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# Occurrence, Distribution, Severity and Future Threats of Lantana bug, *Orthezia insignis* Browne (*Homoptera: Ortheziidae*) in East Harerge Zone, Ethiopia

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***Abstract:*** Orthezia insignis Browne (Homoptera: Ortheziidae) is native to South and Central America, but is now widespread throughout the tropics including South eastern Ethiopia. It is one of the newly emerging invasive alien species invaded Ethiopia. The insect was first observed on Lantana camara in Haramaya University compound. In its first observation the pest species was unknown. For identification of the insect leaf samples were taken from infested lantana and seen under dissecting microscope in Haramaya University Plant Protection Laboratory. During investigation clear pictures and movie videos were taken from the sample leaves by digital camera. The samples were sent to the "South African Agricultural Research Council" and on April 29, 2016 the team responded as the insect is "Orthezia insignis." The clear statement of the South African Agricultural Research Council declared that "the insect is not regarded as a biological control agent of lantana, since it was never intentionally selected, imported, studied or released against the plant. O.insignis is a generalist garden pest that also includes Lantana camara amongst its wide range of host plants. It can be quite damaging if it occurs in large numbers, and in addition to sucking the plant saps, its secretion of honeydew causes black sooty mildew to grow on the plant, thus further reducing the photosynthetic area of the plant. However, it does not have the potential to control L. camara effectively, since the plant is extremely resilient and can outgrow the damage". Data collected from field survey revealed that at Haramaya University compound from the sampled 5 sites of 50 lantana patches 3 (60%) sites and 26 (52%) lantana patches were infested by O. insignis. At Haramaya district of the sampled two Administrative kebeles, Adelle and Walembo (Awaday areas) from 20sites of 200 lantana patches 15 (75%) sites and 142 (71%) lantana patches were infested. At Harari Administrative Regional State of the sampled two Administrative kebeles (Hashange and Gube Mirkannsitu) from 20sites of 200 lantana patches 13 (65%) sites and 139 (69.5%) lantana patches were infested by O. insignis. At Babille district there was no infestation of O. insignis in all sampled 2 adminstrative kebeles of 20 sampled sites and 200 lantana patches. Damage rating of O. insignis was made by setting damage rate scale as: 0%=0 insects per leaf 6%=1-35 insects per leaf; 7 to 13%=36-80 insects per leaf; 14 to 40%= 81-220 insects per leaf, 41 to 60% = 221-350 insects per leaf; 61-80%= 351- 450 insects per leaf, and more than 80% =>451 insects per leaf. Based on these scale the result of O. insignis damage ratting shows that the list and highest population density on single leaf was from 12- 663 adults and crawlers of O. insignis. From the total sampled 240 leaves 12 (5%) were free of O. insignis infestation, and the rest 228 (95%) leaves were infested from the least count of Orthezia, which ranges from 12 to 663 per leaf. The population count for all infested leaves were; 27(11.25%) leaves from 1-35 insects per leaf, 55(22.9%) leaves from 36-80 insects per leaf, 68 (28.3%) leaves from 81-220 insects per leaf, 42(17.5%)leaves from 231-350 insects per leaf, 19(7.9%) leaves from 351-450 insects per leaf and insects count per leaf on 17(7.1%) leaves were greater than 451 O. insingnis, in which 663 insect per leaf was the highest count. The mean average leaf damage was 68% in which the population density on a single leaf counted was 81-220 O. insignis per leaf. From this summary it is possible to conclude that there was high aggregation of O. insignis on a single leaf which may causes high damage on the host. Amongst its wide range host plants, O. insingnis was artificially introduced on two economically important plants (potato and tomato) by putting single infested leaf of L. camara on top of ten potted host plants and on ten potted non-host plant, Parthenium hysterophorus. After three days of artificial introduction the pest was transferred to these potted plants and highly reproduced in number. After thirty days of introduction Parthenium plant start to dry due to high aggregation of O. insignis on stem and leaf than potato and tomato plants. To see the population of O. insignis on non host potted plants of P. hysterophorus, 2cm length of stem and leaves were taken randomly from four plants at bottom, middle and top portion of the plant. The average counts of O. insignis per cuttings were 36, 40, 44 and 32 for stem and 26, 30, 23, and 31 for leaves. The results of artificial introduction of O. insignis on to these host and non-host plants (potato, tomato and P. hysterophorus, respectively) shows for O. insignis dissemination the only important thing is mechanisms of dissemination. If it will be aided by mechanical agents like animals, plant materials, activity of human beings, wind and water, it will be disseminated easily and attack economically important crops and endogenous plant species. From less mobile nature of the insect if immediate measure will be taken, it can be contained on its spot area with no or less dispersible. If it will be left as a simple thing, the fate that the other countries are facing now will be much more in case of ours. Its early establishment on non-host plant including its polyphagous nature, will indicate us the insect is terrible pest and it can attack all economically important horticultural and fruit crops including legume crops, leading to food security problems and other social problems.

***Keywords*****:** *Orthezia Insignis, Invasive, Infestation, Damage, Host and Non-Host.*

## I. INTRODUCTION

Lantana, *Lantana camara* L., is a pan-tropical weed affecting pastures and native forests in over 60 countries worldwide (Parsons and Cuthbertson, 2001). Having originated from South America (Fensham *et al*., 1994), *L. camara* is now naturalized in approximately 60 countries or island groups,

between 35° N and 35° S (Day *et al*., 2003). Most are native to South America, Central America or southern North America, with a few species occurring naturally in Africa and Asia (Day *et al*., 2003; Munir, 1996). It is a composite species, thought to have originated from two or more lantana species from tropical America (Parsons and Cuthbertson, 2001). It is found in many African countries, including some arid regions, and is widespread in Kenya, Uganda and Tanzania. In South Africa, it is common along the east coast and in the tableland area of the north near Tzaneen. Lantana is found throughout India.

Even though it was introduced for horticultural purposes, *L. camara* has become a major invader of agricultural and natural ecosystems. Currently, *L. camara* has been nominated as among the 100 of the "World's Worst" invaders. It is found in many African countries, including some arid regions, and is widespread in Kenya, Uganda, Ethiopia, and Tanzania. In South Africa, it is common along the east coast and in the tableland area of the north near Tzaneen (Michael *et al*., 2003).

*Orthezia insignis* (Homoptera: Ortheziidae) was one of the candidate biological control of lantana registered on 23rd order number. *O. insignis* Browne is native to the Neotropical region (east, south, and west of Mexico's central plateau that includes Central and South America and the Caribbean), probably to Guyana and neighboring countries; elsewhere in the world it has been introduced (CABI, 2015), but is now widespread through the tropics (Wittenberg and Cock, 2001). It is a polyphagous pest that has been accidentally introduced into many tropical countries on imported plants. *O. insignis* was first observed in Sri Lanka in 1893 (Beeson and Chatter-jee, 1939) and may have been the source of the Hawaiian insects (Julien and Griffiths, 1998). It was subsequently introduced into India in 1915 and was encouraged to spread until its polyphagous nature was appreciated (Beeson and Chatter-jee, 1939). *O. insignis* was found in Mexico (Koebele, 1903), Brazil (Winder and Harley, 1983), Cuba (Krauss, 1953a), Guatemala and Honduras on *L. urticifolia*. Before the deliberate release of other insects, *O. insignis* was the only agent capable of decreasing the extent of lantana in India (Beeson and Chatter-jee, 1939). *O. insignis* is common throughout South Africa and its accidental introduction has been reported from Ascension Island and St Helena, off the west coast of Africa, in the early 1980s (Julien and Griffiths, 1998). In both islands, it causes severe damage to lantana and several native species. On St Helena, biological control of *O. insignis* was initiated to protect the native flora. It was successful and the scale population has declined such that *O. insignis* is unlikely to have any impact on lantana in the future (Julien and Griffiths, 1998). Since *O. insignis* is polyphagous, it is not recommended for the control of lantana (Michael *et al*., 2003).

*O. insignis* is polyphagous, usually preferring woody hosts, occurring mainly on the shoots and twigs. Ben-Dov *et al*. (2006, 1998) list hosts from 34 plant families. It is most often found on trees and shrubs of the Verbenaceae (especially *Lantana*, *Clerodendron* and *Duranta* species), Solanaceae (especially *Capsicum* and *Solanum*), Acanthaceae, Compositae (especially *Eupatorium* and other ornamentals) and Rubiaceae (including *Coffea*). Ezzat (1956) successfully reared *O. insignis* on sprouting potato tubers in Egypt, where he recorded the pest damaging a wide range of crops and utility plants such as sugarcane, *citrus*, potatoes, tomatoes, chrysanthemums, shade trees such as *Jacaranda*, and windbreaks such as *Casuarina*.

They also cause indirect damage to the plants by excreting (or more correctly eliminating) honeydew, a growth medium for sooty moulds, which produce a black coating over the leaf surface. This coating interferes with photosynthesis and may cause poor growth, a reduction in fruit size and generally give an unsightly appearance to the crop. It attracts ants and also provides a substrate for growth of sooty moulds (Green, 1922). The moulds results in badly fouled leaves and fruit, and often the quality of the fruit (and subsequently the price consumers and/or trading partners are willing to pay) is reduced. When present in large numbers it kills branches and stems (Ben-Dov *et al*., 2006).

The species is commonly called the Lantana bug mainly due to its preference of *Lantana* species as hosts. In South Africa, the species was considered as a biological control agent for the notorious weed *Lantana camara.* Results of the investigative study showed, however, that the species only have localized impact. Its use as a biological control agent is furthermore discouraged by its polyphagous character, whereby damage to non-targeted plants cannot be excluded (Green, 1922).

*O. insignis* extracts large quantities of sap, causing general host debilitation, but not death (Green, 1922). Build-up of sticky honeydew deposits occurs on nearby surfaces, which may attract attendant ants. Unsightly sooty moulds grow on the sugary deposits (Green, 1922), and badly fouled leaves may be dropped prematurely and the quality of fruits may be reduced. The older females are easy to see on young stems, especially when they walk about and the movement of the white ovisacs catches the light (Green, 1922).

According to Green (1922) *O. insignis* are ideally suited to be transported by water, wind and animal agents including domestic animals and man for its dissemination. Accidental introductions to new countries apparently occur on infested planting material.

The insect, *O. insignis* is newly emerging pest in eastern Harege zone, and found along the street and on farm boundaries unnoticed. Due to its polyphagous nature may attack forest trees, fruits and horticultural crops in the future. This pest is more severe in moisture stressed areas of east and west Harerge zones which are known for their fruits and horticultural crops production. This pest is currently occurs on its common host, *L. camara* and the population is currently increasing at an alarming rate may be due to changes in climate. As the population of the pest increases, there is a probably to establish on fruits and horticultural crops including tree plantations. The objective of this study was, therefore, to assess and report the Lantana bug, *O. insignis* occurrence, distribution, hosts plants, and the probable future trends in eastern Hararege zone.

## II. MATERIALS AND METHODS

### *A. Description of Study area*

The study was conducted at Haramaya University located at 9°24'46.9"N, 42°02'03.2"E at an altitude of 2022 meters above sea level (H.U, 2015; Kifle *et al*., 2016). Haramaya University is located 505 km far away from Addis Ababa. The area has a bimodal rainfall distribution with mean annual rainfall of 780 mm. The long rainy season extends from June to October and accounts for about 45% of the total rainfall. The mean maximum temperature is $23.4^0$C while the mean minimum annual temperature is $8.25^0$C (H.U, 2015; Kifle *et al*., 2016). The rainfall of study area is known as significant moisture

stress of below yearly average in the region typical of drought conditions.

***B. Data collection***

***1. Identification of the Insect***

The insect samples were randomly collected from infested field of *Lantana camara* for identification, and was observed under magnifying light microscope. Under the microscope, clear picture and movie video was captured and recorded using digital camera. The insect was tentatively identified as lantana bug *O. insignis* (Homoptera: Ortheziidae). For further authoritative identification of the insect, sample photos and movie videos captured by digital camera were sent to ICIPE (International Centre of Insect Physiology and Ecology) Kenya and SAARC (South African Agricultural Research Council) Weed Research Team. The team has confirmed the identification.

***2. Distribution and Status of O. insignis on alternate host plants***

To check the distribution of lantana bug, from east Hararge zone three districts namely Haramaya, Babile and Kersa districts and from Harari Administrative Region Erer Weldiya districts were selected for the survey. From each district two Administrative kebeles'' were selected purposively. Field survey was conducted in the selected kebeles' and around Haramaya University. From each administrative kebeles' five sites were selected for the study. At all these sites, *O. insignis* infestations on *Lantana camara* L. (Verbenaceae) were visually categorized as abundant, present (but not abundant), or absent (Fowler, 2005).

***3. Incidence of Orthezia infestation***

From each sampled kebele five sites were selected purposely by looking at the presence of *L. camara*. From each sampling site ten lantana samples patches were randomly selected and the infested patches were counted and expressed in percentage. From each selected lantana patches twelve shoots were picked randomly and checked for *O. insignis* presence. Infested shoots were separated by looking it with necked eye and in some invisible cases, a 10x magnifying hand lens was used for a thorough lookup of instars on the shoots and leaves. Then from the infested shoots 12 shoots of lantana were kept in paper bugs and taken to Haramaya University Plant Protection Laboratory for further investigation. The different growth stages of *O. insignis* were counted carefully with necked eye and for small instars which were invisible with naked eye a 10x magnifying hand lens and dissecting light microscope were used. Identification was made following the Stoetzel (1987) identification keys. For shoot infestation, rating scale was established for *O. insignis* infestation from 0-7 as: *0* = not infested; 1 to 2 shoots infested = slightly infested; 2 to 3 shoots infested = moderately infested; 4 to 5 shoots infested = infested; 5 to 6 shoots infested = highly infested and more than 7 shoots infested = severely infested following the method used by Ademir (2006).

***4. Damage ratting of Orthezia insignis***

Leaf damage rating intervals for *O. insignis* infestation on lantana leaf were rated in percent as described by Ademir (2006): 0 to 6%, 7 to 13%, 14 to 40%, and >40%. These intervals were considered as references for all other host plants (if any) physiological variables. For *O. insignis* infestation on lantana leaves, the number of insects, females and nymphs, were counted carefully using dissecting light microscope; the insects were removed with a stylet and counts were made for the lower and upper limits of the damaged/infested leaf. During the preliminary study of the insect infestation, insects per leaf counted were extremely high in number than the Ademir (2006) rating. Therefore, based on Ademir damage rating we made some amendments of rating established as below: 0 to 6% =1-35 Orthezia per leaf; 7 to 13%: 36-70 Orthezia per leaf; 14 to 40%=80-220 Orthezia per leaf, 41 to 60% =221-350 Orthezia per leaf; 61-80%=351-450 Orthezia per leaf, and >80% = more than 451 Orthezia per leaf.

Then from the infested 12 shoots, 12 leaves from each shoots were randomly taken to the University Plant Protection Laboratory and *O. insignis* present on lantana leaves at different stages were counted carefully by using a dissecting light microscope, using the keys mentioned by Stoetzel (1987).

***5. Artificial introduction of O. insignis on un infested lantana patches***

Lantana bugs are particularly immobile and spend their entire life cycle on a single host plant. For dissemination and easy of supervision twelve sites in Haramaya University compound were selected. Then by cutting twelve leaves or twigs of infected lantana plants, the insect were artificially introduced to new clumps of the host plant by putting one infested leaves or twigs on top surface of the host plant (clumps) at a distance of approximately hundred meters in between the selected clumps. From the date of introduction up to the appearance of symptoms of its establishment, the introduced clumps of plants were visited at three days interval for two months. Finally information gathered from the establishment of lantana bugs on its host plant (*Lantana camar*) from field observations was narrated qualitatively and summarized in percentages.

***6. Artificial introduction of O. insignis on alternate host (potato and tomato) and non-host plants (Parthenium hysterophorus)***

Potato and tomato are among horticultural crops which are commonly produced for home consumption and as commercial crops produced at Haramaya areas including East Hararghe zone. These two horticultural crops are among the listed alternate host plants for *O. insignis*. The two crops are selected purposively for ease of access of the seedlings in the study area. The study of the establishment of this polyphagous insect was made on these crop seedlings planted in pots and kept under shade. After the establishments of the seedlings, infested leaves of *L. camara* were taken from infested lantana patches and single infested leaf was placed on growing tips of all potted seedlings. After artificial introduction of *O. insignis*, the potted horticultural crops were kept for 30days and observation was taken at three days interval and data on *O. insignis* establishment was rated as: 0 = not established; 1 = poorly established; 2 = moderately established; 3 = established and 4 = well established (Fowler, 2005).

***7. Presence of Natural enemies***

There are a number of natural enemies used as biological control of *O.insigns*. To detect the presence of such natural enemies' ten samples of lantana shoot with its leaves and stems were taken randomly and investigated in laboratory under microscope to check the presence of natural enemies.

***C. Data Analysis***

The collected data were subjected to excel spreadsheets and descriptive statistics were used for the analysis.

## III. RESULTS AND DISCUSSION

### *A. Results*

### 1. Insect Identification

The insect was tentatively identified as lantana bug, *Orthezia insignis.* The pictures and movie videos were also sent it to "ICIPE, Kenya" and "South African Agricultural Research Council, Weed Research Team". ICIPE, Kenya did not respond to the request but the "South African Agricultural Research Council, Weed Research Team" responded on April 29, 2016 as the insect is "*Orthezia insignis".* They also said *"*The insect is indeed *Orthezia insignis*. It is not regarded as a biological control agent of lantana, because it was never intentionally selected, imported, studied or released against the plant. It is a generalist garden pest that also includes *Lantana camara* amongst its wide range of host plants. It can be quite damaging if it occurs in large numbers, such as on your photographs, and in addition to sucking the plant saps, its secretion of honeydew causes black sooty mildew to grow on the plant, thus further reducing the photosynthetic surface. However, it does not have the potential to control *L. camara* effectively, since the plant is extremely resilient and can outgrow the damage." This was the procedures we gone through for authoritative identification of the newly emerged insect pest, *O. insignis*.

### 2. Incidence of *O. insignis* infestation

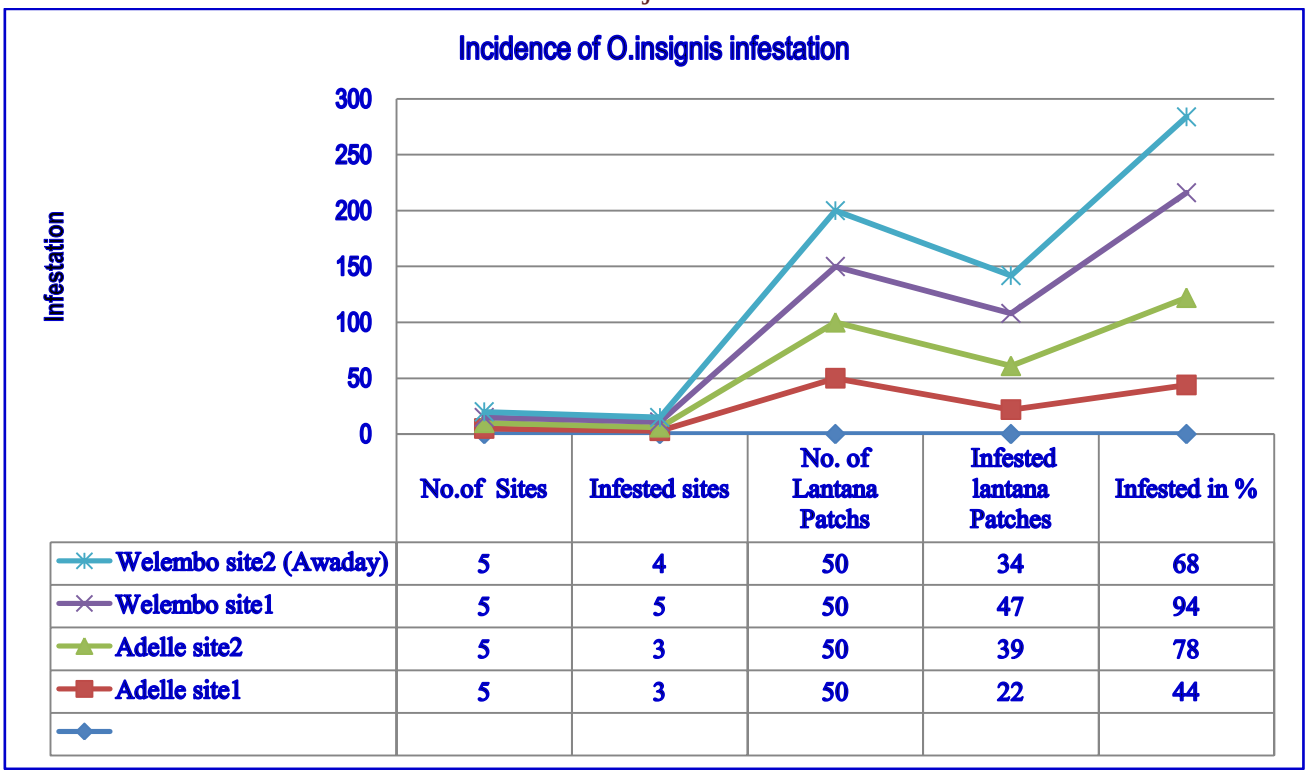
The survey was conducted during dry season from January to April 2016 in Haramaya University compound, Haramaya, and Babile Districts of Oromia Regional State and Harari Regional State. Monitoring was undertaken in sampled stands of *L. camara* in the sampled kebeles. In total the survey includes 65 sites, 650 patches and 7800 shoots of lantana samples, from which 31(47.7%) sites, 296 (48.4%) patches and 3587 (45.9%) shoots were infested by *O.insignis*. The infestation of *O. insignis* on *Lantana camara* in kebeles' of Haramaya, Awaday, Bille, and Gube Merkansitu of Haramaya district and then kebeles' of Hashange and Hamaressa of Sofi district were very severe.

During the survey *O. insignis* was only abundant at Haramaya and Sofi districts at roadsides, farm boundaries and open field. This pattern of occurrence was consistent with *O. insignis* being a recent introduction onto the Haramaya University compound, followed by accidental translocation to Haramaya district rural areas on boundaries of cultivated plots of land and along roadsides, and then dispersed to the neighbor Kersa district. *O. insignis* was absent in the sampled areas of Babille districts. By April 2016, *O. insignis* had become abundant on *L. camara* at Kersa district and Angago (the way to Diredawa), suggesting continued dispersal. The limited distribution of *O. insignis* in Babille lowlands suggested that the location of Babille is to the east of 1st emergence of *O. insignis* in the steep, dry semi arid zone, might not have been exposed to the pest. Consequently, some simple investigations why Babbille area was not contaminated by *O. insignis* were because of the absence of exposure of the potential lantana species by mechanical agents or thorough wind-jet (prevailing winds).

Data collected from Haramaya University compound indicated that out of the 5 sites 3 (60%) were infested and out of the 50 lantana patches 26 (52%) were infested. Similarly from Haramaya district 15 (75%) sites and 142 (71%) lantanta patches and from Harari regional state 13 (65%) sites and 139 (69.5%) the lantana patches were infested (Figure 3). At Babille district there was no infestation of *O. insignis* in all sampled 2 administrative kebeles and 20 sampled sites.

Figure1. Incidence of *Orthezia insignis* on lantana patches (stems and leaves) at Haramaya district Awaday area: [Photo by Temesgen Fita, from field observation]

Figure2. *Orthezia insignis* population naturally occurring on twigs of *lantana camara* and its sooty mold development: [Photo by Temesgen Fita, from Haramaya University compound]




| | No.of Sites | Infested sites | No. of Lantana Patchs | Infested lantana Patches | Infested in % |
|---|---|---|---|---|---|
| Welembo site2 (Awaday) | 5 | 4 | 50 | 34 | 68 |
| Welembo site1 | 5 | 5 | 50 | 47 | 94 |
| Adelle site2 | 5 | 3 | 50 | 39 | 78 |
| Adelle site1 | 5 | 3 | 50 | 22 | 44 |
| | | | | | |

Figure 3. Infestation of *Orthezia insignis* on Lantana Patches in Haramaya Districts (Adelle and Walembo Administration kebele)

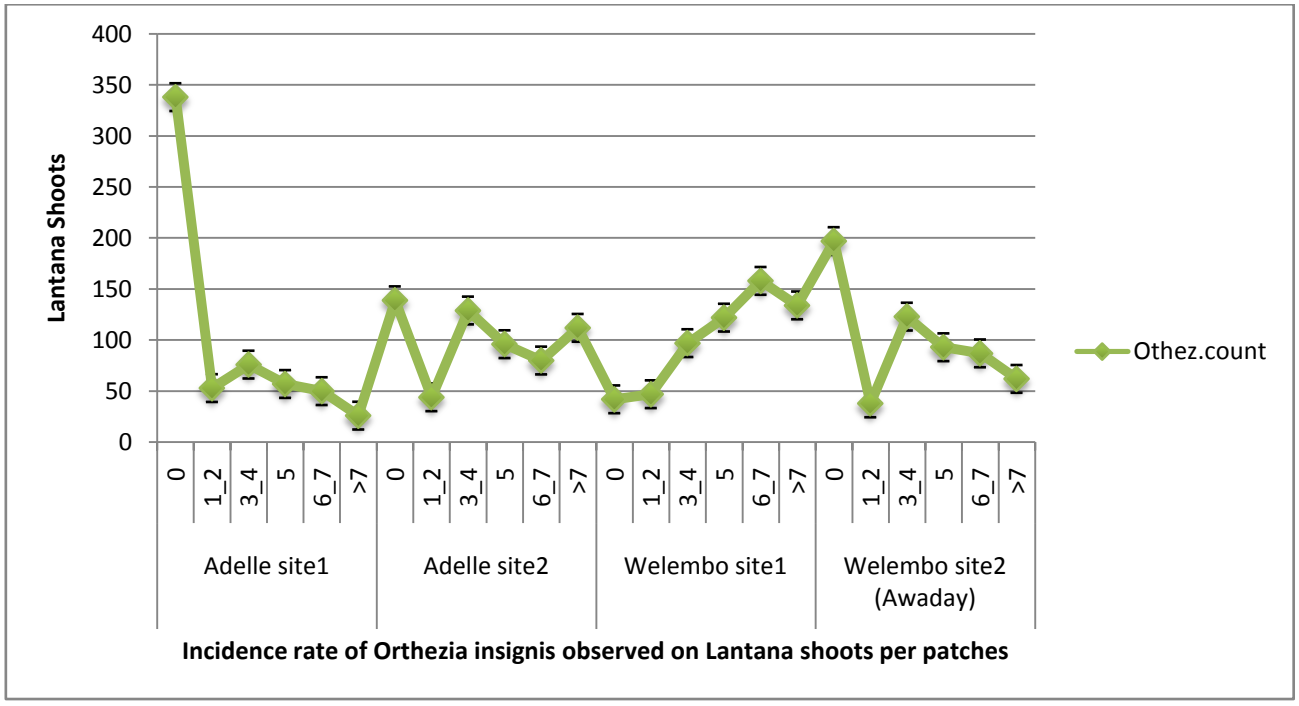



Figure 4(a). Incidence rate of *Orthezia insignis* on Lantana shoots in Haramaya Districts at Walembo and Adelle Administration kebele

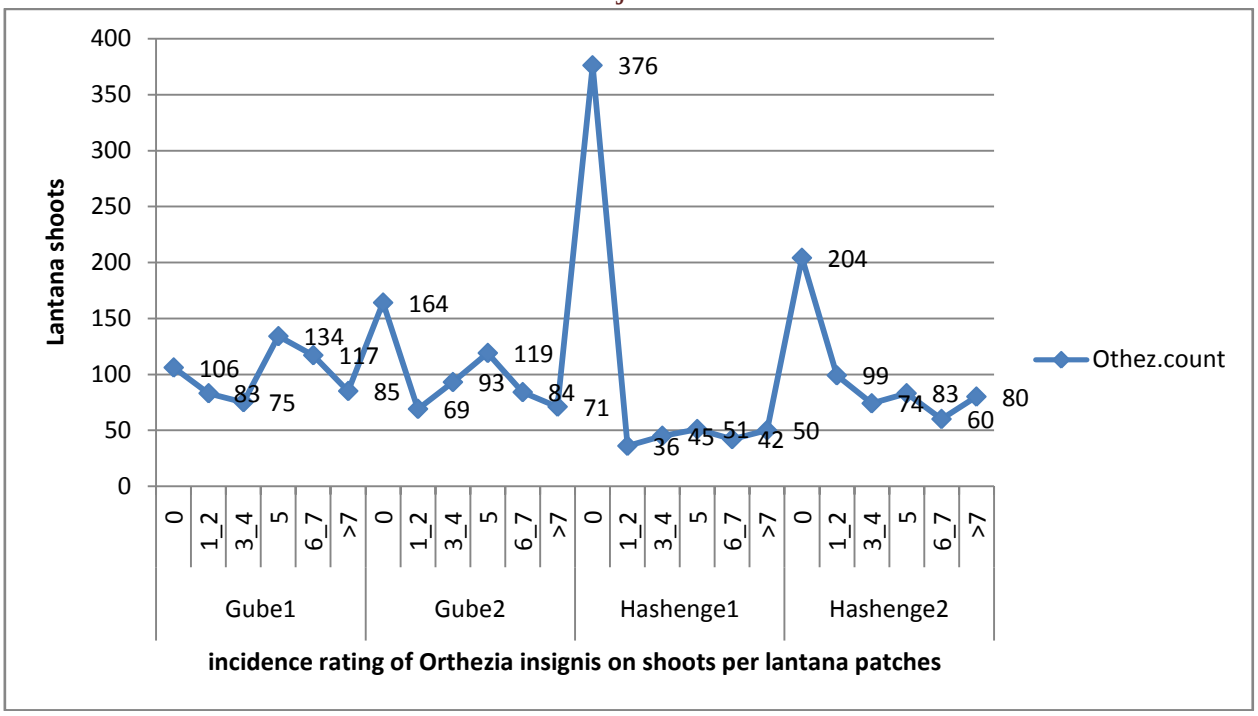



Figure 4(b). Infestation of *Orthezia insignis* on Lantana Patches in Harari Administrative Region of two kebeles (Hashange and Hamaressa)

**3. Damage ratting of *Orthezia insignis***

Data collected at University compound revealed that from all 60 sampled leaves 6 leaves were free of *O. insignis* and the rest 54 leaves had leaf infestation ranging from 6% (77) to 60% (274) *O. insignis* per leaf, in which 7 leaves 6% (1-35), 18 leaves from 7-13% (59-77), 18 leaves from 14-40% (97-182) and 11 leaves from 41-60% (231-274) *O. insignis* per leaf (Figure 5). This data confirmed that the *O. insignis* in this area causes high damage.

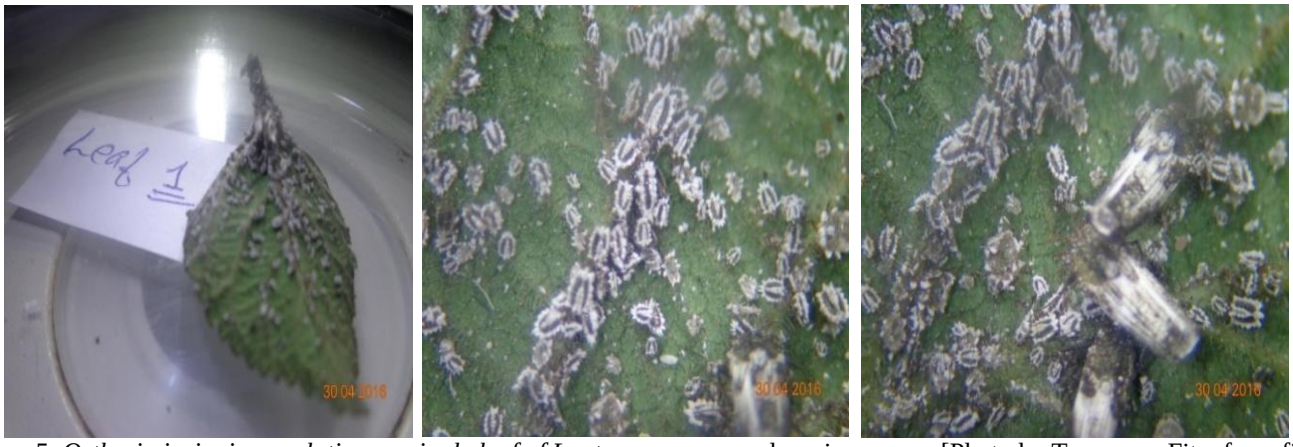



Figure 5. *Orthezia insignis population on single leaf of Lantana camara* under microscope: [Photo by Temesgen Fita, from field observation at Awaday and Bille area]

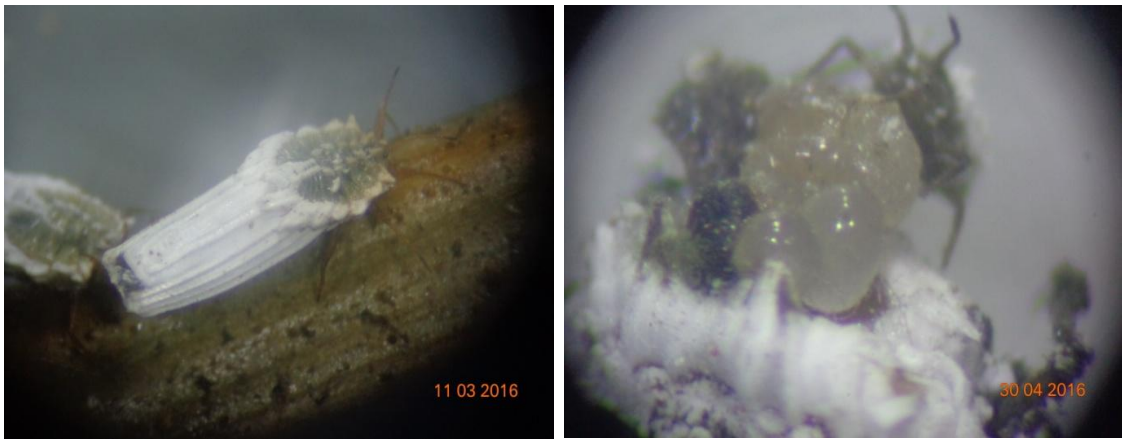



Figure 6. Adult *Orthezia insignis and* female with laid eggs in a waxy ovisac (right side), under microscope: [Photo by Temesgen Fita, from Awaday field samples: observation under microscope, Haramaya University Plant protection Lab.]

With the same procedure data collected from Adelle sites revealed that from all 60 sampled leaves 6 leaves were free of *O. insignis* but the rest had infestation ranging from 6% (77) to 60% (274) per leaf, in which 7 leaves 6% (1-35), 18 leaves from 7-13% (59-77), 18 leaves from 14-40% (97-182) and 11 leaves from 41-60% (231-274) *O. insignis* per leaf. This data confirmed that infestation of O. *insignis* in this area is also high that caused severe damage.

Lantana plants infested by *O. insignis* were also observed in the sampled sites of Haramaya district specially Haramaya town and surrounding areas. Data collected from the sites shows that from all 60 sampled leaves 4(6.7%) leaves were free of *O. insignis* and the rest 56 (93.3%) leaves were infested by *O. insignis* ranging from 6% (1-35) up to greater than 80% (>451). *O. insignis* counted from each leaf shows that 6 leaves 6% (1-35), 11 leaves from 7-13% (38-72), 18 leaves from 14-40% (87- 217), 11 leaves from 41-60% (235-348), 6 leaves from 61-80% (354-446), and 5 leaves >80% (481- 631) *O. insignis* per leaf. The data collected from Haramaya revealed that the *O. insignis* were much more densely populated when compared to other study areas. Sooty moulds developed on leaves of lantana caused blackening of the lantana leaves which has had a negative effect on photosynthetic area of the plant.

In the study areas of Harari Administrative Region data collected from 5 sites of Hashange showed that from all 60 sampled leaves 4 (6.7%) leaves were free of *O. insignis* and the rest other 54 leaves were infested by *O. insignis* at different level of damage. The occurrence of *O. insignis* counted from each leaf ranged from 6% (15-34) to > 80% (457-622) *O. insignis* per leaf, in which 7 leaves 6% (15-34), 10 leaves from 7-13% (37-72), 14 leaves from 14-40% (96-217), 10 leaves from 41-60% (235-347), 10 leaves from 61-80% (363-424) and 5 leaves >80% (457-622) *O. insignis* per leaf. This data confirmed that the *O. insignis* in this area also caused high damage.

From the total sampled 240 leaves 12 (5%) were free of *O. insignis* infestation, and the rest 228 leaves had infestation ranging from 12 to 663 counts. The infestation count for all infested leaves were; 27(11.25%) leaves from 1-35 insects per leaf, 55 (22.9%) leaves from 36-80 insects per leaf, 68 (28.3%) leaves from 81-220 insects per leaf, 42 (17.5%)leaves from 231-350 insects per leaf, 19 (7.9%) leaves from 351-450 insects per leaf and on 17 (7.1%) leaves greater than 451 insects, in which 663 insect per leaf was the highest count. The mean average damage was 68% in which the population density on a single leaf counted 81-220 *O. insignis* per leaf.

In the sample sites of Babille district and Erer Weldiya of Harari Administrative Region, that are both lowland areas, *O. insignis* was not observed. This might be as to the idea of Knight and Holt (2005) which says less mobile insects may require longer periods to re-colonize large disturbed areas. These two kebeles' are the major mango producers and supplier to Harar market.

**4. Testing establishment of *Orthezia insignis* by artificial infestation**

Some literatures indicate that lantana bugs are particularly immobile and spend their entire life cycle on a single host plant. The lantana bug, *O. insignis* has been reported to be transported a distance by water, wind, animal agents etc. (Green, 1992), and become a serious pest in the introduced locality (Booth *et al*., 1995). This preliminary test was done to discover the speed at which *O.insignis* establish and disseminate by mechanical agents on a healthy patches of lantana. For the easy of supervision twelve sites in Haramaya University compound were selected, approximately at an interval of one 100 meters (Figure 7). Highly infested single lantana leaf was placed on to new clumps of lantana plant. Observation was made at five days intervals from the date of artificial introduction up to appearance of symptoms of infestation. The result from the twelve sites showed appearance of symptoms of infestation on eight of the former healthy lantana patch five days after artificial infestation. On the 2nd observation (i.e., 10 days after artificial infestation), the insect was fully established on all patches (clumps) of lantana. This indicates that if the insect is supported any mechanical agent, the establishment and spread is as short as two weeks.


Figure 7. Observation of *Orthezia insignis* establishment on to new lantana patches: [Photo by Temesgen Fita, from Haramaya University Main Campus]

Table1. Ratting of *Orthezia insignis* establishment on to new lantana patches

| Sites code for Infestation | Initial infestation Category | Status of establishment after days of introduction | | | | | |
|---|---|---|---|---|---|---|---|
| | | 5 | 10 | 15 | 20 | 25 | 30 |
| A | WSIT | 1 | 2 | 3 | 4 | 4 | 4 |
| B | " | 0 | 1 | 3 | 3 | 4 | 4 |
| C | " | 1 | 2 | 3 | 4 | 4 | 4 |
| D | " | 1 | 3 | 3 | 3 | 3 | 3 |
| E | " | 0 | 1 | 2 | 2 | 3 | 3 |
| F | " | 1 | 2 | 2 | 3 | 4 | 4 |
| G | " | 2 | 3 | 3 | 4 | 4 | 4 |
| H | " | 1 | 3 | 3 | 3 | 3 | 3 |
| I | " | 0 | 1 | 2 | 2 | 3 | 4 |
| J | " | 1 | 2 | 3 | 4 | 4 | 4 |
| K | " | 1 | 1 | 2 | 2 | 3 | 4 |
| L | " | 0 | 1 | 2 | 2 | 3 | 3 |
| ***Establishment status*** | | | | | | | |
| Not established | 0 | 4 | - | - | - | - | - |
| Poorly Established | 1 | 7 | 5 | - | - | - | - |
| Moderately established | 2 | 1 | 4 | 5 | 4 | - | - |
| Established | 3 | - | 3 | 7 | 4 | 6 | 4 |
| Well established | 4 | - | - | - | 4 | 6 | 8 |

**Symbols**:
WSIT= with one severely infested twigs
Establishment Status: 0 = not established, 1= poorly established; 2= moderately established; 3 = established; 4 = well established
Sites code: A = Stuff resident, B = PhD Student apartment, C = Staff lounge fence, D = HU Model School, E = HU FM Radio area, F = Sawa old Male student dormitory, G = New building of male Student Dormitory side fence, H = New building of male Student Dormitory back side, I= HU new Stadium back side and J = HU new Stadium top side.

**5. Establishment of *Orthezia insignis* on non-host plants (*Parthenium hysterophorus*), and host plants (Potato and Tomato)**

*Parthenium hysterophorus* and *Lantana camara* are amongst alien invasive weed species to the country, Ethiopia. *P. hysterophorus* is widely distributed in Haramaya areas on both farm land and non-farm plots including roadsides. Since *O. insignis* is a polyphagous insect it can become established on a new host and spread. Like the *L. Parthenium hysterophorus* might also become a host plant for *O. insignis.*

To test the establishment of *O. insignis* on *P. hysterophorus*, artificial introduction of *O. insignis* were carried out both in the field and on potted *Parthenium*. For this preliminary study 10 *Parthenium* plants which were voluntarily growing in the field and ten potted *P.hysterophorus* were artificially infested by *O. insignis* as mentioned above. Supervision was made at three days interval after infestation for one month. *O. insignis* on potted *Parthenium* were well established soon after three days of infestation than the field *P.hysterophorus*. During field observation on all 10 infested *parthenium* plants *O. insignis* were poorly established when compared to the potted *P.hysterophorus.* The reason for Orthezia well establishment on potted Parthenium might be due to the protection from wash out by heavy rain and other d environmental hazards. On potted *P. hysterophorus* after thirty five days of infestation, *O. insignis* completely infested the whole plant parts. This showed that host ranges of *O. insignis* in the future can be more than presently known. Janz *et al*. (2006) stated that it has been argued that polyphagy facilitates radical host shifts because less specialized species are more likely to make "oviposition mistakes" on novel hosts, thus enhancing opportunities for diversification. The insect is also tended by ants which may aid in host diversification. Legume crops nearby the potted and infested *P. hysterophorus* were also infested. This is an important consequence of the mutualism is that ants transferred *O. insignis* mechanically to the legume crop. This initiation of selective factors favoring broad herbivore diets is supported by the idea of Pierce *et al.* (2002); Baylis and Pierce (1993); Pierce and Elgar (1985), and which stated that an important consequence of the mutualism is that ant-tended lycaenids feed on a much greater variety of host-plant species than do non-tended species. Establishment and reproduction of *O. insignis* on *P. hysterophorus* plant is the new record finding as a new host for *O. insignis* that has never been listed in the earlier host plants list (Ben-Dov *et al*., 2006, 1998).

Figure 8. *Orthezia insignis* established on Potted *Parthenium hysterophorus* after 3 days of introduction [Photo by Temesgen Fita sample observation from H.U.Lab.]


Figure9 (a & b). Well established artificially introduced *Orthezia insignis* on Potted *Parthenium hysterophorus* after 35 days of artificial introduction: [Photo by Temesgen Fita, from sample observation at Haramaya University Plant Protection Lab.]

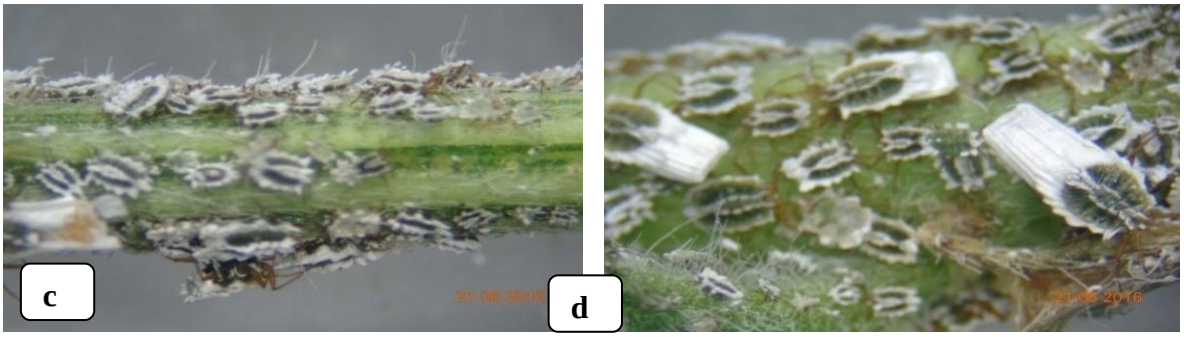



Figure9 (c & d) *Parthenium* stems 2cm length (top) and stems 2cm length (lower) ((left to right) well established aggregated adults and crawlers of *Orthezia insignis*: [Photo by Temesgen Fita, from potted *parthenium* sample observation under microscope, Haramaya University Plant Protection Lab.]

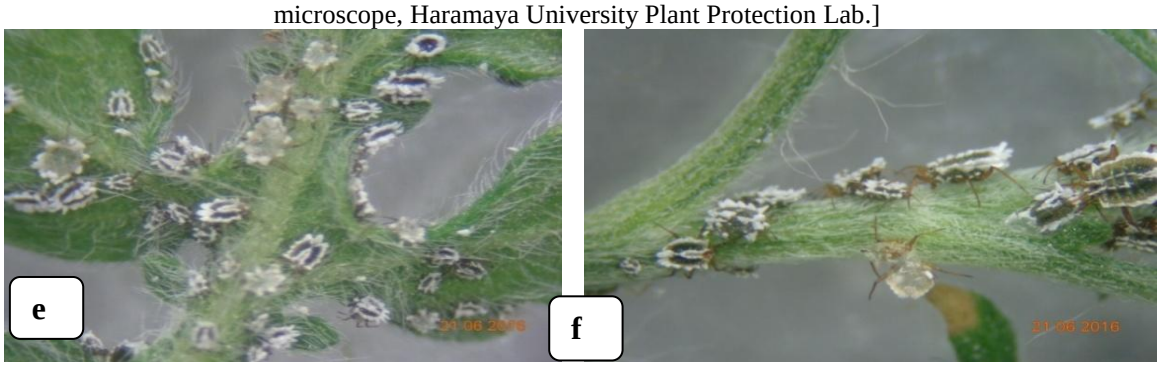



Figure9 (e & f). *O. insignis* on 2cm leaf and 2cm twigs (left to right)

Figure 9 (a-f) well reproduced *O. insignis* on potted *P. hysterophorus* on sampled 2cm length stems, twigs: [Photo by Temesgen Fita, from potted *parthenium* sample observation under microscope, Haramaya University Plant Protection Lab.]

Damage rate of the non host plant was recorded by taking four *parthenium* plants randomly and coded as Pl = *parthenium* plant which were named as $Pl_{(1)}$, $Pl_{(2)}$, $Pl_{(3)}$, and $Pl_{(4)}$. The damage ratting for *O.insignis* was done on the sampled stems and leafs of *parthenium*. The stems of the four plants were carefully cut by knife at the bottom, middle and top of the plant at 2cm length. *O. insignis on* each three cutting of the stem were counted separately and the average counts were taken for each plant. The average counts of *O. insignis* per cuttings were 36, 40, 44 and 32 for Pl $_{(1)}$, Pl $_{(2)}$, Pl $_{(3)}$, and Pl $_{(4)}$. Each *parthenium* plant length were measured before cutting for sample counting, using measuring tap and average length of each plant stems were 45cm, 57cm, 68cm, and 63cm, respectively. Based on the average population data of *O. insignis* taken from 2cm length of stem, the calculated population for Pl $_{(1)}$, Pl $_{(2)}$, Pl $_{(3)}$, and Pl $_{(4)}$ were 810, 1140, 1496, and 1008 *Orthezia* (adult and instars) insects respectively. Insect populations counted on the sampled plants were rated in percent as described by Ademir (2006) and all the populations were >80%, which was more than 220 insects per plant. The same procedures were followed for counting *O. insignis* on leaf part by taking lower, middle and upper leaves from each plant and the average count of *O. insignis* on each leaf were 26, 30, 23, and 31 for Pl $_{(1)}$, Pl $_{(2)}$, Pl $_{(3)}$, and Pl $_{(4)}$ respectively. Highly aggregated *O. insignis* were found on stems when compared to Ademir (2006) leave damage rating. This aggregation of *O. insignis* on stems more than leaves might be due to the more concentration of liquid food from phloem the transport tissue. Leaves also fall down after some weeks of senescence and may not support continuous survival.

Using the same trend, *O. insignis* were artificially introduced on two horticultural host plants, tomato and potato at its vegetative stage by putting infested lantana leaves on top of these two host plants. After three days of artificial infestation O. *insignis* were transferred to Potato plant. In one month duration they reproduced and invaded all parts of the plants. The establishment of *O. insignis* was very slow and poor on tomato plant compared with potato and *Parthenium.*

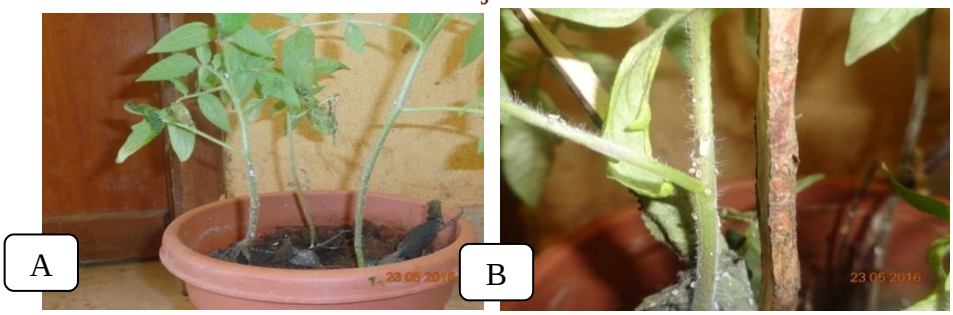



Figure 11. Artificially introduced *Orthezia insignis* (a & b) established on potted Tomato: [Photo by Temesgen Fita, from potted tomato sample observation, H.U. Lab.]

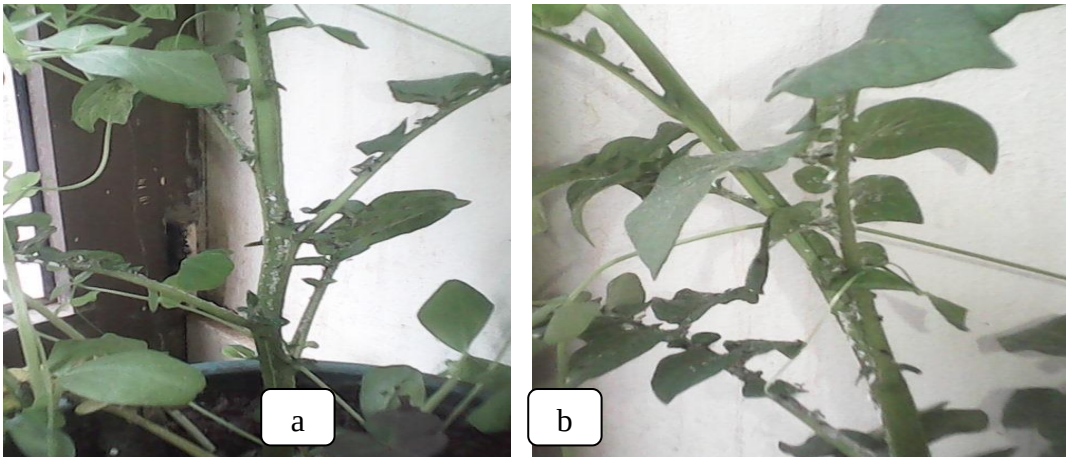



Figure 12. Artificially introduced *Orthezia insignis* established on potted Potato: [Photo by Temesgen Fita, from potted tomato sample observation H.U.Lab.]

Tomato plant naturally contains lycopene, phytoene, phytofluene, *β*-Carotene, tocopherols, sterols , others (i.e. waxes), fatty acids and acylglycerols of which; myristic acid, palmitic acid, stearic acid, oleic acid, linolenic acid, arachidic acid and behenic acid (FAO/WHO, 2009). Price *et al*. (2011) also stated that the exudates of glandular trichomes also contain toxins, which in the case of tomato confer resistance to a variety of herbivores including aphids, whiteflies, lepidopterans and dipteran leaf miners. The same chemicals might limit establishment and reproduction of O. *insignis* on the tomato plant that require further investigation. Another observation on this insect was that there were volunteer legume plants (faba bean and field pea) grown on pots which were used for growing O. *insignis* infested parthenium. Latter on this insect started to establish on the faba bean (*Vicia faba* L.) and field pea. This observation showed the probable future threat to cultivated legumes.

**6. Presence of Natural enemies**

There are a number of natural enemies used as biological control for *O. insigns* and the known one is *Hyperaspis pantherina* (Fowler, 2003). To check the presence of any natural enemies' samples of leaves from ten patches of lantana stand plants which were infested by *O. insigns* were purposively selected and visual observation was carried on each lantana patch. There was no predator observed feeding on this herbivore, except movements of some bugs and mites. In addition to visual observation 10 highly infested lantana twigs with leaves were randomly selected and then the samples were kept in paper bugs and taken to H.U. Plant Protection Laboratory. The samples were carefully observed under dissecting microscope, but no predators or parasites were detected.

***B. Discussion***

During data collection in the study area, the season was winter dry and most of lantana plantation was seriously infested by *O. insignis* and the leaves of lantana were heavily shrinked and collapsed. In all areas of the study sites lantana is found along the boundaries of farm lands and along the road sides. Farmers are using lantana as live-fencing material and all farm lands/plots in the study areas were separated by lantana hedge plantation. The boundaries of chat plantations are surrounded by lantana plants acting as fencing material. Most of the lantana was attacked by this terrible emerging lantana pest. When affected lantana patches were seen at a far distance, patches of lantana looks like fire-burned shrubs. After a while, if lantana plants will be diminished with no doubt *O. insignis* can be transferred to the nearby economically important fruit and horticultural crops like chat, coffee, mango, avocado, sugarcane, potato, tomato, etc., and most probably transmitted to other legume crops and forest plants.

The infestation and the damages of the insect in all study areas, except the areas where *O. insignis* doesn't appear, were almost similar. The other reminder is *O. insignis* can suppress the growth of lantana but it cannot control it due to morphological nature of the plant. During dry season because of moisture stress, it heavily affects the physiology and morphology of the host plant. Later on after some weeks of the first summer rain, the debilitated lantana become rehabilitated and become vigorous plant. In the study area, during the start of summer rainy season, there was enough rainfall and all lantana become re-grow vegetatively and become dense green. This nature of lantana plant makes *O. insignis* cannot be used as a biological control agent of the host plant.

The results of artificial introduction of *O. insignis* on to host and non-host plants shows us that for *O. insignis* dissemination, the only important thing is the mechanisms of

dissemination which only needs any agent to disseminate. If it will be aided by mechanical agents like animals, material goods, human beings activity, wind and water, *O. insignis* can be easily disseminated to nearby to long distance. This indicates that if immediate measure will be taken, it can be contained on its spot area with no or less dispersible advantages. If the pest will be left as a simple thing the fate that the other countries face will be much more problematic in case of our country. Additionally, its' early and easily establishment of *O. insignis* on non-host plant will indicate us the pest is polyphagous in nature and it can attack all economically important plants, leading to food security and social problems.

The issue should come under the national agenda, so that concerned Ministries, Research Centers and Higher Institutions may involve in taking measures to manage the pest. In doing so, the first and most important thing is awareness creation with extension workers and the farming communities to make clear them on how the pest is dangerous to their garden plants and even to the forest plantations. It is well known that lantana is an invasive alien species weed introduced to our country knowingly or un knowingly. In its area of infestation if farmers were convinced to make clear-cut and up-root all lantana plantations from all their farm boundaries and road sides, the pest can be managed within a short period of time. However, the longer it goes unmanaged at this stage, the less opportunity there will be to intervene, the fewer options will remain for its control or management, and the more expensive any intervention will become.

## CONCLUSION

The risk of introduction of new insect pest species is growing with the increase in passenger travel and the trade in plant products worldwide and is likely to continue to do so in the future. It is therefore very important to enhance the methods for regular pest surveillance which is used to assess the risks of alien invasive species and analyze risk management options.

It is considered that preventing the arrival of new species is the least expensive and the most effective method for managing invasive alien species. If this fails, another option is to try to eradicate these species as soon as possible after their arrival. For this to occur, very effective and early detection methods are required.

*Orthezia insignis* Browne (Homoptera: Ortheziidae), is native to South and Central America, but it is now widespread through the tropics including halve parts of African countries and her in Ethiopia it is the newly emerging pest of Lantana. Lantana bug**,** *O. insignis* is polyphagous insect which usually preferring woody hosts, occurring mainly on the shoots and twigs. The insect passes through three immature instars in the female and four in the male (males are rare cases); and the reproduction is parthenogenetic. There are up to three successive generations in a year with three nymphal instars, but reproduction is usually asynchronous, so all stages of development may be present at any time. Its dispersal occurs at the first instar (crawler) stage; these insects are very small, light and can survive several days without feeding. *O. insignis* cannot walk far by themselves but are ideally suited to transport by mechanical agents: water, wind, infested plant material and animal including domestic animals and man. Accidental introductions to new countries apparently occur on infested planting material. Global warming may alter or extend its potential range in tropical countries.

*O. insignis* as a polyphagous insect has host plants from 34 plant families. *O. insignis* adults and nymphs suck the sap from stems and leaves. *O. insignis* feeds by sucking the sap from the phloem of its host. During its feeding it extracts large quantities of sap, causing general host debilitation, but not death. The pest is now restricted to lantana plant causing physical damages. As a by-product, *O. insignis* excretes honeydew with high sugar content which provides a substrate for growth of sooty moulds. The moulds results in badly blackening of leaves of the host. When present in large numbers it kills branches and stems of the attacked plant. During field observations most of lantana patches were covered by sooty mould and they were weak in their stands but very soon rehabilitated after the first week of summer rain, which indicated that lantana is resistant to *O. insignis* attack. In this preliminary study it is confirmed that the insect is an invasive and polyphagous one. The artificial introduction of *O. insignis* on to host and non-host plant and its establishment soon after few days of introduction shows us the insect needs only suited agents for its dissemination to invade new area. Early controlling of this pest on lantana is so easy and manageable, since all lantana plants are found along roadside and on farm boundaries. Early discussion and awareness creation with the community can make the way shorter to manage the pest.

It was easily established on artificially introduced host plants like lantana, potato and tomato, and on non-host plants like parthenium. It was also established on Faba bean and field pea which were volunteer growing legumes nearby experimental pots. It also started to establish on haricot bean which was planted on pots for another experimental purpose. This information gave us a highlight indication of the insect nature and the risks come later on, if it is not managed on its emerged spot.

### *Recommendations*

The considerable increase in the volume of trade exchange, commodity type and origin of trade in plant material from third countries, the introduction of new crops, mobilization of un controlled goods along the borders and the impact of climate change is affecting the boundaries of pests and their vectors. In controlling invasive alien species protective measures is a key aspect. In addition to this the ability to detect and identify accurately and rapidly the introduction of the harmful organism in the plant or plant product being moved is an issue which needs a lot of work to do on. This is often done visually in the first instance, with support from a laboratory for confirmatory testing and subsequent monitoring. Reliance on laboratory testing cause delays since actions can only be taken once the samples have been identified. Therefore, there should be critical analysis of the surveillance methods to be done keeping into account the best practice on the present knowledge.

For the management of this newly emerged invasive insect, immediate containment campaign with strict local quarantine measures in East Harege zone must be carried out, with the involvement of concerned Ministries and stakeholders. Awareness creation and Training at various levels is necessary. The mandated area Agricultural Research Centers, Agriculture Office and Universities should jointly work and design ecologically friendly management options such as implementation of IPM program. In this view, cultural control methods should get first priority and should be practiced to manage *O.insignis* which needs eradication of the host, lantana plant.

Monitoring and inspecting the leaves and twigs of other garden plants and forest trees will be very important to check further pest infestation. *O. insignis* are attacked by the South American coccinellid beetle, known as *Hyperaspis pantherina* Fursch (Coleoptera: Coccinellidae) which is a recognized biological control agent for *O. insignis.* Therefore, further investigation for the presence of natural enemies with its prey and if not present, designing the introduction of an exotic biological control agent for permanent establishment and long-term pest control is recommended.

To protect further introduction of other alien invasive pests quarantine procedures and phytosanitory measures should be strictly followed. Capacity of the Quarantine Centers in detecting invasive alien species should be strengthened. In addition to physical eradication of the host plant chemical control measures against *O. insignis* are often necessary.

If the pest distribution and infestation rate continues without strict management, it will become largely established and affects most of the host and non-host plants which may become an obstacle on the commercial value of horticultural and fruits crops of the country potential. If this pest cannot be managed at this early stage of its emergence, it may also totally affect the ambition of the country for foreign exchange earnings.

### *Future Research Outlook*

- Since *O. insignis* is a polyphagous pest all crops grown by farmers should be tested under green house whether these crops are attacked by this pest.
- The establishment of *O. insignis* on indigenous trees should need further investigation.
- The effect of moisture stress on host plants venerability to O. *insignis* should be tested under managed field conditions.
- Intensive research should be conducted with the aim of discovering and developing new, selective bio-chemicals and besides these screening of chemical pesticides for the insect development and reproduction disrupters (*IDRD*) type which should be reflected in the use of these compounds in integrated pest management programs. Regardless of this, the impact on human health and the environment are two important and related areas that must be considered in the search for safer insecticides.

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