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Research Article

Reaction of Limmu Coffee Genotypes Against Coffee Berry Moth and Coffee Blotch Miner at Field Condition

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Abstract

Coffee is one of the most important commodities and cultivated in various agro-ecologies of Ethiopia. The perennial and evergreen nature of the *Coffea arabica* favors attack by several insects, diseases, mites, and some gastropods. The aim of the current study was to investigate the reaction of coffee berry moth (*Prophantis smaragdina*) and blotch miner (*Leucoptera caffeina*) against Limmu coffee genotypes on naturally infested coffee at Agaro and Gera sub centers. Eleven coffee genotypes were arranged in randomized complete block design with three replications were used and carried out for two consecutive years. Berry damaged by coffee berry moth, and severity of coffee blotch miner was used during data collection. Four coffee trees per row were systematically selected. The severity of infested leaves by coffee blotch miner varied among the genotypes, with 5.0% to 29.44% of the leaves damaged in 2022 and 1.11% to 6.78% in 2023. In 2023 coffee blotch miner damage was much lower (<6%) as compared to 2022 growing season. In 2023 the same coffee genotype ('75227') the damage has been able to decrease by 50%. In 2022 the lowest (3.10%) and highest (31.66%) mean damage was recorded due to coffee berry moth. In 2023 the maximum and minim damage level by coffee berry moth was 1.11% (L20/03) and 54.13% (L02/03), respectively. Coffee berry moth and blotch miner is one of economically important insect pest of Arabica coffee in Ethiopia. Based upon this study, various damage levels was observed among the Limmu coffee genotypes, this could be an interesting direction for future research works to develop resistant or tolerant coffee varieties against coffee pests as one component of integrated pest management option. Future research works should be focused on characterizing and identify biochemical and secondary metabolites of low infested coffee genotypes which could use as an important traits for hybridization.

Keywords

Insect-Plant Interaction, Tolerance, Severity, Ethiopia, Damage, Berry Cluster

1. Introduction

The perennial and evergreen nature of the *Coffea arabica* favors attack by a number of insects, diseases, mites, and some gastropods such as snails and slugs. Over 3000 species of insects and mites associated with coffee worldwide [1]. In Ethiopia over 59 coffee insect pests (including three mites) associated with coffee Arabica were documented since 1966 to 2024 [2]. From identified Arabica coffee arthropods in the country around 30.51% are Hemiptera order, and followed by Lepidoptera (28.81%). Coffee berry moth (*Prophantis smaragdina)* and coffee blotch miner *(Leucoptera caffeina)* are one of the insect pest species under Lepidoptera order affecting coffee berry and leaf, respectively.

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Coffee blotch miner is the most economically important species attacking coffee leaves both at nursery and field condition [3]. The larvae create a distinct blotch mine while feeding gregariously in the upper side of the leaf [4-6]. Mined leaves by coffee blotch miner become dried and fallen, as result yield, and age of coffee tree could reduce [7]. Research carried out by Nantes and Parra [8] on other species of coffee leaf miner demonstrated that a reduction of 25%, 50%, and 75% of the leaf surface area during the dry season led to coffee production declines of 9.14%, 23.53%, and 87.24%, respectively. However, the primary cause of reduced production is attributed to the loss of leaves, which is triggered by elevated levels of ethylene [9]. In addition various insect pests affecting coffee fruit and berry such as coffee berry moth, berry borer, berry worm, berry butterfly, fruit flies, Antestia bugs and soap berry bugs. Coffee berry moth (*Prophantis smaragdina*) damage has the potential to result in significant losses in coffee because it has been shown to have a negative impact on coffee yield [10]. For instance, yield losses of over 25% were reported in eastern Africa by Gaitán *et al.* [11]. More recently, the Kaweri Coffee Plantation Limited management in Uganda announced that the pest was estimated to have caused over 40% of the problems in 2020 [12]. In Ethiopia, coffee berry moth was considered as a minor pest of *Coffea arabica*; however, heavy losses of berries have been documented due to severe attacks at low altitudes [13]. However, significant berry loss has been recorded at a high altitude (1900 masl) of the Gera site in different season. Coffee berry moth attack coffee berries when the berries are found in cluster form or webbed together.

Different agro ecologies and varies coffee genotypes found in Ethiopia are an opportunities for successful development of integrated coffee pest management strategies. The strategy that the national coffee research following is landrace variety development program [14]. Based on this strategy 203 coffee accessions were collected from different parts of Limu coffee growing districts (Limu-Kosa, Gomma and Mana) and tested at Agaro and Gera centers in four sets of trials. From 2003, 2004 and 2005 selections 11 promising coffee accessions which express high yield and acceptable quality was promoted to variety verification trial at Agaro and Gera coffee research sites. So, these promoted genotypes were targeted to be evaluated for multiple pests (major diseases and insects) at naturally infested field at selected localities. Therefore, the aim was to determine the reaction of Limmu coffee genotypes against coffee berry moth and coffee blotch miner.

2. Materials and Method

1. Description of study areas

The study was conducted at Agaro and Gera research sub centers. The area receives an annual rainfall in the range of 1480 to 2150 mm, with the main rainy season between June and September. The elevation of Agaro and Gera is 1697 and 1900 m a.s.l, respectively. Gera sub center representing high altitude and Agaro research sub center representing mid altitude. Based on this coffee blotch miner is low to mid altitude insect pest, and pests are also area specific.

2. Treatments and design

Eleven Limmu coffee genotypes were evaluated against coffee berry moth and coffee blotch miner to identify the plant host interaction. Spacing between coffee and experimental block was 2 and 3m, respectively. The experiment was arranged in randomized complete block design (RCBD) with three replicates. Recommended agronomic practices were applied per recommendation.

3. Coffee insect pests' assessment method

Coffee blotch miner: Four coffee trees per row were systematically selected. Furthermore, each tree was stratified in to three canopy layers (upper, middle and lower) and a pair of branch from each layer was selected for assessment of the insect. The severity of coffee blotch miner was estimated by following the infested leaf area per total leaf following the leaf midrib (Figure 1). The maximum estimation (100%) was given when severe mined leaves covered by blotch and followed by drying and fallen leaf [15]. No damage (0%); or few blotch mines (<5%, when damage symptom <2mm); and 50% when half of leaf area mined by blotch miner and most leaves with long blotch and several mines (50 percent of leaf covered by blotch symptom) and 100% when all leaf area covered by coffee blotch miner.

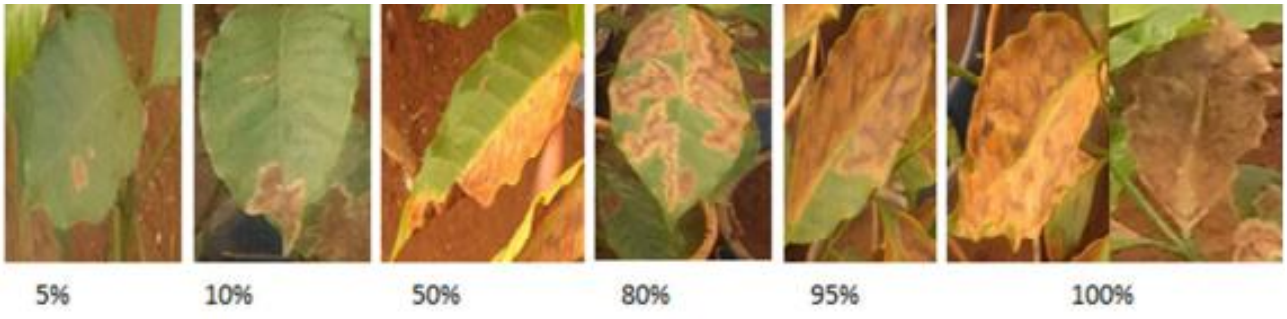

Figure 1. *Coffee blotch miner damage scale. Source: Shimales et al., 2021b.*

4. Coffee berry moth data collection method

Similar to coffee blotch miner data collection, four coffee trees per row were systematically selected. Each tree was stratified in to three canopy layers (upper, middle and lower) and a pair of branch from each layer was selected for assessment of the coffee berry moth damage. Total number of berry cluster and the number of damaged berry cluster per selected bearing branches was counted based up on damage symptom observed on the berry.

Figure 2. *Coffee berry moth damage symtom (Webbed berries by coffee berry moth) on berry clusters at Gera.*

5. Statistical analyses

Data were analysed using using R v 3.6.3 (R Core Team 2020) software. General Linear Model (GLM) procedure was employed for the analysis of the data. Least significant difference (5%) was used for mean separation.

3. Results and Discussion

The aim of the current study was to investigate the reaction of coffee blotch miner and coffee berry moth against Limmu coffee genotypes at field condition on the naturally infested coffee. Accordingly, the reaction of Limmu coffee genotype against coffee blotch miner and coffee berry moth varies in terms of damage.

The percentage of infested leaves by coffee blotch miner varied among the genotypes, with 5.0% to 29.44% of the leaves damaged in 2022 and 1.11% to 6.78% in 2023. In 2023 coffee blotch miner damage was much lower (<6%) as compared to 2022 growing season (Table 1). This does not mean that all evaluated genotypes are tolerant to pest based on 2023 growing season data. However, in 2023 on the same coffee genotype ('75227') the damage has been able to decrease by 50% (Table 1). The main reason for this could be the weather variable of the year may affect the insect abundance. Different response of Limmu coffee genotypes against coffee leaf miner could be due to different level of resistance mechanism. Research indicated that the lower mean number of eggs laid, frequency of oviposition and percentage leaf damage may be an indication of the existence of antixenosis type of resistance in C. arabica cultivars [16].

Besides, the reaction of Limmu coffee genotypes against coffee berry moth showed significant difference. In 2022 the lowest (3.10%) and highest (31.66%) mean damage was recorded due to coffee berry moth. However, in 2023 the damage was higher and varies between genotypes, with maximum and minim damage level of 1.11% (L20/03) and 54.13% (L02/03), respectively (Table 1). This suggests that the difference in damage level among genotypes might be occurred due to the different in defense mechanism. The detailed reason of damage difference could be the future research works to develop tolerant coffee varieties against berry moth as one component of integrated pest management. There are some findings on coffee berry moth damage in forest coffee production of southwestern Ethiopia with varies damage level of 0.65 to 11.62% [17]. Heavy losses of berries have been documented due to severe attacks at low altitudes [13].

Table 1. *Reaction of Limmu coffee genotypes against coffee blotch miner and coffee berry moth.*

Treatments	Severity of coffee blotch miner (%) at Agaro		Coffee berry moth (Gera) damage% at Gera	
	2022	2023	2022	2023
Merda-Cherko	5.56b	1.11b	3.107d	3.31d

Treatments	Severity of coffee blotch miner (%) at Agaro		Coffee berry moth (Gera) damage% at Gera	
	2022	2023	2022	2023
75227	29.44a	10.39a	8.33bcd	11.26bcd
L01/05	5.56b	2.67ab	2.443d	7.97bcd
L02/03	12.33ab	5.39ab	26.8ab	54.13a
L04/03	8.89ab	1.51b	31.66a	49.84a
L10/03	5.55b	6.78ab	3.99d	5.51cd
L12/05	20.11ab	0.44b	11.89bcd	32.86ab
L20/03	3.89b	0.00b	5.553cd	1.11d
L24/03	8.33ab	1.27b	12.33a-d	12.20bcd
L26/03	10ab	1.17b	6.88cd	11.16bcd
L55/01	5.0b	0.56b	24.22abc	28.2abc
LSD (5%)	23.7	8.026	19.52	26.72
CV (%)	75	59.58	39.74	48.34

4. Conclusion and Recommendation

Coffee berry moth (*Prophantis smaragdina)* and coffee blotch miner *(Leucoptera caffeina)* are one of the insect pest species under Lepidoptera order affecting coffee berry and leaf, respectively. More currently, coffee berry moth is becoming one of an economically important pest of Arabica coffee in Ethiopia. Our current study result indicated that there are various damage levels among the Limmu coffee genotypes against coffee insect pests. This indicates the existence of genetic variation in response to the coffee pest damage. Identifying the tolerant varieties against coffee berry moth and blotch miner best fits integrated pest management which usually recommended for coffee producers. Therefore, future research works should be focused on characterizing and identify biochemical and secondary metabolites of low infested coffee genotypes which could use as an important traits for hybridization.

Abbreviations

JARC Jimma Agricultural Research
EIAR Ethiopian Institute of Agricultural Research

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Author Contributions

Tamiru Shimales is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The author declares no conflicts of interest.

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