pods caused by *P. devastans* are similar to those of mirids but those of *P. devastans* are larger (Lodos 1965).

Cocoa mealybugs (Hemiptera: Pseudococcidae) are also important pests since they act as vectors of the cacao swollen shoot virus. Although other insect pests such as *Eulophonotus myrmeleon* Fldr. (Lepidoptera, Cossidae) (stem borer), *Anomis leona* Schauss (Noctuidae), *Earias biplaga* Wlk. (Lepidoptera: Noctuidae) (defoliators), psyllids and aphids are found within the cocoa agro-ecosystem in Ghana, they are regarded as minor pests because they do not cause economic losses, and do not warrant separate control intervention except during occasional localized outbreaks (Padi and Owusu 1998; Awudzi *et al.* 2019).

A survey of farmers' knowledge and perception of mirid control in the Ashanti and Eastern regions of Ghana showed that some farmers cannot correctly identify the major insect pests on cocoa and link them to the damage they cause (Awudzi *et al.* 2016). Farmers generally attribute the damage caused by a particular pest to that of another, making their judgments on the damage levels caused by the various pests on their farms doubtful. The study did not investigate how much knowledge farmers had about pest and damage identification, but it is believed that the correct identification of insect pest species is critical for the development of any integrated pest management program. Incorrect pest identification can result in the misuse of pesticides (Asogwa and Dongo 2009). This could cause a farmer to apply insecticides even in the absence of an important pest. The indiscriminate application of insecticides as a result of lack of knowledge about the economic importance of a target pest has human health, environmental and economic implications (Matthews *et al.* 2003). With increasing concern about food safety and pesticide residue issues globally, there is the need for decision support tools to aid judicious insecticide application on cocoa. Farmers' ability to identify insect pests and damage symptoms is key to the successful implementation of an integrated pest management program. Therefore, there is a need to assess and subsequently improve the ability of both farmers and extension officers to identify cocoa insect pests and their associated damage symptoms to ensure that correct application of recommended control measures is adhered to. There is also the need for capacity building of extension staff, farmer groups and other stakeholders involved in cocoa extension programs on insect pest identification and monitoring to support decision making for effective pest control.

The main objective of this study was to determine farmers' ability to correctly identify cocoa insect pests and their associated damage symptoms for effective pest control.

Materials and Methods

Sample size and study area

A total of 600 cocoa farmers from all cocoa growing regions in Ghana were interviewed. This consisted of 15–20 farmers per community and three or four communities per district randomly selected for questionnaire administration. These communities were randomly picked from a list of cocoa communities in the cocoa districts provided by the Cocoa Health and Extension Division (CHED) of COCOBOD. A map of Ghana showing the study area is presented in Figure 1.

Design of questionnaire and interview

A structured questionnaire with open and closed-ended questions was designed for the study. Questionnaires were administered in farmers' homes. At the end of each survey day, completed questionnaires were cross-checked to ensure they were fully completed. All incomplete or doubtful entries were sent back to the respondent for clarification. This ensured that the views of each respondent were correctly represented, enhancing the reliability of the data collected and information to be deduced from it (Awudzi *et al.* 2016). In most cases, questions were translated into the local language of the area, taking care not to lose any information. Selection of farmers for interview was random and not biased towards gender, religious or political affiliation. Opinion Leaders including village Chiefs, Chief farmers, Assembly Members and Zonal Coordinators in each selected community were briefed on the purpose of the study in the community entry phase

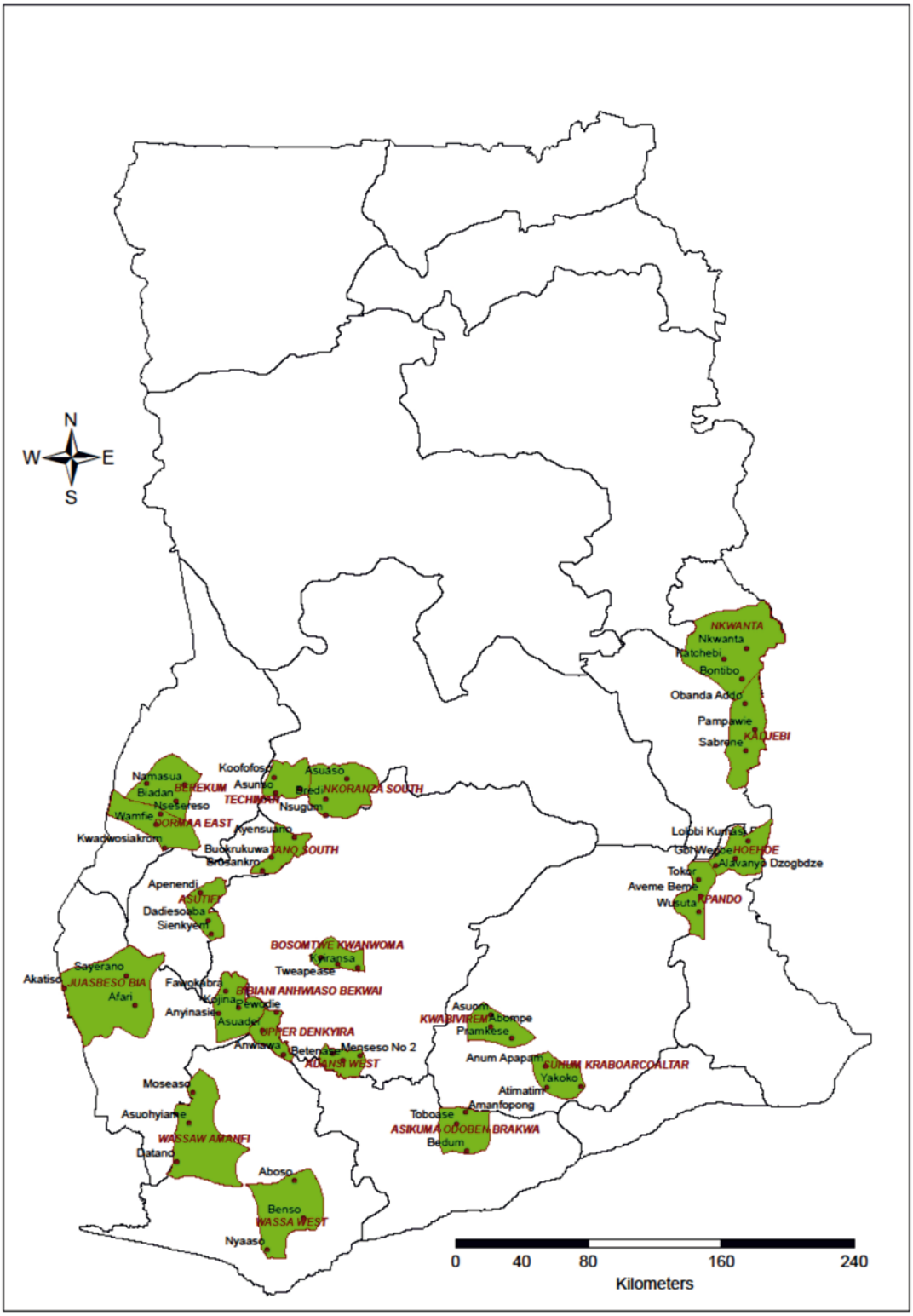

Fig. 1. Map of Ghana showing study areas

before farmers were interviewed. This ensured that farmers received the interviewers through the proper chain of command in each community to enhance the acceptability of interviewers (Awudzi *et al.* 2016). The following variables were used to assess the socioeconomic background of farmers: gender, age, education, marital status, farm ownership status, age and size of farm as well as membership of a farmer group or association. Farmers were also assessed as to their knowledge of insect pest control, their access to information about insect pest control, their understanding of the effects of timely insecticide application on insect pest incidence and yield, and percentage of crop loss due to insect pest damage. An assessment of insecticides used

by farmers was made as well as the timing of applications. Finally, using live or preserved insects, pictures as well as damaged plant parts, the questionnaire evaluated the ability of farmers to identify various insect pests on cocoa and their associated damage. The study took the form of face-to-face interviews with farmers to determine their individual ability to identify a pest correctly, recognize the different developmental stages of the insect pest and then match an insect pest to its damage symptoms. Each farmer was then scored a mark of one for each correct answer given. The total score was then expressed in percentages. A score of 80–100% represents excellent, 60–79% good, 50–59% average, 30–49% below average and 29–0% poor/fail.

Reliability of questionnaire

A pre-testing exercise was carried out in four communities in the Eastern Region (Tafo, Apedwa, Suhum and Osiem) in order to assess whether there were any ambiguities in the questions. A total of 40 cocoa farmers from these communities were interviewed from October 15 to November 15, 2018. Questions that were not easily understood by farmers due to lack of clarity were modified. The actual survey with the final questionnaire started on December 1, 2018 and was completed on October 5, 2019.

Data analysis

Data was analyzed with the SPSS statistical package (version 17). Variation in responses was analyzed to show frequencies and their percentages. Relationship analysis was conducted using a chi-square test to determine if personal and farm characteristics were associated with farmers' knowledge of insect pests and damage identification, timing of insecticide application and the need for pest identification and monitoring before control. Relationships between personal/farm characteristics and membership of a co-operative/farmer association and their relationship to farmer knowledge about insect pests and damage identification were also explored.

Results

Farmer and farm characteristics

Of the farmers interviewed, 70% were male and 30% were female. The age group representing the young adult (≤45 years) was the most dominant, accounting for 65% of the respondents. The majority of respondents were farm owners (86.2%), whereas most of them (62.9 %) had Middle School/Junior High School (MSLC/JHS) educational qualifications with approximately 6% having no formal education. A summary of the personal characteristics of farmers is presented in Table 1.

Farmer associations and farm practices

About 58% of respondents were part of a farmer-based organization, certification scheme or cooperative societies. Among farmers that were part of farmer associations, 48% belonged to local self-help farmer

Table 1. Demographic characteristics of farmers (*N* = 600)

Demographics		Frequency	Percentage
Gender	Male	420	70.00
	Female	180	30.00
Age (years)	Young adult (up to 45 years)	391	65.0
	Old (46+)	209	35.0
Level of education	No formal education	34	5.6
	Schooled up to primary "6"	5	0.8
	MSLC/JHS	377	62.9
	SSS	121	20.2
	Tech/Vocational	21	3.4
	Tertiary	42	7.0
Ownership status	Owner Operator	517	86.2
	Abunu Sharecropper	66	11.0
	Abusa Sharecropper	4	0.6
	Owner & Abunu Sharecropper	13	2.2
Member of Farmer Association	Yes	347	57.9
	No	253	42.1
Type of Farmer Association	Certification Scheme	46	13.1
	Cooperative	133	38.3
	Self Help Group	168	48.5

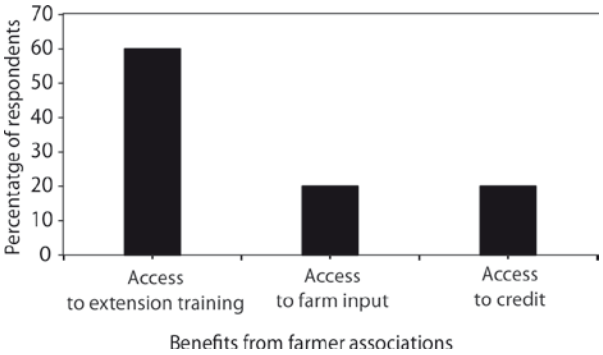

Fig. 2. Sources of motivation for joining a farmer association

associations while 38% were in cooperative societies. The remaining 13% belonged to different certification bodies. The majority of farmers (60%) that were part of farmer associations were motivated to join the group by the training they receive in Good Agricultural Practices (GAP) with 40% of them motivated by access to credit and inputs. The source of motivation for joining a farmer association is presented in Figure 2. Gender ($\chi^2 = 0.03$, $p = 0.8$), age of farmer ($\chi^2 = 1.93$, $p = 0.9$), marital status ($\chi^2 = 4.41$, $p = 0.3$), educational status ($\chi^2 = 1.6$, $p = 0.1$) and farm ownership ($\chi^2 = 1.2$, $p = 0.5$) did not have a significant relationship with membership of farmer group, farmer association or cooperative society.

The largest proportion of farmers had hybrid cocoa on their farms (40%) while 13% had Amelonado, 20% had Amazon and 27% had mixed materials. Most farms were not planted in rows (70%), however, the proportion planted in rows was greater among those farmers who were members of farmer associations ($\chi^2 = 10.5$, $p = 0.01$). A greater proportion of trees planted in rows (as opposed to uneven planting) was found on recently established farms ($\chi^2 = 21.8$, $p < 0.001$) (70% of farms up to 20 years old compared to 20% of farms older than 20 years). Farmers who belonged to farmer associations or groups were more likely to grow hybrids ($\chi^2 = 9.2$, $p = 0.03$) and plant seeds or seedlings from recommended outlets (Seed Production Division of COCOBOD and CRIG) ($\chi^2 = 19.21$, $p < 0.001$). The majority of farmers that had hybrid cocoa on their farms (49% of farmers) were between the ages of 20 and 45 years ($\chi^2 = 13.1$, $p = 0.04$).

Farmers' perception of pest status of insects on cocoa and insecticide usage

Cocoa mirids (local name: Akate) and the stink bug (local name: Atee) were perceived to be the most important insect pests on cocoa. Fifty-one percent (51%) of the respondents perceived mirids to be the most important insect pest on cocoa while the remaining 49% perceived the stink bug as the most important. August appeared to be the month in which most respondents (33%) applied insecticides for the first time in the year with 22% spraying in July, 17% in January and 11% in February (Fig. 3). Most farmers (69%) were aware of the recommended months for the application of insecticides while the remaining 31% had no idea of the existence of such a recommendation. Most farmers perceived August (76%), September (85%) and October (84%) to be the recommended insecticide spraying months (Fig. 4). A majority of respondents (85%) agreed with the recommended months for spraying insecticides.

The presence of insect pests and associated damage symptoms were the most important reasons (52%) why respondents sprayed insecticides in a particular month. The availability of inputs (mainly insecticides) and spraying equipment accounted for 5%, with 8% of them relying on extension advice. A further 8% used the start of the national Cocoa Disease and Pest

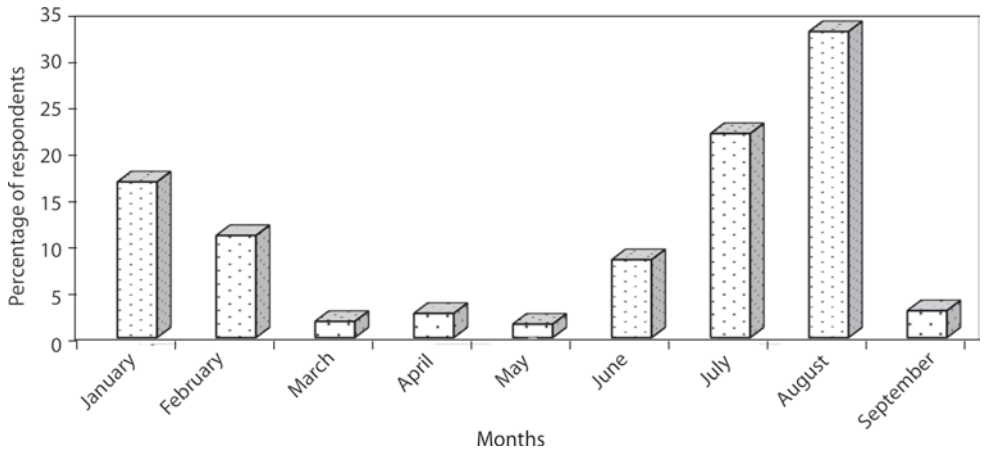

Fig. 3. Responses from farmers as to month in which they first applied insecticide in the year

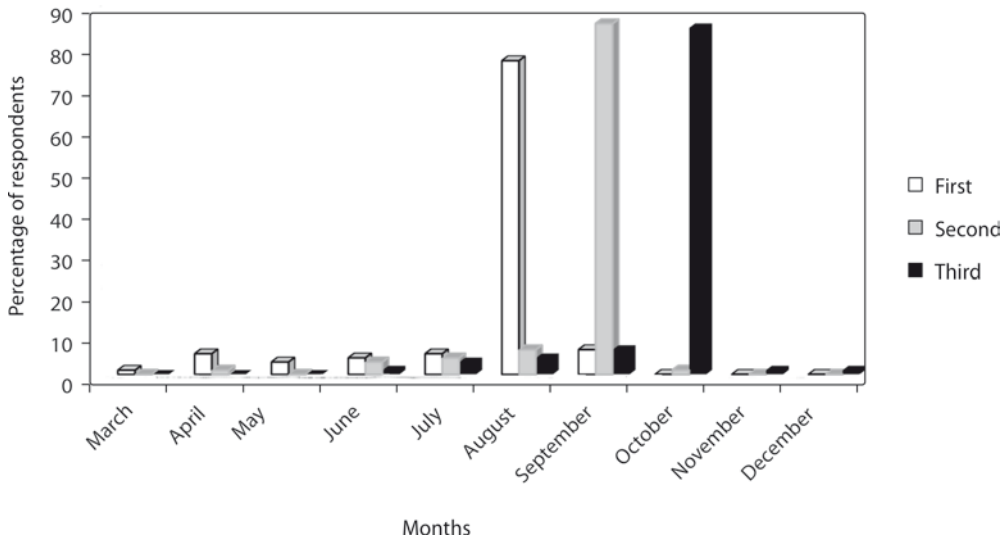

Fig. 4. Responses from farmers as to recommended months to spray insecticides

Table 2. Issues that influenced farmer's choice of the month to start insecticide application

Issues	Percentage (N = 600)
Presence of insect pests	24
Presence of insect pest damage symptoms	28
Production of pods	6
Weather	5
Appearance of flowers	5
Extension officer's advice	8
Another farmer/relative	5
Presence of any insect	7
Availability of inputs and machines	5
The CODAPEC program	8

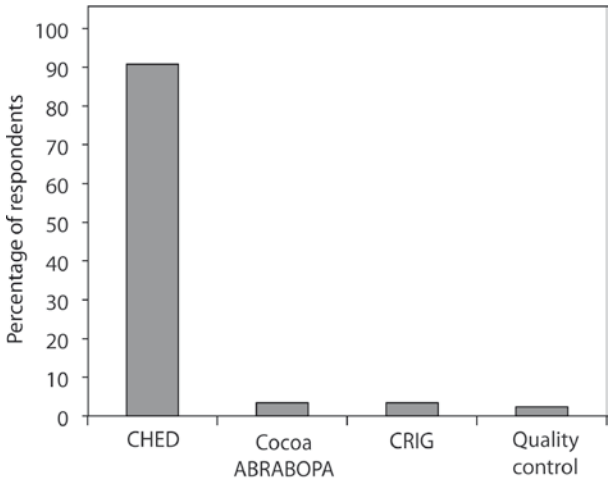

Fig. 5. Farmers responses about institutions that organized training in identification of insect pests and damage symptoms

Control (CODAPEC) program in Ghana to decide when to commence insecticide application (Table 2).

Training in insect pest and associated damage identification on cocoa

The majority of farmers interviewed had not received any training in the identification of insect pests (60%) and associated damage (58%). The CHED was the major source of information and training (90%) in insect pest and associated damage identification among farmers who had some training (Fig. 5). A greater proportion of farmers interviewed (63%) knew of the presence of beneficial insects in the cocoa ecosystem while 37% had no idea of their existence. Spiders and insects like the red weaver ant and bees were mentioned by farmers as beneficial insects.

Identification of cocoa insect pests and their damage symptoms by cocoa farmers

Using live or dead insects, the majority of respondents could not correctly identify the major mirid species in Ghana locally called 'Akate'. Moreover, the majority could not identify and associate the nymphs or young ones of the same insect pest to the adult (Table 3). Most respondents (80%) could not associate the major mirid species to their associated damage symptoms. Similar to the mirid results, the majority of farmers (>80%) could not identify the adult stink bug, nor could they link the nymph to the adult or its associated damage symptoms. Similar results were obtained for other minor insect pest species that farmers were interviewed about. The majority of them was unable to identify the pests; neither could they relate the immature stages to

Table 3. Responses from farmers on insect pest and damage identification

Type of insects	Correct [%]	Wrong [%]
Adult *Sahlbergella singularis*	43	57
Nymph of *S. singularis*	41	59
Mirid damage symptoms by *S. singularis* on pods	24	76
Mirid damage symptoms by *S. singularis* on chupons	17	83
Adult *Distantiella theobroma*	11	89
Nymph *D. theobroma*	6	94
Mirid damage symptoms by *D. theobroma* on pod	8	92
Mirid damage symptoms by *D. theobroma* on chupons	8	92
Adult *Bryocoropsis*	31	69
Nymph of *Bryocoropsis*	31	69
Adult *Helopeltis*	34	66
Nymph of *Helopeltis*	9	91
Damage symptoms by *Helopeltis* on pods	21	79
Adult *Bathycoelia thalassina*	45	55
Nymph of *B. thalassina*	15	85
Damage symptoms by *B. thalassina* on pods	12	88
Cocoa mealybugs	24	76
Damage symptoms by cocoa mealybugs on stem	9	91
Adult cocoa pod borer (*Characoma stictigrapta*)	14	86
Larvae of cocoa pod borer	26	74
Pod borer damage on pods	31	69
Adult cocoa stem borer	28	72
Larvae of cocoa stem borer	52	48
Cocoa stem borer damage	29	71
Termites	29	71
Termite damage/runways	24	76
Adult *Anomis leona*	56	44
Larvae of *A. leona*	26	74
Anomis leona damage on leaves	48	52
Anomis leona damage on pods	41	59
Adult *Earias biplaga*	53	47
Larvae of *E. biplaga*	28	72
Earias biplaga damage on leaves	35	65
Earias biplaga damage on pods	26	74
Adult *Pseudotheraptus devastans*	22	78
Nymph of *P. devastans*	9	91
Damage symptoms by *P. devastans* on pods	23	77
$N = 600$		

their adults, nor link the pests to their damage symptoms. Overall, more than 95% of the respondents scored less than 29%, placing them within the poor/fail category of the scoring scale (Table 3).

No significant relationship was observed between regions and farmers' knowledge about insect pests and damage symptoms ($\chi^2 = 2.1$, $p = 0.4$) as the majority scored less than 29%. Almost all of the respondents (98%) agreed that correct insect pest identification is critical for effective pest control in cocoa.

Discussion

Correct identification of pests and diseases in any agricultural system is fundamental for effective management. Inadequate ability to identify pests results in indiscriminate application of pesticides resulting in the destruction of beneficial organisms in the ecosystem (Donald 2004). Farmers' skill in pest identification is therefore key to the successful implementation of any integrated pest management program.

However, studies in Ghana on farmers' ability to identify pests as a tool for pest management have not received the attention needed. Previous studies suggest that farmers' knowledge of insect pest identification is poor, resulting in a significant variation in insecticide dosage and application frequency in each growing season (Awudzi *et al.* 2016). Some 8% of cocoa farmers in Ghana, therefore, use the start of the COCOBOD CODAPEC program as an indicator of when to initiate insect pest management on farms (Adjinah and Opoku 2010; Kumi and Daymond 2015). Other farmers use the presence of insects in general and damage symptoms as indicators of the need to apply insecticides. This does not take into account the pest or ecological status of the insects on farms. Farmers sometimes rely on 'word-of-mouth' from other farmers for decision making on pest management which may not necessarily be accurate.

This survey showed that cocoa farming is a male dominated profession. This is in agreement with previous research done in most cocoa growing countries in West Africa (Olujide and Adeogun 2006; Baah 2008; Awudzi *et al.* 2016). Contrary to most published information, the majority of cocoa farmers interviewed were below the age of 45 (Baah 2008; Awudzi *et al.* 2016), indicating a growing participation of young people in cocoa cultivation. The low income of cocoa farming families is usually a disincentive for young people to be engaged in the cultivation of the crop. An aging farmer population results in cocoa farms being abandoned after the demise of their owners (Asante *et al.* 2002). If this trend of young people becoming increasingly involved in cocoa farming is sustained, this could positively impact productivity and sustainability of the industry. It must be noted that current governmental policies aimed at encouraging youth to go into cocoa farming may be a contributory factor to this result. This study also showed that farmers' age and the variety of cocoa grown are related. The majority of farmers that had hybrid cocoa on their farms were between the ages of 20 and 45 years. The results suggest that with time, the use of hybrid planting materials could increase if the increasing number of young people involved in cocoa farming is sustained. Farmers who belonged to famer-based organizations (FBO) are more likely to grow hybrids in rows. This is similar to observations made in previous studies reported elsewhere (Opare 1980; FAO 1999; Baah 2006; Sonwa *et al.* 2008; Awudzi *et al.* 2016).

Cocoa mirids have been known to be the most important insect pest on cocoa for decades (Entwistle 1985; Owusu-Manu 1997; N'Guessan *et al.* 2008; Anikwe *et al.* 2009a; Adu-Acheampong *et al.* 2014). Management has centered on chemical control methods with the screening of several chemicals for their suitability for use on the crop (Owusu-Manu and Osei-Bonsu 1996; Owusu-Manu 1997). Owusu-Manu (1971) reported *Bathycoelia thalassina* as another important pest of cocoa causing approximately 18% crop loss annually. From the current study, cocoa mirids and the stink bug are both perceived to be important insect pests on cocoa. With 51 and 49% of the respondents perceiving mirids and stink bugs, respectively, to be the most important insect pests of cocoa, currently there is little distinction between the perceived severity of the two. This confirms a recent study on the reassessment of the temporal distribution and damage of *B. thalassina* on cocoa in Ghana (Awudzi *et al.* 2018). The study indicated that the population and status of the pest has changed and currently causes crop losess similar to losses caused by cocoa mirids.

As a result of the varied sources of information as to when to apply insecticides, farmers start insecticide application in different months, with most applications being done in August, as was previously recommended. In that recommendation, farmers were to spray monthly from August to December, with the exception of November (Owusu-Manu 1997). Currently, changes in pest population dynamics and distribution have caused a change in the spraying regime to start in March and April and continue in August and September (Sarfo 2013; Adu-Acheampong *et al.* 2014; Awudzi *et al.* 2017; Awudzi *et al.* 2018). Insect pests such as the stink bug *B. thalassina* and some defoliator species (mainly *A. leona* and *E. biplaga*) which were not important in the first half of the year in the past have now assumed pest status in the first half of the year, hence the need for the change.

Previous studies suggested that farmers relied mostly on the recommendations of CODAPEC to initiate insecticide application on their farms (Kumi and Daymond 2015; Awudzi *et al.* 2016). However, the present study suggests that the presence of insect pests and associated damage symptoms were the major reasons (52%) why farmers sprayed insecticides in a particular month and not the CODAPEC program as suggested by previous studies. In this study, only 8% of the respondents said the CODAPEC program influenced when they initiated insecticide application on their cocoa farms. This may be due to crop losses to insect pest damage as a result of delays in the operations of the

CODAPEC program. Most farmers complained about not getting adequate quantities of insecticides on time for insect pest control, hence a reduction in reliance on the program for pest control (Baffoe-Asare *et al.* 2013; Kumi and Daymond 2015). Relying on the start of the CODAPEC program is therefore not the best approach to insect pest management as the program may be delayed due to logistical problems such as late arrival of pesticides in various districts and the frequent breakdown of spraying machines (Baffoe-Asare *et al.* 2013). Significant losses of cocoa yield can occur due to insect pest damage when there is a delay in the start of the program. Therefore, a shift from dependence on the CODAPEC program to observing the presence of insect pests and damage symptoms is a more effective approach.

This study also showed that a majority of the cocoa farmers interviewed had not been trained to identify insect pests and their associated damage symptoms. The CHED was identified as the main provider of training in the identification of insect pests and their associated damage. Even though most farmers had not been trained to identify insect pests on cocoa, they were aware of the presence of beneficial insects as a result of their indigenous knowledge of the cocoa ecosystem. Arthropods such as spiders, red weaver ants and bees were mentioned by most farmers as beneficial insects on cocoa and other crops (Entwistle 1985).

This study suggests that the majority of cocoa farmers in Ghana cannot correctly identify insect pests. Furthermore, they cannot differentiate between the different developmental stages of insect pests or link a particular pest to its characteristic damage symptoms. This could explain why responses by most farmers to questions on damage caused by insect pests on cocoa in 2013 were mostly inaccurate (Awudzi *et al.* 2016). The inability of farmers to correctly identify insect pests on a crop results in indiscriminate application of insecticides all year round as seen in the case of cocoa. Insecticides may even be applied in the absence of insect pests that warrant chemical control, affecting biodiversity, food safety and hence, human health.

Over 95% of the respondents scored marks less than 29%, placing them within the poor/fail category of the scoring scale. This suggests the need to intensify farmer education in the identification of insect pest species and their damage symptoms on cocoa. Integrated pest management strategies can only be practiced if farmers knowledge about pests and damage symptom identification is enhanced. Variations in micro-climates between farms within a square-mile could influence the type and presence of insect pests (Dudt and Shure 1994; Bos *et al.* 2007; Bisseleua *et al.* 2009; Babin *et al.* 2010). A farmer's ability to identify insect pests and differentiate between the different developmental stages and link them to their damage symptoms would enhance the efficiency of control methods. Insecticides would then only be applied when needed and not on a blanket or calendar-date system.

As demonstrated in previous studies (Baah 2008; Awudzi *et al.* 2016), this study confirms that membership to a farmer group is mainly because of the need to enhance working knowledge about farm management practices. It is therefore important to encourage the formation of farmer groups across the entire cocoa landscape to enhance farmers' knowledge about farm management practices (Baah 2008). Membership to a farmer association was closely related to the farmer's choice of when to start insecticide application, with the majority of farmers using the presence of insect pests and damage symptoms (52%) to decide when to start insecticide applications. The CHED can intensify their training of farmers through these farmer groups to enhance their knowledge of the different insect pests on cocoa, their developmental stages and characteristic damage symptoms. The absence of significant differences between regions as to farmers' knowledge of insect pests and damage symptom identification signifies the need to intensify farmer education on the subject in all cocoa growing regions for effective insect pest management.

Conclusions

The ability of farmers to correctly identify insect pests and associated damage symptoms is critical to effective pest management. This study showed that farmers failed to both accurately identify insect pests and accurately differentiate between major and minor insect pests. Some farmers knew about the existence of beneficial insects such as the red weaver ants. This has severe consequences for pest management, particularly when using species-specific pest management approaches. Even though information about insect pests and damage symptom identification is available, not all farmers have received the necessary training. The study also showed that local farmer groups and extension services will be vital in enhancing farmers' knowledge of insect pests and damage identification for the successful implementation of IPM programs on cocoa on Ghana.

Acknowledgements

The authors are grateful to the staff of CRIG (Entomology and Social Science and Statistics Divisions)and the Cocoa Health and Extension Division (CHED) for their contribution during the administration of the questionnaire and data entry. The authors are also grateful to Dr. Owusu Domfeh (Plant Pathology

Division, CRIG) for proofreading the manuscript. We also wish to acknowledge the help of Mr. Nkroma Y. Dankwa for generating the map of the study sites. This paper is published with the kind permission of the Executive Director of CRIG (CRIG/03/2020/009/005).

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