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# Farmers' Knowledge, Perception and Management practices on the Distribution of Barley Shoot Fly *Delia arambourgi* in Central Highlands of North Shewa, Ethiopia

Fekadu Tewolde[1]* and Muluken Goftishu[2]

[1]Debre Beirhan Agricultural Research Center, PO. Box 112, Debre Birhan, Ethiopia,

[2]Haramaya University, PO. Box 138, Dire dewa, Ethiopia

*Corresponding author, Email fekadutewolde12@gmail.com

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**ABSTRACT**

*Survey was conducted in three barley producing districts of North Shewa in July and August 2021 with the objective of determining the distribution of barley shoots fly (BSF) and to assess farmers Knowledge, perceptions and shoot fly management practices related to shoot fly (BSF). Samples were collected at every 3 to 5 km intervals in 180 sample fields at each sampling field; five sample spots were randomly selected in a zigzag manner. To assess farmers' perceptions a total of 171 barley growers randomly selected from each district who are interviewed using structured questions. Data analysis was conducted using SPSS (version 20). Survey result revealed that barley shoot fly infestation found in ranges from 10 to 50%, Highest infestation was recorded (31.7%) in Tarmaber followed by (30%) in Basonawerena and (25%) Ankober. BSF Infestation with district and altitude have slight correlation. But mean percentage of dead heart among districts ranged from 6.3% to 11.4%. Among the major pest of barley (74.9%) of farmers identified insect, diseases, vertebrate pests and weed as economical important. Shoot fly (Delia arambourgi Segyu) was the most sever insect pest; its distribution accounts 82.8 % in Basonawerna, 79.3% in Tarmaber and 67% in Ankober. Over 55% of respondents stated that barley shoot fly damage occurred 2 weeks after emergence. Infestation rates were 53% in Basonawerena 51% in Tarmaber and 60 % in Ankober. A small proportion of the farmers in Tarmaber and Ankober (15.5%) followed by those in Basonawerna (13.4%) apply chemical insecticides for BSF control. High proportion of the farmers practiced cultural control methods to manage barley shoot fly, early sowing resulted in reduction of infestation and increase grain yield. Farmers' perceptions and survey results suggest that to future research on sowing date and seed dressing insecticides as management practice may leads to increments in barley yields.*

**Keywords:** Barley, Barley shoot fly *Delia arambourgi*, Distribution, Farmers Knowledge

## 1. INTRODUCTION

Barley is among the predominant of cereal crops cultivated in Ethiopia. It is the fifth important cereal crop next to teff, maize, sorghum and wheat covering an area of 951,993.15 hectares with an annual production of about 2.5 million tons in main season (CSA, 2018). Both food and malt barley grains are mostly used as food for human consumption, malt, and feed for animals (Yosef *et al*., 2011). Furthermore, barley straw is a useful material for thatching roofs of houses and for use as bedding (Grando. and Helena, 2005). It has a wide range of adaptation and can be grown in altitudes of over 3400 m.a.s.l on steep slopes, degraded soils, and in marginal areas with occasional drought and frost where other cereals threaten to grow (Berhanu *et al.,* 2005). In most parts of Ethiopia, barley is grown twice a year, in the main rainy season locally called *meher* (June to October) and in the short rainy season locally called *belg* (February to July) (Bayeh and Grando, 2011).

In spite of the importance of barley and the efforts made so far to generate improved production technologies, its productivity under subsistence farmers' condition in Amhara region is estimated to be 1.9 ton/ha which is below the national average yield of 2.2 tons/ha (CSA, 2018). The low yielding is attributed to a multitude of abiotic and biotic factors. Among the biotic factors insect pests particularly the Russian wheat aphid and barley shoot fly are considered as key insect pests (Tafa and Bayeh, 2011).

Barley shoot fly specially (*Delia* spp) is the most economical important insect pests of barley recorded in Ethiopia (Muluken *et al.,* 2009). Improved varieties released so far in Ethiopia were highly susceptible to barley shoot fly (Tamene *et al*., 2016). Two shoot fly species; *Delia arambourgi* Seguy and *Delia flavibasis* Stein (Taffa, 2003) was recorded in Ethiopia, resulting in substantial yield losses.

Understanding the pest distribution, abundance, and farmer's Knowledge, pest management practice is the vital information used to make decision regarding pest management options. Previous attempts on barley shoot fly research primarily focused on cultural practices and germplasm screening (SARC, 2004, 2005, 2006; Tafa and Bayeh, 2011). However, in the central highlands of Ethiopia, information related to the distribution, abundance, and farmers perceptions of barley shoot fly which are essential for making management decisions concerning *D. arambourgi* is lacking.

Therefore, the objectives of this study were: To assess the distribution and farmers' Knowledge perception and management practices of BSF in the central highlands of north Shewa.

# 2. Materials and Method

## 2.1. Distribution of barley shoot fly

### 2.1.1. Description of the study areas

Survey and farmers' management methods of barley shoot fly were conducted on three major barley growing districts of North Shewa zone, namely Basoena Werena, Ankober and Tarmaber in 2021 main cropping season.

Ankober is geographically, located 9° 38' N latitude and 39° 44' E longitude. The elevation of the site is 3152 m.a.s.L It has a bimodal rainfall pattern, Meher season (June to November) and Belg season (February to June). Barley is the dominant cereal crop in the area. (DBARC, 2016 unpublished). It is located at from 09º 35' 45" to 09º 36' 45" latitude and from 39º 29' 40" to 39º 31' 30 " longitude. It has unimodal rainfall with an altitude of 2850. Whereas Tarmaber located at Latitude: 9° 50' 56.6" (9.8491°) North and Longitude: 39° 43' 56.4" (39.7323°) east. It has bimodal rainfall pattern the site Elevation: 3,155 meters.

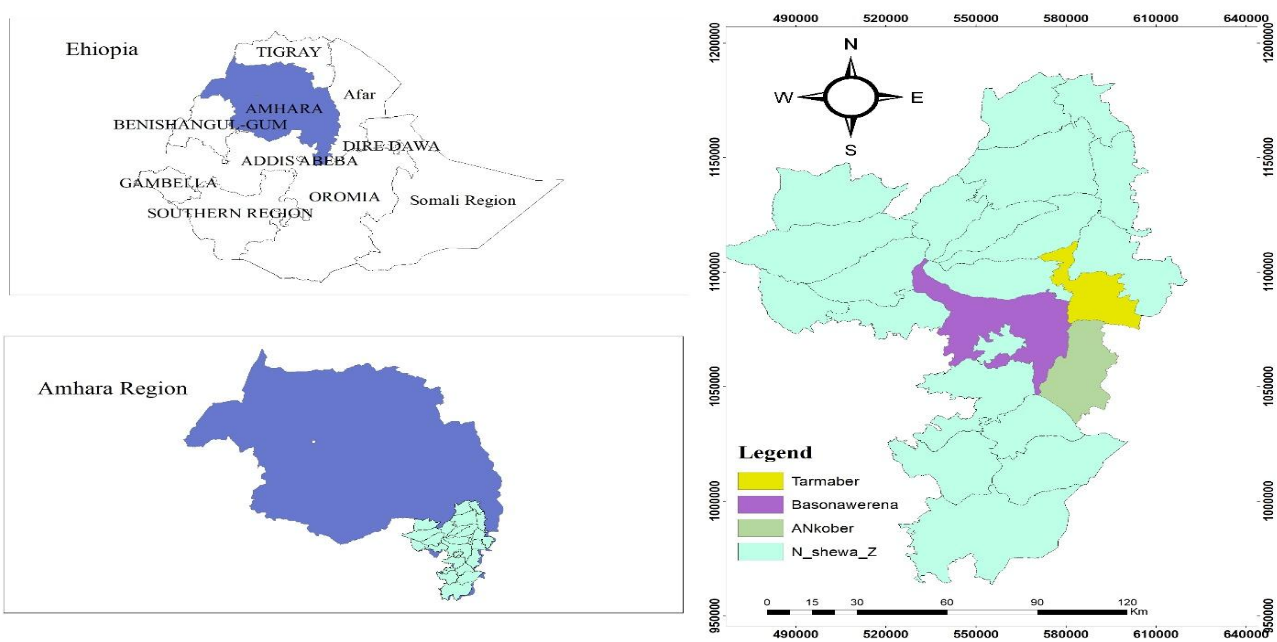


Figure 1. Location map of the study districts

### 2.1.2. Sampling procedures, sample size and data collection

Field survey from each district 60 and a total of 180 barley fields were randomly selected at 3 to 5 km intervals based on the availability of barley fields. In each field, five sample spots were randomly selected in a zigzag manner. At each sampling spot, data on infestation and dead heart, barley seedlings showing damage symptoms counted from a total of 100 plants with in 1m$^2$ quadrat then the infestation result categorized in (1-10%,11-20%,21-30%,31-40%, and 41-50% (Salvatore *et al* 2010).

Infestation was considered as a range of symptoms from early leaf mining to dead hearts. Subsequently data on dead heart was recorded. Dead heart referred to seedlings ambushed by barley shoot fly whose central shoot had already dried or showed wilting (Tafa, 2003).

Data on infestation and dead heart percentage of barley shoot fly were determined using the formula (Arshad *et al*., 2019).

$$Infestation(\%) = \frac{Number of dead heart damage}{Total sample} x100$$

Number of barley plants in each plot out of 100 was counted in quadrat ($1m^2$) and the number of barley plants showing dead heart formation was calculated and convinced into % dead heart by applying specified formula (Sathish *et al*, 2017).

$$Deadheart(\%) = \frac{Number of plants with dead heart}{Total number of plants} x100$$

### 2.1.3. Data analysis

For BSF distribution data analysis was done using SPSS statistical software (Version 20) IBM Corp (2020). Percentage data were subjected to square root transformation before the analysis to stabilize variance if the percentage data is 1 to 30% no arcsine transformation need square root transformation could be applied.

## 2.2. Farmer's Knowledge perception and Management Practices of Barley Shoot Fly

### 2.2.1. Sampling procedures, sample size and data collection

The sampling procedures and method of data collection followed the work of Muluken *et al*. (2017). Thus, districts were purposively selected taking the production statistics of barley and barley growers (DBARC, 2016). Within each district, three kebele from Basonawerena (Keyet, Bakelo, Dengora), Tarmaber (Woinber, kosober, Tidber) and Ankober (Temke, Laygorebella, TachGorebela) were purposively selected based on accessibility to road. From each kebele, 19 respondents who grow barley were selected making a total of 57 respondents per district and 171 in the whole sample. The selections of farmers were made based on their willingness to participate in the study. To avoid any potential bias, farmers were informed that the survey was for academic research purposes only.

A household survey, using structured questionnaires for personal interviews with selected respondents, was done. Survey questionnaires were pre-tested using a small sample of farmers. Results of the pre-test were taken into consideration to confirm whether the proper language was used without loss of meaning. Variations in understanding of the questioners among farmers were taken into account and fixed before the final interviews were undertaken. The interview was made in the local language (Amharic). The questionnaires were discussed during face-to-face interviews with individual farmers and addressed information on farmers' socioeconomic profile (age, gender, education, and family size), varieties of barely used for planting, and reasons for preferring those varieties.

Interviewed farmers were rank the major production constraints of barely and emphasis was given to their perception of barley shoot fly pest, time of planting, type, dose of insecticides applied, time, insecticides application frequency and other barely shoot fly management. For each question, the percentage of farmers who gave similar responses was calculated for each district. Percentages of farmers in all districts which were given similar responses to a question was calculated based on the total number of farmers who responded to each question (Ebenebe *et al.,* 2001).

## 2. 3. Data analysis

Respondents' data was summarized using descriptive statistics, e.g., mean, frequencies and percentages. One-way analysis of variance using chi-square ($\chi 2$-test) in SPSS (version 20) IBM Corp. (2020). were undertaken to assess differences among districts and farm practices of farmers influencing the pest status of barley shoofly.

# 3. Results and Discussion

## 3.1. Distribution of Barley Shoot Fly

### 3.1.1. Shoot fly infestation and dead heart across districts

Infestation of barley shoot fly was insignificant among districts. In all the surveyed districts barley shoot fly infestation level ranged from 10 to 50%. The highest infestation percentage fall in the range of 21-30% at each district ($\chi^2 = 8$), the degrees of freedom (df = 8), and (p = 0.36). The maximum infestation percentage was recorded 50% at Tarmaber (31.7%) followed by Basonawerna (30%) and Ankober (25%) Ankober (Table 1). This result is in conformity of Muluken *et al*., (2009) regarding the onset of barley shoot fly damage, most of sample taken indicated that barley shoot fly start infestation from two weeks after seedling emergence young barley seedlings (two to three leaf stages) are most preferred for oviposition. It caused 31 to 50 percent of yield losses. Similarly, research conducted in Bale highlands on infestation level of barley shoot fly frequently reaches 100% on susceptible barley cultivars and causes considerable yield loss (SARC, 2005). In sorghum, this pest causes maximum yield losses of 75.6% (Biradar and Sajjan2018). Barley shoot fly caused considerable yield loss on most barley field experiment at various site of Debre birhan Agricultural Research Center (DBARC2016).

**Table 1**: Barley shoot fly infestation across districts

| District | Farm surveyed | Infestation level (%) 10 | 11-20 | 21-30 | 31-40 | 41-50 | χ2-test | p-value |
|---|---|---|---|---|---|---|---|---|
| Basonawerena | 60 | 23.3 | 5.1 | 25.0 | 16.6 | 30.0 | | |
| Tarmaber | 60 | 16.6 | 11.7 | 31.7 | 25.0 | 15.0 | | |
| Ankober | 60 | 25.0 | 11.7 | 21.7 | 23.3 | 18.3 | | |
| Mean | | 21.6 | 9.6 | 26.1 | 21.6 | 21.1 | 8 | 0.36 |

Mean percent dead heart ranged from 6.3 to 11.4 at Tarmaber and Ankober, respectively. Maximum numbers of dead heart were recorded in Basonawerna followed by Ankober and Tarmaber (Table 2). This Prevalence result showed that economic importance of *D. arambourgi* in the central highlands of North Shewa. Similar research done at Bale and Arsi indicated that the presences of infestation and dead heart in several barley growing areas of the country reflect the economic importance of barely shoot fly (Amare and Bayeh, 1996).

**Table 2:** Dead heart counts record across districts

| | Farm surveyed | Maximum | Minimum | Mean | Standard error |
|---|---|---|---|---|---|
| Basonawerna | 60 | 29.3 | 1 | 8.2 | 0.42 |
| Tarmaber | 60 | 11 | 2.3 | 6.3 | 0.29 |
| Ankober | 60 | 17.6 | 2 | 11.4 | 0.58 |

#### 3.1.2. Associations of shoot fly infestation with biophysical factors

Infestation was positively correlated with weed infestation (r = 0.9*). However, field management with weed condition and district negatively correlated (r = 0.55**); (r=- 0.2**) respectively (Table 3). The infestation of barley shoot fly was positively and significantly correlated with weed infestation. Because the weeds serve as alternative hosts for the fly, and they create a more favorable the weeds serve as alternative hosts for the fly, or do they create a more favorable microclimate for its survival and reproduction microclimate for its survival and reproduction. Infestation with district and altitude has slightly correlation. However, infestation was inversely correlated with field management. Different biophysical factors play a key role in determining the incidence and dominance of a particular pest or pest complex (Meena *et al*., 2013).

**Table 3:** Correlation coefficients of shoot fly infestation with bio physical factors

| | Infestation | District | Alti-Tude | Variety | Field management | Weed infestation |
|---|---|---|---|---|---|---|
| Infestation | 1 | -0.07 | 0.1 | 0.02 | -0.024 | 0.9* |
| District | -0.07 | 1 | 0.09 | 0.04 | -0.2* | 0.14 |
| Altitude | 0.1 | 0.09 | 1 | 0.016 | 0.122 | -0.026 |
| Variety | 0.02 | -0.04 | 0.016 | 1 | 0.053 | -0.089 |
| Field management | -0.024 | -0.2* | 0.122 | 0.053 | 1 | -0.55* |
| Weed infestation | 0.9* | 0.14 | -0.026 | -0.09 | -0.55* | 1 |

## 3.2. Farmer's knowledge perceptions and Management Practices of Barley Shoot Fly

### 3.2.1. Household demography of the farmer's Age

Our study reveals that out of 57 mean of interviewer 27% of the respondents were in middle age category (31 to 40) old but 25.2% were aged between 41and 50 years, 19.5% of the farmers were age between 51 to 60 while 10.5% of the households were older than 60 on the other hand 17.8% of the households were younger than 30 years. In all the districts addressed the majority of the respondents (92.5%) had households that were headed by males (Tables 4).

***Gender***

The result revealed that gender has significant difference from 7.5 female to 92.5 male house hold. Previous studies showed that literate male-headed households are more likely implement new agricultural technologies than female-headed households (Doss and Morris, 2001).

**Table 4**: Summary of socio-economic characteristics, agricultural and barley farming experience of the respondents

| Variable | District Basonawerena | Tarmaber | Ankober | Mean | χ2-test | p-value |
|---|---|---|---|---|---|---|
| Age of the household head | | | | | 3.7 | 0.7 |
| 18-30 | 20.6 | 17.2 | 15.5 | 17.8 | | |
| 31-40 | 29.6 | 29.3 | 22.4 | 27 | | |
| 41-50 | 24.1 | 24.1 | 27.5 | 25.2 | | |
| 51-60 | 18.9 | 15.5 | 24.0 | 19.5 | | |
| Greater than 60 | 6.8 | 13.9 | 10.6 | 10.5 | | |
| Gender of House hold% | | | | | 8.6* | 0.01 |
| Male | 84.5 | 94.8 | 98.3 | 92.5 | | |
| Female | 15.5 | 5.2 | 1.7 | 7.5 | | |
| Level of education (%) | | | | | 27.6 | 0.001 |
| Primary | 67.2 | 70 | 53.7 | 62.2 | | |

| | | | | | |
|---|---|---|---|---|---|
| Secondary | 23 | 20 | 17 | 20 | |
| Diploma | 5.2 | 0.0 | 0.0 | 5.2 | |
| No formal education | 4.6 | 10 | 29.3 | 12.6 | |
| Years of farm experience (%) | | | | | 5.7 |
| 1-15 | 36.2 | 31.3 | 25.9 | 31.1 | |
| 15-30 | 39.7 | 36.2 | 31.0 | 35.6 | |
| 31-45 | 18.9 | 22.2 | 34.5 | 25.3 | |
| 46-60 | 5.2 | 10.3 | 8.6 | 8.0 | |

***Education***

Education is assumed to be an important factor in accessing innovative new improved agricultural technologies and increased agricultural productivity (Elahi et al., 2015).

In this study, the highly significant coefficient of education of the household head shows that the probability to changes farmers knowledge in-creases with an increase in the years of schooling.

There was a significant difference in level of education across district ($\chi^2$ = 27.6), (df = 8.9) at (p=0.001) (Table 4) Overall, 62.2% of the respondents had attended primary school, 20% had secondary and 5.2% had diploma and the rest 12.6% had no formal education. High levels of education have been connected to higher adoption in other circumstance. A similar trend was also reported from eastern Ethiopia (Muluken *et al*., 2017). Moreover, level of education has a significant impact on early adoption of agricultural technologies (Khan and Damalas, 2015)

The illiteracy level was the highest in Ankober where 29.3% of the household heads had no formal education the result revealed that farmers had little to moderate knowledge about shoot fly characteristics. Around 92.5% of the producers were male farmers this suggests that barley farming in this region is gender oriented.

***Years of farm experience in farming***

The coefficient of years of experience in farming has a positive sign for most of the farmer knowledge and control measures, indicating a positive relation between farming experience and possibility of adapting shoot fly management practices.

Thirty one percent of farmers had farmed barley for 15 years and 35.6% of the respondents grown barley 15 to 30 years. On the other hand, 25.3% of them farmed barley 31 to 45 and 8% of the farmers had 46 to 60 years of experience (Table 4).

### 3.2.2. Constraints of barley production from the farmer's perspectives

Among the major barley production constraints identified pest problem (50%) Lack of improved seed (14.3%), Shortage of labor (12.6%), Shortage of land (10.9%) Shortage of fertilizer (7.5%) as a main production constraint and drought (4.63%) as a least constraint but insignificant differences were observed as among each district on barley production challenges among districts ($\chi2$ =15.1, *df* =10, *p*<0.12) (Table 5). Among pests, insect pests particularly shoot fly was ranked first by the majority of farmers in all the three districts. This result is in line with (Tafa., 2003; Tafa and Tadesse, 2005; Muluken *et al.,* 2009) barley shoot fly is considered as a major pest of barley and minor pest of wheat and teff in Ethiopia

Among the described pests, the large proportion of farmers out of 57 respondents (31%) mentioned insect pests in general such as (shoot fly aphids, Epiachna and beetles) as a major constraint to barley production followed by vertebrate pests, diseases and weed. Among insect pests particularly shoot fly was ranked first by the majority of farmers in all the three districts. Barley shoot fly is considered as a major pest of barley and minor pest of wheat and teff in Ethiopia (Tafa and Tadesse, 2005; Muluken *et al.,* 2009) (Table 5).

**Table 5**: Mean score of constraints reported by barley farmers in three districts of North Shewa

| | District | | | | | |
|---|---|---|---|---|---|---|
| Farmers' perception | Basonawerena | Tarmaber | Ankober | Mean | χ2-test | p-value |
| Major constraints | | | | | 15.1 | 0.12 |
| Pest problem | 58.6 | 44.8 | 46.6 | 50.0 | | |
| Shortage of land | 4 | 8.6 | 20.7 | 10.9 | | |
| Lack of improved seed | 12.0 | 17.2 | 13.8 | 14.3 | | |
| Shortage of fertilizer | 5.2 | 12.0 | 5.2 | 7.5 | | |
| Shortage of labor | 17.2 | 10.5 | 10.3 | 12.6 | | |
| Drought | 3.45 | 6.9 | 3.4 | 4.7 | | |
| Major pests of barley | | | | | 27.9 | 0.001 |
| Insect pests | 37.9 | 27.7 | 27.6 | 31.08 | | |
| Diseases | 31.0 | 10.3 | 27.6 | 22.96 | | |
| Vertebrate pests | 3.5 | 43.1 | 27.6 | 24.73 | | |
| Weeds | 27.6 | 18.9 | 17.2 | 21.23 | | |

### 3.2.3. Farmer's knowledge and Perception of barley shoot fly other insect pests of *Barley*

Out of 171 farmers' 82.8 % in Basonawerna, 79.3% in Tarmaber and 67% in Ankober ranked shoot fly first as a major insect pest out of the major insect pests. The economic importance of Epilachna varies among districts accordingly, 3.4% in Basonawerna, 12.1% in Tarmaber and 19.0% in Ankober accounted for this pest. Around 12% of the respondents in Basonawerna account beetle as constraints for production of barley. On the other hand, 3% of the farmers at Basonawerna 7% at Tarmaber and 10% at Ankober indicated aphid as an insect pest of barley (Fig 2).

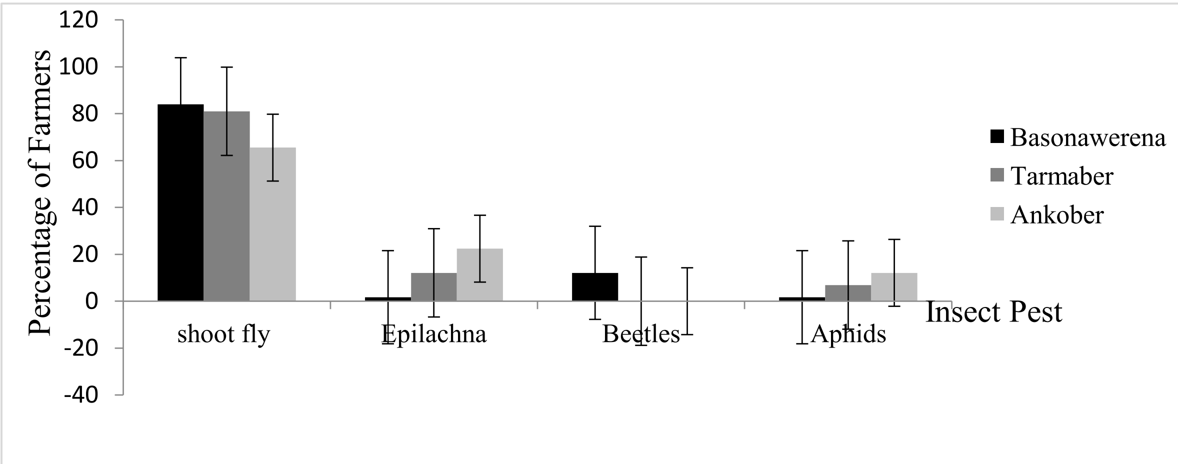


**Figure 2:** Major insect pests of barley among district

### 3.2.4. Impact of shoot fly and onset of barley shoot fly

There was no significant variation among districts to estimate the onset of barley shoot fly damage from first week to forth week after barley emergence. But the majority of the farmers (55.1%) estimated that barley shoot fly infestation started two weeks after seedling emergence (Table 3). This investigation is in line with to Muluken *et al*., (2009) young barley seedlings (two to three leaf stages) are most preferred for oviposition.

In the case of farmers did not apply any control measures economic losses from shoot fly. Reports shows that the range from 5 to 90% had significant differences among districts in estimation of yield losses of barley due to shoot fly ($\chi2$ =35.3, *df* =20, *p*<0.01). The majority of the respondents (46%) estimated loss on the range of 31-50%. (Table 6).

This result is in conformity with study conducted in Bale highlands infestation level of barley shoot fly frequently reaches 100% on susceptible barley cultivars and causes considerable yield loss. Biradar and Sajjan2018 confirmed that Shoot fly *Atherigona soccata* Rondani is a major yield limiting factor that causes large scale damage on major cereals sorghum. This pest causes maximum yield losses of 75.6%. Barley shoot fly caused considerable yield loss on most barley field experiment at various site of Debre birhan Agricultural Research Center (DBARC2016).

**Table 6**: Percentage of shoot fly damage in relation to planting date and estimated yield losses

| Farmers' perception | District | | | Mean | χ2-test | p-value |
|---|---|---|---|---|---|---|
| | Basonawerna | Tarmaber | Ankober | | | |
| BSF feeding damage | | | | | 3 | 10.6 |
| 1 week after emergence | 27.7 | 36.2 | 24.1 | 29.3 | | |
| 2 weeks after emergence | 53.4 | 51.7 | 60.3 | 55.1 | | |
| 3 weeks after emergence | 15.5 | 10.3 | 13.9 | 13.2 | | |
| 4 weeks after emergence | 3.4 | 1.8 | 1.7 | 2.3 | | |
| Estimated yield losses % | | | | | 35.3 | 0.01 |
| 5-10 | 6 | 20.7 | 10.4 | 12.4 | | |
| 11-20 | 8.6 | 6.9 | 10.3 | 8.6 | | |
| 21-30 | 17.2 | 17.6 | 19 | 17.9 | | |
| 31-50 | 51.9 | 47.6 | 40.5 | 46.6 | | |
| 51-70 | 8.3 | 4.9 | 12.0 | 8.4 | | |
| 71-90 | 8 | 2.3 | 6.9 | 5.7 | | |

#### 3.2.5. Farmer's shoot fly management practices

No significant difference was recorded among districts in the use of chemical insecticides for the management of barley shoot fly. A small proportion of the farmers at Tarmaber and Ankober (15.5%) followed by Basonawerna (13.4%) apply chemical insecticides for the control of barley shoot fly. More than 85% of the interviewed farmers did not apply insecticide due to lack of awareness on what, how much and when to apply, unavailability, and high cost are the main reasons for not applying synthetic insecticides. This study is in line with study done in (SARC, 2005)

Synthetic insecticides were evaluated and recommended for the control of barley shoot fly; recommendations have been largely ignored by subsistence farmers in the study districts. Likewise, concerning the use of improved barley varieties was 87 % of farmer' did not use improved seed. Few farmers in Ankober (14.5%) district followed by Basonawerna (13.2%) and Tarmaber (11.3%) used improved varieties of barley (Table 7).

Significant differences were observed on planting date among districts ($\chi 2 = 12.0$, $df = 2$, $p<0.017$). Early planting was practiced by the majority of farmers (48.85%). This result is supported by (Tafa and Muluken 2007) high proportion of the farmers practiced cultural control methods to manage barley shoot fly. Among the cultural control early sowing significantly minimized infestation and resulted higher yield than late sowing. Similar research conducted in shoot fly management investigated that early and uniform sowing of resistant cultivar over large areas reduce damage by shoot fly. Research indicated that early sowing (7-10) day before the onset of rain could avoid the active period of shoot fly incidence (Biradar and Sajjan2017). However, a small proportion of the respondents (8.65%) practiced late planting. 42.5% proportion of farmers said that planting barley early and/or late had advantage.

Regarding to the fertilizer use (27.6%) apply chemical fertilizer, (8%) of the farmers applied organic fertilizer that influence the shoot fly status;the remaining (64.4%) of farmers did not practice these management (Table 7).

Out of 57% of respondents at each district (32.8%) done hand weeding practice. Weeding used as cultural management practice to minimize the damage incurred by barley shoot fly. This result is in line (Biradar and Sajjan2018) with research finding implies that removal of infested seedlings and fodder sorghums, grasses alternate hosts.

**Table 7**: Different management methods for barley shoot fly

| Farm practice | District | | | Mean | χ2-test | p-value |
|---|---|---|---|---|---|---|
| | Basonawerna | Tarmaber | Ankober | | | |
| Insecticide used | 13.4 | 15.5 | 15.5 | 14.8 | 4 | |
| Not used | 81.6 | 87 | 86.46 | 85.2 | 3.6 | |
| Use of improved barley varieties | 13.2 | 11.3 | 14.5 | 13.0 | 3.3 | |
| Planting date | | | | | 12 | 0.017 |
| Early planting | 34.5 | 58.6 | 53.4 | 48.8 | | |
| Late planting | 6.9 | 5.2 | 13.8 | 8.6 | | |
| Both | 58.6 | 36.2 | 32.8 | 42.5 | | |
| Chemical fertilizer | 34.5 | 31.0 | 17.2 | 27.6 | 15 | 0.01 |
| Organic fertilizer | 6.9 | 17.2 | 0.0 | 8.0 | 19.4 | 0.01 |
| Un known | 58.6 | 66 | 69 | 64.5 | 3 | |
| Hand weeding | 43.1 | 36.2 | 19.0 | 32.8 | 12.3 | 0.01 |

## 4. Conclusion

The survey result across district indicated that seedling infestation and dead heart appeared across all districts. Therefore; the presence of this damage reflects *Delia arambourgi* Seguy prevalence and distribution was the most predominant and being the most serious species in the central highlands of North Shewa. The distribution of shoot fly pests across these barley growing areas is almost similar. Barley growing farmers in the study areas are mostly categorized under young to middle aged class. Moreover, the majority of households in the surveyed districts are headed by literate males. Even if the majority of the interviewed farmers replied that they were well acquainted with shoot fly and the damage it causes on barley. Most of the farmers in all districts were not protecting their farm against the damage caused by barley shoot fly.

Awareness raising training given to barley growers for proper *Delia arambourgi* Seguy identification, its biology and management Moreover; Training should be given on the use of appropriate safety precautions on pesticide use and its side effects on public health and environment. There is therefore the need to carefully study how existing control practices can be improved upon, where necessary to enhance their effectiveness in *Delia arambourgi* suppression in barley growing areas. Based on farmers response and our observation in the future new research examining injury reduction on choice sowing date aside from effective insecticides, under different cropping season may provide yield increments in barley.

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