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Distribution and Severity of Coffee Pests and Diseases in Central Uganda

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Abstract. This study aimed to determine the incidence and severity of coffee pests and diseases and any relationships between them. Five coffee producing districts in Uganda, namely, Masaka, Mubende, Mpigi, Kayunga and Luwero were selected. 10 coffee farms were evaluated per district. Pest and disease incidence were determined as the percentage of trees with the disease or pest. Disease severity was evaluated on a 1-5 scale while pest damage was expressed as a percentage of tissue damaged. Results showed significant differences in incidence and damage/severity among all the major pests and diseases in the region except foliage beetles. The most damaging pest was the BCTB with an incidence between 15% and 26%. The next most damaging pests were the tailed caterpillars and Skeletonisers, both *lepidoptera* with incidence of 20.4% and 16% respectively. The most severe disease was Red blister (*Cercospora coffeicola*) with a severity score 2.0 and incidence 51.6%. No novel pests or diseases were discovered. Further studies are recommended to understand factors proliferating the pests and diseases.

Keywords: Robusta, Coffee, Distribution, Pest, Disease.

Introduction

Coffee is one of the world's most consumed beverages, and is the second most traded commodity worldwide after crude oil (Abafita *et al.,* 2021; Deshmukh, 2021), The crop which was first discovered by goat herders in the Ethiopian forests (Deshmukh, 2021), is now cultivated in over 50 countries worldwide and consumed by one third of the world's population(CABI, 2006). Uganda ranks as the second largest producer of the crop in Africa and the sixth largest in the world (FAO 2022). The crop has been one of the most important sources of foreign exchange for the country, at one point contributing over 95% of the country's foreign exchange in the 1980s (Babigumira, n.d). Today, the crop contributes 18% of the country's total revenue (FAOstat, 2018; UCDA, 2021). Uganda produces two types of coffee: Robusta coffee (*Coffea canephora* Pierre ex A.) and Arabica coffee (*Coffea arabica*). Robusta coffee is mainly grown in the lower altitude areas (below 1200 meters above sea level), and it accounts for 80% of

Uganda's coffee production, while Arabica dominates the highlands (Hindorf and Omondi, 2010). Central region is the leading coffee producing area in the country, contributing 38% of the country's total annual production (UCDA, 2019). The region produces primarily Robusta coffee. However, coffee production in the region is far below the attainable yields. According to Wang *et al.,* (2014), the region produced on average 778Kg/ha compared to the attainable yield of 1737 Kg/ha. This is largely attributed to pests and diseases.

Over 900 pests are known to attack coffee although only a few of these are economically important (Kimani *et al.,* 2002; CABI, 2007). In 2014, coffee pests and diseases were reported to cause an annual loss of 8 million USD (MAAIF, 2014), unfortunately, despite several studies targeting individual pests or diseases, notably the coffee wilt disease and black coffee twig borer, no study has been done to document the general status of pests and diseases currently impacting Robusta coffee production in Uganda, particularly in the Central Region, even though factors are increasingly devastating production of the crop. This study was therefore undertaken to determine the incidence and severity of coffee pests and diseases in central Uganda.

Materials and Methods

A field survey was conducted in greater Masaka, greater Mubende, greater Mpigi, Kayunga and Luwero districts, in September, 2020 (Fig 1). The district selection was based on the large older district classification rather than the much smaller newer districts whose boundaries are not yet uploaded on most mapping or navigation applications. In total, the survey targeted 50 farms, this number was determined by the authors to be adequate based on experience and studies which elucidate that disease (and pest) incidences in perennial crops like coffee tend to cover large areas because of increased opportunities for pathogen movement within and among plantations in the same environment (Ploetz, 2007), thereby negating the need for very high sample rates. From each district, at least 2 coffee growing sub counties were selected at random from a list of all coffee growing sub counties in the district, within each sub-county, 5 coffee farms located at least 2 Km from each other were visited and evaluated.

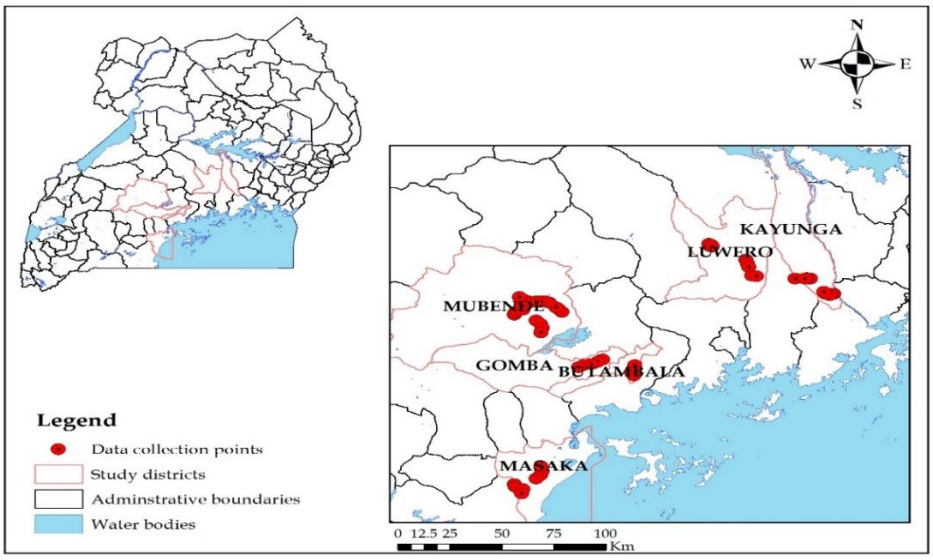

Figure 1. Study Area

Disease incidence and severity

Ten coffee trees were evaluated along a diagonal transect across the field from the beginning to the end of the coffee garden. The distance between the trees was determined by dividing the total length of the diagonal by the number of trees to be selected (ten). A maximum of 1 acre was selected per field for evaluation.

Incidence and severity of each disease identified in the field was evaluated. For each tree evaluated, the presence or absence of disease was denoted as; 0=Absent, and 1=Present. The incidence of the disease was determined as the percentage of the total number of coffee trees evaluated in the farm that were infected with the disease. Diseases which lead to wilting of the whole plant were only evaluated for incidence and not severity. Severity of a disease per tree was evaluated by determining the severity score on the leaves and berries of the most bearing branch in each campus direction; East, West, South and North. Disease severity was evaluated using a similar 1-5 scale for both leaf damaging diseases (Leaf rust and brown eye spot) and berry damaging diseases (Red blister), whereby: 1=no disease; 2=1%≥10%; 3=10%≥25%; 4=25%≥50%; 5=50%≥100% or death.

Pest incidence and damage

Five trees selected at intervals from among the ten initially evaluated for diseases were also evaluated for pest incidence and damage. In total 12 key pests namely: The stem borer, root mealybug, Black coffee twig borer (BCTB), Leaf miners, Skeletonisers, tailed caterpillars, leaf eating beetles, coffee lygus, canopy mealybugs, scales, berry moths, and the Coffee berry borer were identified for evaluation based on farmer reports and a rapid assessment conducted prior to the survey (unpublished report). Additionally, provision was made in the data sheet for evaluation of pests not listed in the data sheet. The pest incidence per tree was determined as the presence (1) or absence (2) of a pest, the field incidence was the percentage of trees damaged by the pest. For Stem borers and root mealybugs only the incidence of the pest (percentage of affected trees) was assessed. The presence of stem borers was determined by the presence of entry hole(s) bored by the pest most times with saw dust around it. Root mealybug incidence on the other hand was determined by digging around the stem to expose the roots, the presence of whitish mass of mealybugs most times with small black ants around them confirmed their presence. For all the other pests, only damage was evaluated. Damage was determined as the percentage of tissue (leaf area or cherries or twigs) damaged by the pest per tree as follows:

1. BCTB damage = $\frac{Number\ of\ bored\ twigs}{total\ \ number\ of\ twigs}$
2. Leaf miners, skeletonisers, leaf eating beetles, lygus, canopy mealybugs and scales damage = $\frac{Number\ of\ leaves\ damaged\ or\ affected\ by\ pest}{total\ \ number\ of\ leaves}$
3. Berry moths and berry borers = $\frac{Number\ of\ berry\ clusters\ damaged\ or\ bored}{total\ \ number\ of\ berry\ clusters}$

Data Analysis

All data was entered into excel sheets and analysed using R statistical software (R Core Team, 2021). The data was subjected to ANOVA in order to compare the means.

Results

Most of the fields surveyed were less than 5 acres in size. The field conditions varied from fairly managed to neglected coffee. Most of the fields had very old coffee trees, the farmers did not employ good agronomic practices evidenced by old unpruned or unstamped coffee trees with visual evidence of low soil fertility. The district of Mpigi had the most neglected coffee fields.

Coffee pest incidence and damage in central Uganda

Results indicate significant differences ($P \leq 0.000$) in major pest incidence and damage in central Uganda (Table 1). The only exception is the foliage beetle which did not show any significant difference in damage across among the districts.

The other pests that were observed in order of incidence or damage were; Tailed caterpillar causing damage ranging from 14.1 to 26.4%, and the BCTB causing damage ranging from 15 and 26% across the studied districts. Luwero district had the highest damage by tailed caterpillar. The most occurring pests in the region by damage levels were the tailed caterpillar (20.44%) and the BCTB (20.22%), the Skeletoniser (16.02%) was the distant third. The other pests that were observed in order of incidence or damage were

Tailed caterpillar damage ranged from 14.1 to 26.4%, while BCTB damage occurred between 15 and 26% across the studied districts. Luwero district had the highest incidence of tailed caterpillars (26.4%) closely followed by Kayunga (25.2%). Kassanda had the lowest damage by the pest. Masaka had the highest BCTB damage in the region at 25.26 % followed by followed by Luwero at 23.4%. Coffee in Mubende district was the least damaged by the pest (15.5%). Similarly, high incidences of Skeletonisers, tailed caterpillars and stem borers were observed across all the districts. Root mealybug was only observed in Mpigi district where approximately 10% of the coffee trees in the district were affected.

Table 1. Percentage Pest Incidence and Damage in Central Uganda

District	Percentage pest incidence and damage											
	Stem borer incidence	Root mealybug incidence	Beetles damage	Berry moth damage	Tailed Caterpillar damage	Coffee berry borer damage	Lygus damage	Leaf miner damage	Canopy mealybug damage	Scales damage	Skeletoniser damage	BCTB damage
Mubende	0.00	13.9	1.8	1.1	14.1	9.2	0.2	2.1	4.4	1.2	8.3	15.5
Kayunga	0.00	9.8	3.1	0.7	25.2	2.0	1.6	4.1	7.3	1.1	17.4	16.9
Luweero	0.00	5.0	2.8	1.7	26.4	0.7	0.0	1.9	0.9	0.1	18.0	23.4
Masaka	0.00	17.8	2.3	0.4	19.8	1.6	3.7	5.9	2.3	0.0	18.8	25.3
Mpigi	9.56	8.8	2.3	0.2	16.7	6.8	1.0	1.1	0.5	0.3	17.6	20.0
Regional mean	1.912	11.06	2.46	0.82	20.44	4.06	1.3	3.02	3.08	0.54	16.02	20.22
P value	0.016*	0.0078**	0.38	0.018*	0.000***	0.000***	0.000***	0.000***	0.000***	0.02*	0.000***	0.000***

Disease incidence and severity

Results indicate occurrence of 4 major coffee diseases in all sampled districts namely: Red blister (RB), Brown eye spots(BES), Leaf rust(LR) and Coffee wilt disease (CWD), (Table 2); Generally Red blister disease had the highest incidence and severity across the region, followed by brown eye spots and leaf rust in that order. CWD incidence was the lowest across the region. There were significant differences in disease incidence and severity across the districts except for CWD. Generally, Mubende district had the lowest incidence of Brown eye spots (BES), Leaf rust (LR) and Red blister disease (RB). However, the district had the second highest incidence of CWD at 2.91%. Mpigi district followed by Kayunga district had the highest incidence of BES (79 and 65 % respectively) while Kayunga district closely followed by Mpigi district had the highest incidence of Red blister disease. The two districts had the highest RB and BES severities. Masaka district had the highest incidence and severity of coffee leaf rust disease.

Table 2. Disease Incidence and Severity

District	Disease incidence and severity						
	BES inc (%)	*BES sev*	*RB inc (%)*	*RB sev*	*LR inc (%)*	*LR sev*	*CWD Inc (%)*
Mubende	11	1.1	28	1.4	2	1.3	2.9
Kayunga	65	1.7	81	2.8	32	1.5	0.4
Luwero	37	1.5	42	1.6	24	1.2	2
Masaka	43	1.5	31	1.5	64	1.9	1.6
Mpigi	79	1.7	76	2.3	38	1.6	5.6
Regional Mean	47	1.5	51.6	1.92	32	1.5	2.5
P value	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.54

Mpigi had the highest incidence of CWD by far. In general, Mpigi district has the highest disease burden in the region (Table 3).

Discussion

This is the first publication of the pest and disease situation in central Uganda. This survey results show that all the major coffee pests and diseases previously reported by Rutherford and Phiri, (2006), were present in the central coffee growing region of Uganda. However, there were significant differences in the incidence and severity/ damage of most of the pests and diseases in the region. Pest and disease incidence and severity or damage is influenced by several environmental and biological factors. Notable among these are climactic (Jassogne *et al*., 2013; Kagezi *et al*., 2018; Groenen, 2018), and edaphic factors (Peace, 2020) on addition to other field management practices. Mpigi district for example with the highest disease burden in the region also had the oldest unpruned or unstumped coffee trees.

Among diseases, Red blister also known as berry blotch had the highest incidence and severity scores. These results confirm several in country reports which state that the disease also known as 'ekikaata' in the region had become the most important (Miriti and Snyder, 2023; Plantvillage, 2022; UCDA). The disease begins as small reddish-brown spots on the berries which grow to form large dark lesions with greyish centres which may or may not be sunken

with a reddish-brown outer ring. The pathogen is known to flourish in warm humid environments on plants under water or nutritional stress. Climate change and decreasing soil fertility due to continuous cultivation (soil mining), with little to no use of fertilisers is possibly responsible for the current disease levels and may lead to further proliferation of the disease if not managed. Further studies are needed to establish all the factors exacerbating the disease in the region, and possible mitigation measures. Additionally the association between the incidence and severity of the disease, and yield loss is not yet well understood, requiring further studies. A high or low red blister score didn't necessarily coincide with a higher or lower brown eye spot score. This weak relationship between the two *Cercospora coffeicola* diseases may indicate differences in the pathogen strains causing the two diseases. Nevertheless, further studies involving genotyping a wider collection of isolates of both diseases is required to approve this fact. Incidence and severity of Leaf rust and brown eye spots. Increased and decreased in a similar way at each location, meaning that environmental factors affected both diseases similarly. Environmental factors including Wind, rain splash, insects and humans are the main agents of spread of inoculum, and suitable environmental conditions are required for proliferation of the diseases (Agrios, 2005; Matovu *et al.,* 2013). For the case of CWD, 2.5% of the trees in the region were infected with the disease which is a substantial reduction compared to 2002 when the national average was 44.5%, most of which was contributed by central Uganda (Phiri and Baker, 2009). Indicating that CWD which by 2002 had affected 90% of Uganda's Robusta coffee farms and destroyed over 45% of Robusta coffee trees in the country, has been well controlled in the region. Nevertheless, the fact that the disease still occurs in all the districts albeit at very low levels is a cause for concern due to the existence of primary inoculum which can potentially upsurge to pre-2002 levels if current control measures are relaxed and favourable conditions prevail. CWD was not necessarily high or low in the same locations as the other diseases indicating differences in proliferating factors. This is in line with earlier research which reported that field management interventions especially phytosanitary measures played the biggest role on CWD incidence and spread (Kangire, 2014). The disease incidence and associated economic impact can be mitigated by cutting and burning infected plants, avoidance of using implements between coffee trees without proper sterilisation, and the use of resistant varieties.

Our results showed that the BCTB is the most prevalent and damaging pest in the region. Similar findings were reported by Kagezi *et al.* (2018); Kagezi *et al.* (2016). The results also indicate that damage due to the pest is on the increase in the region. In 2012 the damage was at 13.9% (Kagezi *et al.*, 2013), it is now at 20.2%. There is no clear explanation yet for this increase in the pest incidence. However, the significant reduction in soil fertility levels due to population increase putting pressure on the land (New Vision, 2021), coupled with the effects of climate change (Bunn *et al.,* 2019) which have led to increased stress on the coffee plants is the most plausible reason for the pest upsurge. According to Ranger *et al.* (2010), stress on coffee trees cause them to produce stress related volatile compounds which are known to attract ambrosia beetles like the BCTB. There is therefore need for urgent intervention against soil degradation, climate change and extensive research on effective management strategies against the pest to avert extensive economic damage. Damage from Skeletonisers and tailed caterpillar, both of them *lepidoptera* were the second and third most important in the region. These two pests affect the crop by reducing the amount of photosynthetic areas leading to reduction in yields depending on the amount of infestation. There is need for further studies to understand the ecological factors proliferating these pests and their economic damage levels.

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