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Identification of Insect Pest Species of Maize, Their Infestation and Damage Levels at Ziway Dugda Woreda, Arsi Zone, Ethiopia

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The survey was carried out in 2017 main cropping season to support farmers for correct insect pest identification. Three Kebeles, Hallo, Sambaro and Herara with five farmer's fields randomly selected. Ten representative plants were taken from each field. Data on mean larval density per plant, percentage leaf infestation and damage levels were assessed. Results from mean larval density per plant showed that significant difference between insect species (R^2= 0.96, Pr (>|Z|=0.013) where the highest 1.55-2.30 was recorded from *C. partellus.* There was a significant difference between *C. partellus* and *M. trapezalis; S. frugiperda* and *M. trapezalis* in percentage leaf infestation (R^2=0.75, Pr. (>|Z|=2e-16) where, the highest were recorded from *C. partellus* and *S. frugiperda* representing 50-90% and 40-90% respectively. From the above, *C. partellus* and *S. frugiperda* were at risk, as a result insecticide was recommended. *M. trapezalis* showed a lower infestation level so that hand picking was more economical than use of insecticide. Hence, registration and detail molecular identification will be needed as *M. trapezals* is the first record on maize crop in Ethiopia.

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1. INTRODUCTION

Maize is the most widely grown staple food and is an essential crop as part of the national food security strategy and economic wellbeing. Maize crop has a potential to produce more calories and food per area of land cultivated than all significant cereals grown. The production of maize was estimated to 1037.79 metric tons with an average yield of 5.62 tones/ha worldwide. In sub-Saharan Africa maize occupying more than 33 million hectares of land each year and covers nearly 17% of the estimated 200 million hectares cultivated land (FAOSTAT, 2015). More than 300 million people in sub-Saharan Africa depend on maize as source of food for livelihood and economic wellbeing. Nevertheless, the low average regional maize grain yields as high as 1.7 tones/ha in West Africa and 1.5 tones/ha in East Africa, and 1.1 tones/ha in Southern Africa that are still persistent in farmers' fields, meeting the projected increased demand for maize grain [1].

The popularity of maize in Ethiopia is partly because of its high value as a food crop as well as the growing demand for the stover as animal fodder and source of fuel for rural families. Approximately 88 % of maize produced in Ethiopia is consumed as food, both as green and dry grain. Maize production and its status in determining food security in the country received a major focus. There is evidence that the increased productivity and production of maize is also having a significant positive impact on poverty reduction [2,3]. Out of the total grain crop production area, maize is second next to teff and first in productivity which comprises 21114876 hectares (16.91/%) of land and 71508354.11 (26.80%) quintals productivity with average yield of 3 tones/ha respectively as compared to sub-Saharan Africa that estimated to 1.8 tones/ha which is still far below the global average yield of maize 5 tones/ha [4].

Here, Arsi Zone is a well-known potential area for crop production particularly cereals crops, among, Ziway Dugda Woreda is famous in maize production, out of total crop cultivated land 13,070 hectares of land covered by maize in the year 2017 (report from woredal office). However, due to its geographical location the area is prone to drought from erratic rainfall and biotic stress. Among biotic stress spotted stem borer *Chilo partellus* (Swinhoe) (Lepidoptera: Crambidae) and African stem borer *Busseola fusca* (Lepidoptera: Noctuidae) are reported as major insect pest of maize in the area [5].

Emana, [6] reported a yield loss of 28% due to stem borers in Ethiopia and under severe infestation yield loss ranging from 25 to 50% had been documented. Emana and Tsedeke, [7] reported yield losses ranging from 10 to 100% from Arsi Negele. The average yield losses can be estimated between 20 and 50% [8]. Although, it was reported that crop losses in Ethiopia by *C. partellus* and *B. fusca* range from 15 to 100% [9].

Likewise fall army worm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) an invasive insect pest currently invades maize crop in the area. Fall armyworm causes major damage to economically important crops: overall costs of losses for maize, sorghum, rice and sugarcane in Africa are estimated to be approximately $13,383m [10]. Infestations during the mid to late corn stage resulted in yield losses of 15-73% when 55-100% of the plants were infested with *S. frugiperda* [11]. Moreover, maize leaf folder/leaf roller, *Marasmia trapezalis* (Guenée) (Lepidoptera: Crambidae) where, the pest status not known elsewhere in Ethiopia before is observed in maize crop, however, the pest was reported from different African and Asian countries. Its primary host is rice, maize, sorghum, sugar cane and grass. As reported the species *Cnaphalocrocis medinalis* and *Marasmia patnalis* are a major pest of rice in many Asian countries. Evidenced, the species *M. trapezalis* is well distributed in African countries [12,13].

It was reported on maize from Tanzania, maize and grass from Uganda and sorghum from DR. Congo (Prins and Prins, 2014; Prins and Heughebaert, 2017). The incidence of the pest was reported on sorghum from South India, Karnataka, it ranges from 35-58.70% with an average of 46.85% [14]. Feeding greatly reduces the general vigor and photosynthetic ability of an infested plant and the crops exposed to secondary infection. The maximum yield loss caused by leaf folders is reportedly due to feeding on the flag leaf [14]. The entire above made the insect pest identification more complex, increase the pest pressure consequently the crop damage becomes severe and farmers have doubt of their production. Hence, the aim the present survey was to give support for farmers in the correct insect pest species identification, determine infestation and damage levels to intervene with appropriate management.

2. MATERIALS AND METHODS

2.1 Description of the Study Area

The study was carried out at Ziway Dugda woreda, it is one of the woreda in the Oromia Region of Ethiopia part of the Arsi Zone located between 7^{0}27'00'N-8^{0}00'34''N Latitude and 38^{0}45'00''E-39^{0}03'13''E Longitude in the Great Rift Valley at an altitude range 1500-2300 m. a. s. l. With annual rainfall ranges from 200 to 1200 mm. Due to its altitudinal location, the climatic conditions of the woreda is dominantly moderately warm which has a temperature ranging from 20°C to 25°C.

The woreda situated at 222 km from capital city of Addis Ababa and 47km from Arsi Zone Assella town. Relatively, the woreda shares a boundary line with Tiyo woreda in the south, east and south-east, Munessa woreda in the south-west, Hetosa woreda in the East, Dodota woreda in the north and northeast and East Shewa Zone in the north, north-west, west and south-west direction. The woreda has a total area of 1247 km^2 which accounts for 31.7% cultivable land, 6% pasture, 46.3% forest, and the remaining 16% is considered swampy and mountainous which is covered by alluvial and lacustrine deposits soil type. The majority (92.5%) of the population depend on agriculture for their livelihood [15].

2.2 Experimental Materials and Procedures

2.2.1 Sampling procedures

A survey was carried out in 2017 main cropping season; three representative Kebeles namely Hallo, Sambaro and Herara were randomly selected. In each Kebeles five representative maize fields were selected considering uniform crop growth stage that reached the knee height. Data on relative abundance, larval population count and a number of plants showing leaf damage symptoms in respective of a particular insect species were recorded from ten randomly selected plants from each field.

2.2.2 Data collected

2.2.2.1 Identification of insect pest species

The current identification was made on morphological characteristics of the larvae collected like larval forms, body and head pigmentation and maize plant damage symptoms related to each insect species to support farmers for their timely actions. Identification was supported by different kinds of literature and protocols, particularly protocol used for fall armyworm identification was developed by [16, 17]. Since, there were no well-developed protocols for stem borer identification, for this purpose industry biosecurity plan for the grains industry prepared by plant health Australia was used [18]. Maize leaf roller identification was made based on [12,13].

2.2.2.2 Relative abundance of insect species

The species composition was identified after the larvae were collected and identified. The relative abundance of each insect species was calculated based on the number of the larval population counted using the formula:

$$\text{Relative abundance}(\%) = \frac{\text{Total number of larval count for species}}{\text{Total number of larval count for all species}} \times 100$$

2.2.2.3 Larval population count

Larval population for each of the insect species was collected and counted from ten randomly selected maize plants at knee height. First, the damage symptoms were observed on the selected plants and larvae were obtained by carefully inspecting in the whorl and rolled or folded leaf. The collected larvae were categorised under the three species based on larval forms, head and body pigmentation, as well as plant parts, affected particularly young larvae of *M. trapezalis* tie or role the maize leaf and both *S. frugiperda* and *C. partellus* larvae can be found in the whorl leaf.

2.2.2.4 Infestation and crop damage assessment

Infestation level and leaf damage on maize plants at knee height in the field was assessed. This was done by counting the number of plants showing leaf damage symptoms in respective of a particular insect species from ten randomly selected maize plants. Percentage infestation level and leaf damage were calculated using the formula below adopted from (Singh et al.1983).

$$\text{Infestation levels}(\%) = \frac{\text{Number of plants showing damage symptom}}{\text{Total number of plants inspected}} \text{ x } 100$$

2.2.3 Data analysis

Data collected on larval population count and percentage number of plants showing leaf damage were subjected to logistic regression analysis using general liner model (GLM) in R-Software (vr.3.4.1). Before analysis data were checked for normality and logit transformed. Regression analyses on larval population count and percentage number of plants showing leaf damage were carried out and mean separation was done at 95% confidence interval.

3. RESULTS AND DISCUSSION

3.1 Insect Pest Species Identification

Currently, insect pest species identification was carried out based on damage symptoms observed on plants, plant parts and larval forms as well as larvae pigmentation. Pictures from maize plant parts damage, larval forms and pigmentation observed with its feeding habits on plant parts were taken and cross-checked with the available literature. Earlier instar larvae of the insect species are hard to identify morphologically because early instars of several other Lepidoptera, the particularly Noctuidae family are very similar.

I. Spotted stem borer, *Chilo partellus* (Swinhoe, 1885).

Taxonomic position: Class insecta, (Lepidoptera: Crambidae).

Species origin: Asia [19,20,21].

A. Distribution

In Africa, first reported in Malawi in 1930, it became established in East Africa in the 1950s, since then it has spread to Southern and Central Africa, Botswana, the Comoros Islands, Eritrea, Ethiopia, Kenya, Lesotho, Malawi, Mozambique, Somalia, South Africa, Sudan, Swaziland, Tanzania, Uganda, Zambia and Zimbabwe [18,21].

B. Larval forms

Spotted stem borer larvae are creamy white to yellowish brown in color, with four purple brown longitudinal stripes and usually with very conspicuous dark brown spots along the back, which give the larvae a spotted appearance. When fully grown the larva has a prominent reddish brown head. It has a prothoracic shield (a plate on the dorsal surface of the thorax) which is reddish brown to dark brown and shiny [18].

C. Damage symptoms:

Damage occurs as a series of small holes in lines (pin holes) in younger leaves and patches of transparent leaf epidermis (window panes) in older leaves. Holes in stem caused by larvae tunneling into the stem can result in broken stems or drying and eventual death of the growing point of the maize (dead heart) [18].

II. American fall armyworm, *Spodoptera frugiperda* (J.E. Smith, 1797).

Synonyms: *Laphygma frugiperda* (J.E. Smith).

Taxonomic position: Class Insecta, (Lepidoptera: Noctuidae).

Origin: Native to tropical and subtropical regions of the Americas.

EPPO code: LAPHFR [16,17].

A. Distribution

This species is recognized to comprise two morphologically identical but genetically distinct strains (rice and maize strains) in America. The presence of these two strains was confirmed from Ghana and the possible routes of entry to Africa likely the adults and/or egg masses transported on direct commercial flights between the Americas and West Africa, followed by dispersal by adult flight within the African continent [22,23].

It was reported in Ethiopia in 2017 by Ministry of Agriculture and Natural Resources where the first time recorded on maize in Sheka Zone of the Southern Nations, Nationalities and Peoples Regional State of Ethiopia (ENA, 2017); Nigeria, Benin and Togo in 2016 reported by International Institute of Tropical Agriculture

(IITA); Democratic Republic of Congo, Zimbabwe, Sao Tome and Principe in 2017 by Food and Agricultural Organization of the United Nations (FAO); Ghana and Kenya reported in 2017 by Republic of Kenya Ministry of Agriculture, Livestock and Fisheries; South Africa, Swaziland and Zambia in 2017 as reported by International Plant Protection Convention (IPPC) [16,22,10].

B. Larval forms

Young larvae are greenish with a black head, the head turning to orange in the second instar. Particularly the dorsal surface of the body of the third instar larvae becomes brownish and lateral white lines begin to form. In the fourth to the sixth instars the head is reddish brown, mottled with white, and the brownish body bears white sub-dorsal and lateral lines. Elevated spots occur dorsally on the body; they are usually dark in color, and bear spines. The face of the mature larva is also marked with a white inverted “Y” and the epidermis of the larva is rough or granular in texture when examined closely [24]. It was confirmed that the use of DNA barcoding allowed unequivocal identification of this new pest from Ghana based on the larvae alone [22].

C. Damage symptoms

However, the larvae cause damage by consuming foliage; the symptoms caused by larvae are not specific to *Spodoptera* but generic for most primarily foliage feeding Lepidoptera species (Smith et al., 1997). Early stages can be found scraping the epidermis of the underside of the leaves. Young larvae initially consume leaf tissue from one side, leaving the opposite epidermal layer intact.

The second and third instar larvae begin to make holes in leaves, and eat within the whorl and a mass of holes, ragged edges and larval frass. Feeding in the whorl of corn often produces a characteristic row of perforations in the leaves [24]. Larvae never tie leaves together. Young plants of maize up to an age of 30 days can be cut through at the base, similar to symptoms caused by cutworms. At high densities, larvae feed gregariously and disperse in swarms, usually moving to grasses when available [17].

III. Maize leaf folder, *Cnaphalocrocis trapezalis* (Guenée, 1854).

Transferred to *Marasmia* by [25,12].

Taxonomic position: Class insecta, (Lepidoptera: Crambidae).

Insect origin: Sierra Leone.

A. Distribution

DR Congo, Egypt, Gambia, Kenya, La Reunion, Madagascar, Mali, Mauritius, Nigeria, Senegal, Sierra Leone, Somalia, South Africa, Sudan, Tanzania, Uganda, Zambia, Zimbabwe, Kenya (Fig. 1C) [12,13].

B. Larval forms

Body of the larvae is slender, greenish yellow with stiff brown bristles; larvae wiggle rapidly when disturbed. In each leaf, a greenish yellow larva with setae over its body was found. Head and thoracic shield were brownish.

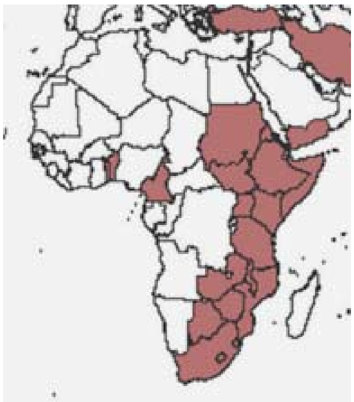
C. Damage symptoms

The larvae of *M. trapezalis* feed on scraping the green mesophyll of maize leaves, thereby causing a reduction in the leaf area available for photosynthesis. They leave the vascular bundle including the sheath and sclerenchyma intact. The young larvae move towards the basal regions of young leaves, their first feeding sites and each individual starts to build a feeding chamber by folding a leaf lengthwise and connecting its edges with silk. The caterpillar lives and feeds from inside of this tubular structure. The affected leaf blades will then show linear longitudinal pale white stripe or transparent streaks. The maximum yield loss caused by leaf folders is reportedly due to feeding on the flag leaf and heavily infested fields may have scorched looking patches [14].

3.2 Relative Abundance of Insect Species

A total of 965 larval populations were collected in 2017 main crop season at Ziway Dugda, of this 595, 262 and 108 larval population representing C. *partellus, S. frugiperda* and *M. trapezalis* respectively. The relative abundance of each species showed that *C. partellus* was the dominant species accounting for 61.66% whereas the rest of the species *S. frugiperda* and *M. trapezalis* accounting for 27.15 and 11.19% relative abundance respectively.

A. Distribution map of *S. frugiperda*



B. Distribution map of *C. partellus*

C. Distribution map of *M .trapezalis*

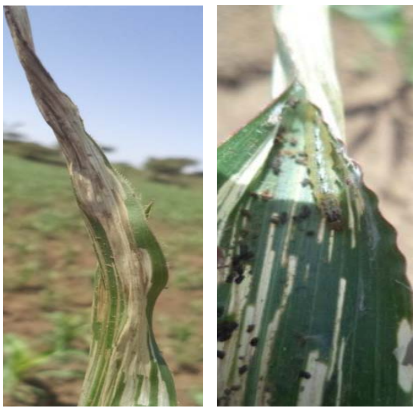
D. Early instar larvae of *S. frugiperda*

E. Early instar larvae of C. *partellus*

F. Early instar larvae of *M .trapezalis*

G. Damage symptoms of *S. frugiperda*

H. Damage symptoms of *C. partellus*



I. Damage symptoms of *M. trapezalis*

J. Larvae of *S. frugiperda*

K. Larvae of *C. partellus*

L. Larvae of *M .trapezalis*

Fig. 1. Distribution map, larval instars and damage symptoms of insect species on maize crop

3.3 Mean Larval Density per Plant

There were significant differences in the mean number larval densities per plant between insect species (R^2= 0.96, Pr (>|Z|=0.013), were the highest larval density per plant was recorded from *C. partellus* that is 1.55-2.30 and 0.70-1.10 and 0.05-0.30 larvae density per plant were recorded from *S. frugiperda* and *M. trapezalis* respectively (Fig. 2). *C. partellus* is the major pest in low altitudes, low rainfall and warm areas of the country [6]. Tilahun, [5] density of *C. partellus* ranged between 6.8 and 12.83 per ten plants across the growth stages in maize with 8.71 at vegetative stage at Dugda Bora. Mosisa et al. [26] with samples collected from sowing date trials at Ziway, maximum stalk borers per maize plant were 13.2. Emana et al. [27] mean density per infested plant ranged between 0.02 and 2.12 borers. C. *partellus* ranged from 1.2-2.3 larvae per plant across the locations. Numbers of C. *partellus* larvae at knee height stage were highest compared to the other plant growth stages.

Oscar et al. [28] made study on *S. frugiperda* attack rate and level of damage on corn compered two sowing periods in two locations and reported 1.16 and 1.65 larvae per plant at optimal and late sowing period respectively in one location and 0.28 and 0.26 larvae per plant at both sowing period in another location where the highest larval density per plant recorded when plants at three to four leaf stage. Also, *S. frugiperda* densities as low as 0.2-0.8 larvae per plant during the late whorl stage may be sufficient to reduce yields by 5-20% [29] (Capinera, 2014). Generally, only one larva per leaf roll is found; after feeding on one-fold for about 2-3 days, it moves to another leaf, thus, each larva destroys a number of leaves during its growth period [14].

3.4 Infestation Level and Crop Damage Assessment

The percentage infestation and plant leaf damage were statistically significant between *C. partellus* and *M. trapezalis* and also the same trends observed between *S. frugiperda* and leaf roller (R^2=0.75, Pr. (>|Z|=2e-16), however, statistically there was no significant difference between *S. frugiperda* and *C. partellus* (Fig. 3).

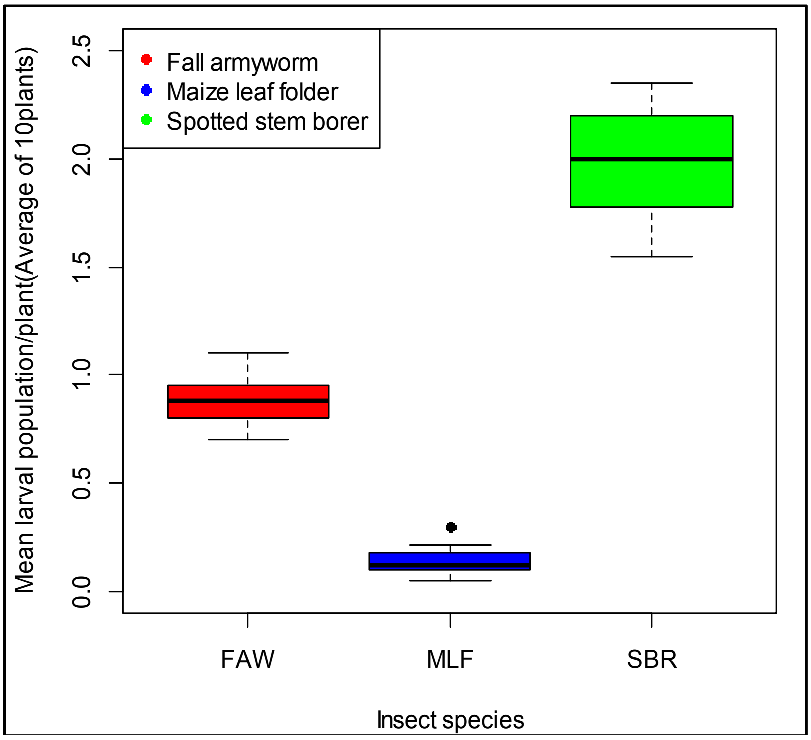


Fig. 2. Insect pest species and their mean larval population per plant (aver. of 10 plants) recorded in 2017 main cropping season at Ziway Dugda Woreda

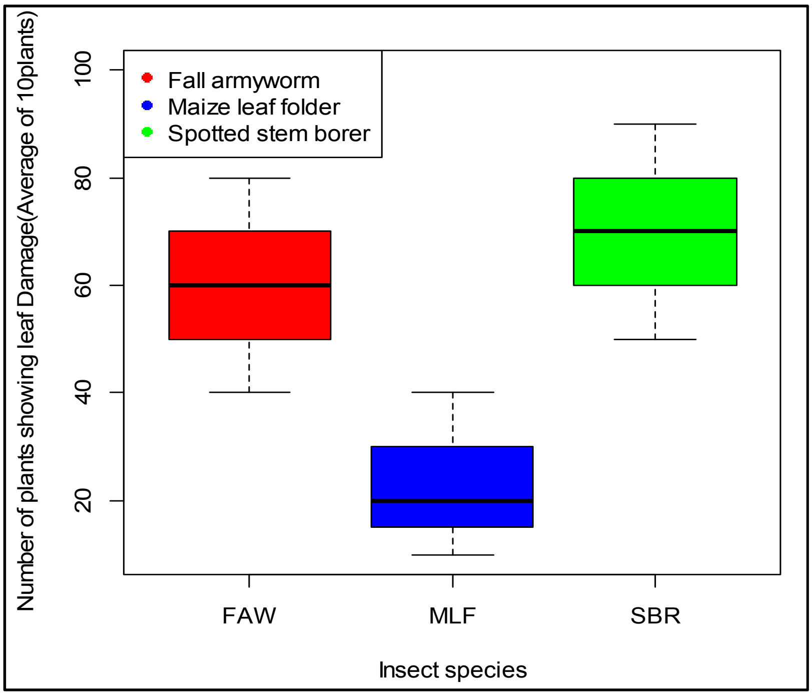


Fig. 3. Insect pest species and their percentage number of plants showing leaf damage on maize recorded in 2017 main cropping season at Ziway Dugda Woreda

The highest percentage infestation and leaf damage was recorded from *C. partellus*, it ranges from 50-90%, similarly, as it was reported by Mosisa et al. [26] in Ziway areas the percentage infestation in maize due to *C. partellus* ranges from 63.6-95%. The percentage infestation and leaf damage for *S. frugiperda* ranges from 40-90%, similar works have been reported on percent whorl stage infestations and damage level in maize due to *S. frugiperda*. Hruska and Gould (1997) reported 55-100% of the maize plants were infested with *S. frugiperda*) while, another study reported when 63% of plants were infested resulted in 20.9% yield reduction under natural conditions.

Moreover, Don et al. (2016) reported that at much lower levels of infestation 15% resulted in significant yield reduction of 7.7% and 15.5% yield reduction when 20% of plants were infested. Oscar et al. [28] made study on fall armyworm attack rate and level of damage on corn compering two sowing period in two locations and reported 55 and 52% attack rate at optimal and late sowing period respectively in one location and 20.75 and 18.60% attack rate at both sowing period in another location.

Further, it was reported that mean larval densities of 0.2 to 0.8 larvae per plant during the late whorl stage could reduce yield by 5 to 20 percent (Capinera, 2014). Generally, the early and intermediate whorl stage was less sensitive compared to the late whorl stage which was most sensitive to *S. frugiperda* damage. The lowest percentage infestation and leaf damage was recorded from leaf roller, *M. trapezalis*, it ranges from 10-40% with an average of 28.33%, this result was much lower than the report of Shankara and Nagaraj, [14] who reported the overall incidence of leaf roller ranged from 35 to 58.70% on sorghum with an average of 46.85 % during cropping period.

4. SUMMARY AND CONCLUSION

Maize is the most widely grown staple food and is an important crop as part of the national food security strategy worldwide. However, the production of maize hampered by both a biotic and biotic factors. Among biotic factors spotted stem borer, *Chilo partellus* and African stem borer, *Buseola fusca* are the major insect pest of maize that contributed to crop yield reduction. Currently as of the 1st June, 2017 severe outbreak of fall armyworm, *Spodoptera frugiperda* and maize leaf folder, *Marasmia trapezalis,* where the pest status not known elsewhere in Ethiopia were reported. Thus, in sum made the insect pest identification more multifaceted for intervention, increases insect pest pressure consequently the crop damage become severe. Hence, the present survey was aimed at to give support for farmers in correct insect pest identification, determining infestation and damage level of the insect pests to intervene with appropriate management.

Three representative Kebeles namely Hallo, Sambaro and Herara with five representative farmers' fields from each Kebele were randomly selected. Ten representative plants randomly selected from each field. Data on larval population count, relative abundance for each species, and percentage number of plants showing leaf damage were assessed. Before collecting, damage symptoms on the selected plants and plant parts were observed for the presence of larvae and the larvae were carefully inspected in the whorl and within the folded or rolled leaf. The collected larvae were identified and categorized under the three species based on head and body pigmentation, plant and plant parts damaged and its larval frass.

At the young larval instar larvae of the three species are clearly distinct, larvae of *S. frugiperda* show dark brown head with inverted "Y" shape and cutting leaf margin inward showing ragged leaf edges , whereas *C. partellus* show deep brown head with brownish body color showing window pan hole inline on the leaf and *M. trapezalis* has light brown head and greenish yellow body color and tie or fold the maize leaf and feed within leaving white pale color lengthwise on the leaf (Fig. 1G, H, I, J, K, L). Likewise, both larvae of *C. partellus* and *S. frugiperda* never tie the leaf so, larvae collected from folded or rolled leaf directly categorized under *M. trapezalis,* moreover, the larvae of *M. trapezalis* waggle rapidly when disturbed.

However, at early instar stage identification of the species is so far the most difficult stage because they feed by scraping the green mesophyll leaving white pale on the leaf. Still larvae of *M. trapezalis* is greenish body color however, head pigmentation and larval fras are relatively helpful for both *C. partellus* and *S. frugiperda* larvae identification at early instar stage (Fig. 1D, E, F). Relative abundance of the species indicated that *C. partellus* resulted in the highest relative abundance whereas the lowest was from *M. trapezalis* and *S. frugiperda* was the intermediate. Larval density per plant was statistically significant between the species where the highest larval density recorded from *C. partellus* it ranges from 1.55-2.30, this result agreed with the report of Emana et al. [26] reported mean density per infested plant ranged between 0.02 and 2.12 borers and C. *partellus* ranged from 1.2-2.3 larvae per plant. Tilahun, [5] reported density of *C. partellus* ranged between 6.8 and 12.83 per ten plants across the growth stages in maize with 8.71 at vegetative stage at Dugda Bora. Mean larval density per infested plant for *S. frugiperda* ranges from 0.7-1.10, moreover larval density per plant, percentage infestation and plant damage due to this pest was reported by different authors on maize crop. Oscar *et al*., [28] reported 1.16 and 1.65 larvae per plant at optimal and late sowing period on corn respectively, whereas in another location 0.28 and 0.26 larvae per plant was recorded at both sowing period*.* There was evidence that mean larval densities of 0.2 to 0.8 larvae per plant for *S. frugiperda* during the late whorl stage reduce yield by 5 to 20% and at 15 and 20% infestation level resulted in 7.7 and 15.5% yield reduction respectively [29] (Capinera, 2014). *M. trapezalis* accounted for 0.05-0.30 larval density per plant. Here the lower population for *M. trapezalis* may be due to the presence of a single larvae per folded leaf "never seen more than one larvae per folded leaf in this survey" that means a single larva per plant when exist.

Significant difference was observed between *C. partellus* and *M. trapezalis* and similar trends were observed between *S. frugiperda* and *M. trapezalis* in percentage infestation level and leaf damage. However, there was no significant difference in percentage infestation level and leaf damage between *C. partellus* and *S. frugiperda*; this indicated that the aggressive nature of the pest as it was reported the pest is highly voracious and migratory [30].

The highest and lowest percentage infestation level and leaf damage was recorded from *C. partellus* and *M. trapezalis* respectively. It was possible to conclude that from mean larval density per plant, percentage leaf infestation and damage level both *C. partellus* and *S. frugiperda* were at higher risk. However, the emphasis was given for hand picking it is impossible to overcome under such severe insect pest outbreak with multiple species as a result insecticide was recommended for immediate action however, it is not a sustainable solution.

It is also possible to reduce both stem borer and fall armyworm damage by insecticide applications at early infestations than later infestations to achieve economic result [31]. However, the infestation level of *M. trapezalis* was lower it was recommended that hand picking is more appropriate and economical than use of insecticide so that farmers could collect the larvae by cutting the folded or rolled leaves. Meanwhile, the lower infestation level and leaf damage was recorded from *M. trapezalis;* it was observed in maize crop in Arsi Zone at Munesa, Tiyo, Dodota, Arsi Robe, Sude and Marti woredas.

There is no any literature which supports its presence and status in Ethiopia and also as it was observed from the distribution map of the pest Ethiopia is not registered (Fig. 1C). As to its current distribution somebody in India suggested that it could be attributed to climatic changes in the recent years as a result registration of the insect pest as well as detail molecular identification to the species level will be necessary. Finally, insecticide and hand picking are not a sustainable solution so that seeking for alternative management options like biological control and integrated pest management in line with the current changing climate will be needed.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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