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# Effects of Desmodium on Coffee Blotch Leaf Miner, *LeucopteraCaffeina* (Lepidoptera: Lyonetiidae) at Jimma, Southwestern Ethiopia

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## ABSTRACT

*Cover crops (desmodium) provide diverse services in agricultural production specifically for pest management and soil fertility improvement. However, there is limited information about the impact of cover crops, specifically desmodium on coffee insect pest intensity, which is paramount for developing cultural pest management method. Therefore, this experiment was conducted for three consecutive years to determine the effects of desmodium and its mulching materials on blotch leaf miner incidence. About five treatments were arranged in randomized complete block design with three replications. Total number of leaves and damaged leaves were counted per three branches.The proportions of infested coffee leaves out of the total number of leaves were considered as incidence. Lower (6.66%) average infestation of blotch miner was found on desmodium trimmed once a year and used as mulch, and the higher (14.40%) was recorded from control treatment (without mulch and cover crop). This finding demonstrates that desmodium mulched materials and cover crop had effect on blotch leaf miner incidence on naturally infested field by blotch leaf miner. Over all, this study highlights how cover crop and mulch can be used for cultural insect pest control. Furthermore, data on coffee yield and cost benefit analysis are most importance in determining the significance of this finding, as this is ultimately what is important for farmers.*

**Keywords:** *Coffea arabica L.,Cover crop, Incidence, Mulch*

## INTRODUCTION

Ethiopia is the center of origin and diversity of Arabica coffee. In Ethiopia, the average national production is very low (636 kg $ha^{-1}$) as compared to other major coffee producing countries (CSA, 2020). This is partly due to the widespread and prevalence of coffee pests (insects, plant diseases and weeds). Insect pests are one of the biotic factors that contribute to low yield and quality (Million, 2000). Over 49 species of insect pests were identified on coffee in Ethiopia, which were categorized as major, potential and minor pests (Million and Bayisa, 1986; Million, 1987, 2000, Esayas *et al*., 2008). Coffee blotch leaf miner, *Leucopteracaffeina* comes next to Antestia bug in economic importance *(*Million and Bayisa, 1986; Million, 1987; 2000). Severe defoliation because of high infestation by coffee blotch leaf miner is expected to decrease yield (Million, 2000). In the country, its incidence was reported by different authors (IAR, 1986; Fuad, 2010; Samnegard *et al.*, 2014; Chemeda *et al.*, 2015; Tamiru, 2019).

Cultural practices can have direct or indirect impact on coffee pest densities/intensities reduction. Among cultural practices, cover crop/s such as desmodium and recommended mulching materials are often used by small scale farmers, as coffee pest (weeds) management option. Desmodium plant is among the multipurpose cover crop, and cover crops were generally characterized by lower densities of phytophagous insects and more species of

natural enemies in other crops such as in apple orchards and vineyards (Altieri *et al.*, 1985). In addition, growing green manure legume cover crops improve soil fertility and soil physical properties (Muriethi *et al.*, 2003; Endale *et al.*, 2015; Larkin, 2019), and able to suppress weeds (Endale *et al.*, 2015; Gerhards and Schappert, 2020).

The characteristics of the cover crop and recommended mulching materials can affect pests directly, but also indirectly through increasing physiological resistance and natural enemies. For example, cover crop has to be increases the abundance of beet armyworm pupae's natural enemies (predators) as compared to conventional production plot (Pullaro, 2006). Yet effects of cover crop and recommended mulching materials on coffee insect pest are rarely studied and its benefit may vary from environment and types of cover crop used in different cropping systems. From a management perspective, it is also important to know whether the cover crops and its mulching materials are reducing blotch leaf miner incidence or not. Moreover, understanding the effect of desmodium and its mulching materials on insect infestation may give insight to develop cultural insect pest management option that may provide as an element of integrated pest control method, and also minimize the use of synthetic pesticides. Therefore, the objective of this study was to determine the effect of desmodium and mulch on coffee blotch leaf miner intensities.

## MATERIALS AND METHODS

### Description of Study Area

This study was conducted at Jimma Agricultural Research Center (JARC) on station. JARC is found in Oromiya regional state in Jimma zone, 360 km southwest of capital city of the country, Addis Ababa. It is located to 07°46''N latitude and 36°47'E longitude coordinate and at an elevation of 1753 meter above sea level (masl). It represents the medium agro ecological zones which receives annual rainfall of 1572mm on average. Its mean minimum and maximum temperature is 11.6$^0$c and 26.3 $^0$C, respectively. The major soil type of the center is chromic nitosol and cambiosl of upland and fluvisol of bottom land (JARC, 2004).

### Experimental Design, Management and Treatments

The treatment plots have been arranged in randomized complete block design with three replications. Spacing between coffee and experimental block was 2 and 3m, respectively. Compact coffee variety i.e. 74110 was used for this experiment. Five treatments such as desmodium free growth (not trimmed), desmodiumtrimmed once a year and mulched, trimmed once and taken out, trimmed once and 50% mulched and 50% out and control treatment was tested for coffee blotch leaf miner infestation on natural infested coffee field. The trial was carried out for three consecutive years (2016/17 to 2018/19); on pesticide free plot and recommended agricultural practices were used.

### Sample Selection and Assessment of Blotch Leaf Miner *Leucopteracaffeina*

From each plot, six coffee trees were systematically selected employing the zigzag sampling method. Out of 30 coffee trees per a single plot, 12 coffee trees were selected and assessed for the insect incidence on naturally infested field. Furthermore, each tree was stratified in to three-canopy layer (upper, middle and lower canopy strata) and a pair of branch from each layer was selected for assessment of the insect. Branches were randomly selected from each of the trees per plot. The total number of leaves, as well as the number of damaged leaves by *L. caffeina* was counted on selected branches based up on damage symptom observed on the leaves.

### Insect Assessment

The coffee blotch leaf miner *L. caffeina* is one of the most problematic insect pests on Arabica coffee in Ethiopia. The coffee blotch miner *Leucopteracaffeina* (Washbourn) [family Lyone tiidae] oviposits its eggs in rows of 1 to 13 eggs (Notley 1956), and the larvae create a distinct blotch mine while feeding gregariously in the upper side of the leaf. This is the distinct symptom of coffee blotch miner differentiated from other leaf feeding insect pests. Finally, incidence was determined as the proportion of infected coffee leaf out of the total number of leaf counted**.**

### Statistical Analysis

The collected *Leucopteracaffeina* incidence data was analysed using the General Linear Model (GLM) procedures of SAS 9.30(SAS, 2012). The significant differences between treatments were separated using Least Significant Difference (LSD) using SAS, 2012.

## RESULTS AND DISCUSSION

The results showed that there was significant difference between treatment on *L. caffeinia*

infestation during 2016/17 and 2017/2018, while no significant effect was observed among treatments during 2018/19 (Table1). The percentage of damaged leaves varied largely from year to year, and among the treatments. The coffee blotch miner average incidence was lower (<7%) during 2016/17and 2017/18 cropping season, but increased during 2018/19 to 15.34% on control plot (Table 1). The incidence of blotch leaf miner was observed similar densities among treatments during 2016/17 and 2017/18, except control plots. Whereas, in 2018/19 the incidence increased from 6.66 % (desmodiumtrimmed once a year and mulched) to 14.40% (control) plots (Table1). We found that insect level was similar in all treatment except control with low percent incidence. The average infestation was low (<10%) almost in all treatments and had effect on coffee blotch miner infestation in all years (Table 1). Lower mean percent incidence was recorded in all treatments as compared to control, this is probably because of desmodium cover crop and its mulched materials improved the soil fertility status (Endale *et al.*, 2015), and coffee plant may escape from insect damage than control.

The lowest mean incidence was recorded from desmodium free growth during 2016/17 cropping season but, desmodium free growth had a more inconsistent effect. In all years, the desmodiumtrimmed once a year and mulched had a major effect on blotch leaf miner damage followed by desmodium free growth, with higher pest level on control treatment (Table1). Mulched treatment might be parasitized the larvae or pupae of fallen leaf mined by *L. caffeinia* or the presence of desmodium free growth probably conserve the natural enemies and reduce its incidence.

**Table1.** *The effects of desmodium on Leucopteracaffeina incidence at Melko, 2016/17-2018/19*

| **Treatments** | **2016/17** | **2017/18** | **2018/19** | **Mean (%)** |
|---|---|---|---|---|
| Free growth desmodium | 4.7(2.2)$^{b}$ | 4.98$^{b}$ | 14.9(3.8) | 8.19 |
| Desmodium trimmed once a year and used as mulch | 5.9(2.5)$^{ab}$ | 6.27$^{b}$ | 7.8(2.8) | 6.66 |
| Desmodium trimmed once a year and taken out | 8.6 (3.0)$^{a}$ | 4.24$^{b}$ | 17.2(4.2) | 10.01 |
| D. trimmed once and 50% mulch and 50% taken out | 4.9(2.3)$^{b}$ | 4.15$^{b}$ | 16.9(4.2) | 8.65 |
| Control (without mulch and desmodium) | 8.6 (2.9)$^{a}$ | 14.7$^{a}$ | 19.9(4.3) | 14.40 |
| **Mean** | 6.54 | 6.87 | 15.34 | 9.58 |
| **LSD (0.05)** | 3.45 | 2.48 | Ns | |
| **CV (%)** | 13.4 | 19.2 | 24.7 | |

*D. desmodium; LSD= least significance difference and CV= coefficient of variation. Values in the parenthesis were square root transformed. Means followed by the same letters are not significantly different (p<0.05).*

The present study demonstrates that desmodium cover crop and its mulched materials were found to decrease the blotch miner incidence. Desmodiumtrimmed once a year and mulched decrease the coffee blotch miner densities. This could be because of mulched materials might be creating a more favorable environment for its natural enemies (especially on fallen leaf mined by coffee blotch miner, as coffee blotch miner pupate on leaf and/or on fallen leaf). For instance, predation of other insect pest pupae (beet armyworm) was 33% greater in cover crop mulch compared to conventional production plots (Pullaro, 2006). Matching this expectation, we found that the insect pest was lower in desmodium cover crop and its mulched materials, which supports the hypothesis that cover crop and mulch could increase the natural enemies (Appendix Fig. 1b). Mulch affects insect pests, and different mulching materials used for diverse purposes, and might be impacts the arthropod herbivores and natural enemies (Kahl *et al.*, 2019).

Next to desmodiumtrimmed once a year and mulched treatment, the low mean incidence was recorded from desmodium free growth (Appendix Fig1. c) may conserve natural enemies of blotch miner (Appendix Fig1. b). A similar result has been reported by other investigators that cover crop was enhancing the natural enemies' population while suppressing pest populations in tea plantation in China (Chen *et al.*, 2019). They also indicated that abundance and species richness of predators was greater in tea plantations intercropped with *Chamaecristarotundifolia* and *Indigoferahen decaphylla*. Flowering cover crops can provide valuable forage for wild bees and beneficial insects (Lee-Mader, 2015). This beneficial insect (parasitoids) can be also reducing the blotch leaf miner densities. Cover crop can

increasing vegetation biodiversity in coffee farms thereby reduce the pest infestation through disruption of the spatial and temporal cycle of pests (Ratnadass *et al.* 2011). Another explanation for low infestation of coffee blotch leaf miner, due to leguminous nature of the crop (Muriethi *et al., 2*003), the soil fertility status will increase thereby the crop physiological resistance to pests can also increases (Ratnadass *et al.*, 2011).

## CONCLUSION AND RECOMMENDATION

This study suggested that desmodium cover crop and its mulched materials had significant effect on coffee blotch leaf miner intensities. This study also demonstrated that such cultural practices can reduce the insect pest (specifically, *L. caffeinia*) density and could be used as one mechanism pest management option for coffee growers. Furthermore, data on coffee yield and cost benefit analysis are most important to determine the significant effect of the cover crops, desmodium which is prominently useful for farmers in terms of production and cost benefit.

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**Appendix Figure1.** *Emerged adult blotch leaf miner and its parasitoids. A. Leucopteracaffeina adult moth under microscope and B, Emerged parasitoids (black and brown color and smaller than Adult moth) from desmodium cover crop. C. desmodium free growth (with flower). Photo: Tamiru S. April, 22 /2020, JARC entomology laboratory.*

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