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Impact of the black twig borer on Robusta coffee in Mukono and Kayunga districts, central Uganda

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1 SUMMARY

An outbreak of a "serious" pest of coffee was reported in Mukono and Kayunga districts in central Uganda in December 2008. In response, a survey was carried out in the two districts to determine the identity, spread, incidence and damage caused by the pest. The pest was preliminarily identified as the black twig borer, *Xylosandrus compactus* (Eichhoff), which was found on coffee in both districts infesting 37.5% of the surveyed Robusta coffee farms. The infestation in Mukono was higher than in Kayunga, being 50 and 8.3%, respectively. The percentage of trees attacked (incidence) in the two districts was 21.2, with 3.7% of their twigs bored (damaged). Mukono district had a much higher incidence (35.3%) and damage (4.9%) compared to Kayunga with 0.8% for both parameters. The most serious damage was recorded in Namuganga and Nabbaale subcounties in Mukono district, the apparent epicentre of the outbreak. It was evident that the pest was spreading to other subcounties surveyed within and outside Mukono district. This pest poses a threat to coffee production in Uganda and immediate comprehensive mitigation action should be taken.

2 INTRODUCTION

Coffee plays a central role in the economy of Uganda, accounting for approximately 20% of total annual export earnings. The livelihoods of an estimated 1.5 million households in Uganda depend on coffee. It is therefore a key commodity in the fight to eradicate poverty and hunger, which is the first Millennium Development Goal. Despite its importance, coffee production and export volumes have been declining for almost a decade. The export volume declined from a peak of 4 million 60 Kg bags in 1996/1997 to 2.7 M 60 Kg bags in 2006/2007 financial year (Anonymous, 1997; Anonymous, 2007). The decline was mainly attributed to the effect of coffee wilt disease (CWD), which was first reported on Robusta coffee in 1993 in Bundibugyo district, western Uganda (Adipala *et al.* 2001). In Uganda, Robusta coffee contributes over 80% of total production as well as export volume while the balance is from Arabica coffee. Currently, Robusta coffee production depends on the trees that survived CWD, which destroyed over 44.5% of the established trees between 1993 and 2002 (Anonymous, 2003). Just as the hope for recovery from CWD pandemic using resistant materials is gaining momentum, a new threat, the black twig borer (BTB), *Xylosandrus compactus* Eichhoff (Coleoptera: Scolytidae), has emerged. It is reported to attack up to over 225 plant and forest tree species (Ngoan *et al.*, 1976).

The BTB causes extensive damage to coffee (mainly Robusta) and cocoa throughout tropical Africa, Indonesia, southern India and the West Indies (CABI, 2005). There has been no recent assessment of crop losses caused by

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X. compactus. In India, Ramesh (1987) observed that losses due to *X. compactus* were 21% on 45-year-old coffee plants and 23.5% on young plants. The pest bores into the young branches (twigs), killing them in a few weeks. The entrance holes are about 0.8 mm diameter and are located on the underside of branches.

The BTB feeds on *Ambrosia* fungus and belongs to the ambrosia group of beetles (Entwistle, 1972). Once inside the twigs, it does not feed on the host plant material but uses it as a medium for growing the fungus. Therefore, absence of a suitable host is not a limiting factor. Any woody material of suitable moisture content and size supports its survival. The life cycle of BTB is completed in about one month (Ngoan *et al.*, 1976). The males spend their entire lives inside the brood gallery. The females, however, leave the brood gallery after mating to infest other hosts/branches to lay eggs. Adult females can be dispersed at least 200 meters, and it is likely that dispersal over several kilometers is possible, especially if wind-aided (Entwistle, 1972). The transportation of infested plant parts is of more importance for long distance dispersal of BTB.

BTB females can reproduce parthenogenetically (without mating), in which case the offspring are all males (Entwistle, 1972; Hara & Beardsley, 1979). As a result, the introduction of only a few females may lead to the establishment of an active population if suitable host plants can be found and environmental conditions are conducive. Based on its prolific reproductive potential and dispersal capacity, BTB is therefore a high risk quarantine pest in areas not yet infested locally.

A number of control options for BTB with varying effectiveness and sustainability have been recommended. Monocrotophos, an insecticide, is reported to have been used effectively against the pest in India (Meshram *et al.*, 1993). Chlorpyrifos was reported to kill between 77 and 92% of all stages of BTB in Florida and China (Mangold *et al.*, 1977; Yan *et al.*, 2001). Permethrin or bifenthrin, quinalphos or chlorypyrifos plus cypermethrin are also reported to give good control (Bambara, 2003). However, the decision to use chemical control is influenced by environmental and human health concerns (Pimentel, 2005). In addition, it is also difficult to apply chemicals to the concealed habitats in which BTB feeds and they can be unaffordable by many farmers. The most effective but uneconomical cultural control practice is pruning and burning of infested twigs. This is because continuous pruning reduces the number of berry bearing branches and eventually reduces coffee yields. Practices that promote tree vigour and health will aid recovery from BTB damage.

In Africa, there are no known effective biocontrol agents for BTB. The entomopathogenic fungus, *Beauveria bassiana* is reported to cause some mortality in BTB and its efficacy in controlling the pest needs to be investigated (Brader, 1964; Balakrisman *et al.*, 1994). Ethanol-baited traps have been demonstrated to effectively attract BTB; while verbenone and limonene repel the pest (Elsie *et al.*, 2006; Dudley *et. al.*, 2008).

A number of outbreaks of BTB have been reported in Uganda. The first outbreak was in Bundibugyo district in 1993. This coincided with the advent of coffee wilt disease (CWD) in the district that almost wiped out Robusta coffee (Adipala *et al.*, 2001). The second outbreak was reported in 2002 in Rukungiri, Kanungu and Bushenyi districts. In September 2007, an outbreak of BTB was again reported in Nabbaale subcounty in Mukono district. The most recent outbreak of the pest was reported in December 2008 in Mukono and Kayunga districts. Previous outbreaks of BTB, however, were overshadowed by the alarming devastating effects of CWD, so no serious attention was paid to them. During their visits to farmers, coffee scientists at COREC and Uganda Coffee Development Authority have advised farmers to cut and burn affected branches/trees or apply the recommended chemicals as more effective control measures are sought.

After the current pest reports, a survey was carried out in the two districts affected

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between 8th – 11th December 2008. The objectives of the survey were to establish the identity, infestation levels and damage caused by the pest. This paper is therefore an account of the findings of the survey.

3 METHODOLOGY

The survey was conducted in six and four sub-counties in Mukono and Kayunga districts, respectively. Four subcounties were randomly selected from each district in addition to Namuganga and Nabbaale in Mukono where the loudest outcry over BTB was made. The other four subcounties from Mukono were Kasawo, Nagojje, Ngogwe and Ntenjeru. In Kayunga district, Kayunga, Busana, Nazigo and Kangulumira subcounties were surveyed. In each of the ten subcounties, a total of three coffee farms selected randomly from different parishes were assessed giving a total of 30 farms. Two on-station coffee blocks at COREC, Kituza-Mukono were also randomly selected and assessed for BTB infestation.

Each study farm or block was sub-divided into four roughly equal quadrants. Three coffee trees were randomly sampled along the diagonal of each quadrant, making twelve trees in total for one farm. Data were collected on the infestation status of every sampled coffee tree, number of primary branches (twigs) on the coffee tree and number of twigs bored by BTB. Data on farmers' comments in relation to the BTB problem were also taken. The percentages of infested farms (infestation), BTB infested trees (incidence) and bored twigs (damage) were computed for each farm. Data on infestation, incidence (%), damage (%) and farmers' comments were analysed using SPSS Release 12.0.0 (4 September 2003). Pictures of BTB adults and larvae were taken using a camera fitted to a stereomicroscope, while those of its damage symptoms were taken using a digital camera. Samples of bored twigs were collected from each infested farm, dissected and BTB specimens recovered from them were kept in labeled glass vials for submission to the insect diagnostic laboratory at the National Agricultural Laboratories Research Institute, Kawanda, as well as for preservation for future reference.

4 RESULTS AND DISCUSSION

The survey confirmed an outbreak of a coffee pest that was causing the death of primary branches, which bear the berries, which are the economic parts of the tree. Based on field observations of symptoms and mode of attack, and on observation and structural analysis of the samples collected during the survey, the preliminary identity of the pest was determined to be the black twig borer, *X. compactus* Eichhoff (Plate 1). The picture of the adult in Plate 1 is closely identical to that published by CAB International (2005). Plates 2 and 3 indicate early and advanced symptoms of damage by BTB on coffee, respectively. BTB is reported to cause necrotic lesions and wilting of leaves and twigs, and the death of the entire tree (CABI, 2005). Plate 4 shows an entry hole for BTB into a coffee twig. A whitish pile of dust from boring may be seen at each BTB entry hole. The discoloration of the infested branch as shown in Plate 4 is one of the typical symptoms of BTB. BTB is one of the few species of ambrosia beetles that can attack and kill live twigs and branches. The observed symptoms were preliminarily associated to those caused by BTB as described previously (CABI, 2005). However, confirmatory identification is underway at the National Agricultural Laboratories Research Institute, Kawanda, Uganda.

Among the surveyed farms, 37.5% were infested by BTB (Table 1). In Mukono district the pest was detected in all sampled subcounties except in Ngogwe. Namuganga and Nabbaale were the worst affected subcounties with all the farms surveyed attacked by BTB. Mean BTB incidence of 86.9% was registered at Namuganga with 12.5% damage on coffee twigs. Mean incidence of BTB at Nabbaale was 58.3% with 8.9% damage. Ntenjeru, Nagojje and Kasawo had 1 out of the 3 farms surveyed (33.3%) infested. BTB incidences in these subcounties were 25, 11.1 and 6.3%; and the damages were 3, 6.2 and 0.9% for Ntenjeru, Nagojje and Kasawo, respectively.

BTB damage at Naggoje subcounty was interestingly the highest despite having lower incidence than Ntenjeru. This implies that there was more spread within the infested coffee tree than to new ones but the reason for this is not known. Mean incidence of 35.3% and damage of 5.6% were recorded in Mukono district. In Kayunga district on the other hand, the pest was

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only present in one farm in Nazigo subcounty, which borders Namuganga in Mukono district. Both incidence and damage in this farm were 0.8%. This indicates that BTB attack in Mukono district was much more than in Kayunga, and lends credence to the presumption that the out-break of BTB was epicentred in the worst affected subcounties of Mukono district (Namuganga and Nabbaale), from where it spread to the other subcounties that still had low incidences and damages.

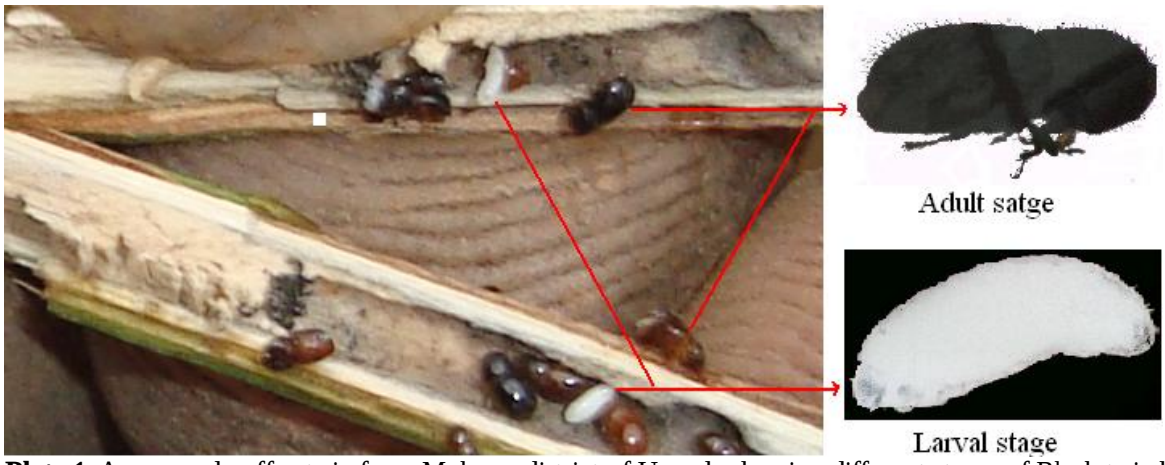

Plate 1: An opened coffee twig from Mukono district of Uganda showing different stages of Black twig borer (BTB).

Plate 2: A coffee tree on a farm in Mukono district with branches killed by the Black Twig Borer.

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Plate 3: A Coffee tree killed by Black Twig Borer on a farm in Mukono district

Plate 4: A Black Twig Borer entry hole on a coffee twig from a farm in Mukono district

At Kituza, 41.7% incidence and 7.5% damage were recorded on average. This therefore implies that the reported occurrence in Nabbaale subcounty in 2007 has within one year, spread to several subcounties both within and outside Mukono district. The prolific rate of reproduction and mode of spread of BTB (CABI, 2005) are indicative of its ability to spread fast within and outside the infested areas.

This survey was carried out in response to reports from extension agents and media groups about BTB in Mukono and Kayunga districts. The status of the pest in other districts remains unknown. No regulatory control measures against BTB have been put in place owing to lack of knowledge on how widespread the pest is. There is therefore an urgent need to conduct a broader survey of BTB in all major Robusta coffee growing districts in Uganda. The information from the broader survey will be critical for formulating a national strategy to prevent spread and damage due to BTB.

Farmers' comments regarding the black twig borer problem

The comments made by farmers visited regarding BTB are summarized in Table 2. Among these farmers, 51% had no idea of BTB while the rest had heard about it through the electronic and/or read about it in the print media. Three percent of the farmers reported having applied Malathion, an insecticide, to control BTB, while the rest had done nothing about the problem. Some 3% of the farmers believed that this pest was introduced to their area by pesticide dealers to create market for their insecticides. This is a point of view that ought to be immediately discouraged because it distracts the farmers from appreciating the real nature of the problem, and prejudices them against acquisition of insecticides to control the pest in their farms. Coffee wilt and red blister diseases were named major challenges to coffee production by 39 and 15% of the farmers, respectively. Coffee berry borer was reported as a major constraint to coffee production by 6% of the farmers, while 3% of them considered scales and death due to overbearing as their major challenges.

5 CONCLUSION AND RECOMMENDATIONS

The outbreak of BTB, *X. compactus* (Eichhoff), in Mukono and Kayunga districts was confirmed in December 2008. The pest was spreading very fast and had so far infested 37.5 and 21.2% of the farms and trees, respectively, in the two districts and damaged 3.3% of the coffee primary branches (twigs). The available management strategies for BTB which rely on crop hygiene and insecticides are ineffective, uneconomical and hazardous to the environment and humans. There is therefore a need to devise an integrated pest management strategy to manage BTB. Exploration of physical, molecular and biochemical interactions involving BTB and coffee may be helpful in guiding breeding for resistance and use of volatile organic compounds against BTB. An investigation into the factors governing population dynamics of the pest can also be of help to prevent its spread and damage. A nationwide survey of Robusta coffee growing districts is recommended to get a broader picture of the distribution and damage caused by BTB. Elucidation of any interactions between BTB and

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CWD could help in fighting the two calamities of coffee concurrently.

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Table 1: Infestation, incidence and damage due to the black twig borer in Mukono and Kayunga districts

District	Sub-county	Percentage of infested farms / blocks* (Infestation)	Percentage of infested trees (Incidence)	Percentage of infested twigs (Damage)
	Ntenjeru	33. 3	25	3
	Nagojje	33.3	11.1	6.2
	Ngogwe	0	0	0
Mukono	Kasawo	33.3	6.3	0.9
	Namuganga	100	86.9	12.5
	Nabbaale	100	58.3	8.9
	Mean	**50**	**35.3**	**5.6**
	Kayunga	0	0	0
	Busana	0	0	0
Kayunga	Nazigo	33.3	8.3	7.5
	Kangulumira	0	0	0
	Mean	**8.3**	**0.8**	**0.8**
COREC, Kituza		100	41.7	7.5
Overall mean		**37.5**	**21.2**	**3.7**

* For COREC, Kituza

Table 2: Percentage of farmers who made the various comments during the black twig borer survey in Mukono and Kayunga districts

Farmers' comments	Percentage
No idea of black twig borer	51
Coffee wilt disease is the major problem	39
Red blister is a major problem	15
Coffee berry borer is a major problem	6
Black twig borer was ill introduced by pesticide dealers	3
Controlled black twig borer with malathion	3
Scales are a major problem	3
Death due to overbearing is a major problem	3

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