RESEARCH ARTICLE

Seasonal distribution and abundance of Thrips (Thysanoptera: Thripidae) on onion producion in central zone of Tigray, Ethiopia

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ABSTRACT

Knowledge of insect pest population dynamics and abundance can help to predict when and where the highest infestations will occur. This information is very important to apply the right pest control measures at the right time and place. Therefore, a field survey was conducted in four onion producing districts namely, Ahferom, Mereb-leke, Adwa and Laelay-maychew from 2015-2016 to assess the distribution, abundance and significance of thrips on onion production. Survey results indicated that only onion thrips (Thrips tabaci) was found in all study areas. Thrips were found to be widely distributed on onion crops in all of the areas surveyed and were important insect pests of the crop. Onion thrips abundance varied according to growth stage of the plant, months, locations (altitudes) and weather factors mainly (temperature and rain fall). The number of onion thrips per plant was low in the early December however; it was progressively increased to the peak population in March. The highest pest load of thrips population on onion was observed during March at Mereb-leke, Ahferom, Adwa and Laely-maychew with 340, 270, 266 and 227 thrips per plant, respectively. The highest number of onion thrips was recorded at lowland areas (1386 m.a.s.l.) at Rama, which were characterized by sandy to loam soil type and hot weather conditions. Onion thrips population was positively correlated (r = + 0.94) with increasing temperature and negatively correlated (r = - 0.93) with relative humidity. At higher infestation, thrips caused up to 50-75% yield loss and others observed 30-50% yield reduction when control measures are not taken 27.5 and 50% of the respondents, respectively. These results are important for the management of onion thrips by growers.

Key word: Onion thrips, onion, abundance and farmers

INTRODUCTION

Onion thrips is originated in the Mediterranean region. It was first found in Hawaii in 1915, currently it is found all over the world where onion is grown (Brian, 2006). They are poor fliers (MAFF, 1997); however their feathery wings allow them to be readily carried by air currents. In the tropics, thrips population on annual crops are possibly affected more by

immigration than in north temperate regions, due to the north-south movement of inter tropical convergence zone. Thrips can colonize crops from sea level up to 2000 m above sea level (Mishra *et al*., 2014). In Ethiopia, the particular insect is also distributed throughout the country, particularly in onion growing areas (Tadele and Amin, 2014).

The rate of development of *Thrips tabaci* is positively affected by increased temperature and decreased by increased relative humidity (Hamdy *et al*., 1994). In addition to their effect on thrips activity, temperature and relative humidity further influence the intrinsic rate of natural increase of the thrips (Murai, 2000).

Onion thrips damage to young onions is more devastating than on larger plants late in the growing season (Zsofia and Adam, 2012). Thrips prefer to feed on the newly emerged leaves in the center of onion necks. Under crowded conditions, they will move toward leaf tips to feed. Both adult and larval thrips feed within the mesophyll layer using a punch-and suck motion. Older leaves that have been folded over may also be a preferred feeding site for the pest (Paibomesai *et al*., 2013). Onion thrips consume mesophyll cells, which eventually results in a loss of chlorophyll and reduced photosynthetic efficiency (Boateng *et al*., 2014). The mouthparts are beak-shaped with one enlarged mandible (tooth). The beak and mandible is thrust forward to puncture the leaf epidermis and sap released from injured plant cells is sucked up. Removal of chlorophyll causes the feeding area to appear white to silvery in color. Areas of leaf injury can occur as patches and streaks (Diane, 2008). When damage is severe, these small patches can occupy most of the surface of the leaf and the plant cannot adequately photosynthesize and nutrient transportation to the bulb is reduced. Yield reductions in the form of reduced bulb size is the primary effect of onion thrips (Rueda and Shelton, 2003; Cranshaw, 2004).

Onions are most sensitive to thrips injury during the rapid bulb enlargement phase that occurs in dry season, particularly during irrigation season in Ethiopia (Tsedeke, 1985). Accelerated plant maturity and senescence due to thrips injury may truncate the bulb growth period. Following harvest and during storage, thrips may continue to feed on onion bulbs, causing scars that reduce quality and aesthetic appearance of bulbs. *Thrips tabaci* feeding damage results in leaf tissue silvering and photosynthesis reduction, leading to bulb size reduction and yield loss (Carl, 1997). Damaged leaves may become papery and distorted. Infested terminals lose their color, roll, and tiny black "tar" spots of thrips excrement are evident on leaves with heavy feeding injury (Diane, 2008).

Feeding on leaves also can create an entry point for plant pathogens (Orloff *et al*., 2008). In addition to the direct damage, thrips cause viral and fungal diseases on onions under field and storage conditions. It is an important vector that is an organism that transmits infection from one host to another. Both adults and the wingless larvae are attracted to white, yellow and other light colored blossoms and are responsible for spreading tomato spotted wilt virus (TSWV) and impatiens necrotic spot virus. Plant pathogens penetrate the injured plant easily. *Alternria porri* Ellis penetrate the surface of plant pierced by thrips and cause necrotic spot on the leaves and large population of thrips increase the incidence of fungal pathogen in the field (Rueda and Shelton, 2003). *Thrips tabaci* transmits purple blotch on onion (Mckenzie *et al*., 1993; Carl, 1997). Similarly, the infected bulbs in the field cause *Botrytis allis* (Hann) disease in stored onions (Mayer *et al*., 1987). Thrips are the only vectors of tospo viruses and *thrips tabaci,* in particular, is the vector of Iris yellow spot virus (IYSV), genus Tospo virus (Bunyaviridae), a severe and widespread disease infecting onion, leek, iris and wild *Allium* species. Symptoms of iris yellow spot include dry, elongated, straw-colored to tan or white lesions on onion leaves and scapes (the flowering stems of bulb plants). Small lesions may resemble thrips-feeding injury (Tilm and Carrie, 2014). Recently, onion thrips was shown to transmit a bacterial pathogen *Pantoea ananatis (center rot)* to onion (Dutta *et al*., 2014). *P. ananatis* causes center rot in onion and has caused substantial economic losses in the United States.

In Ethiopia, it is an important insect pest that affect onion yield by direct feeding as well as reducing the quality and quantity by rasping the leaves and other tissues of onion crops to release the nutrients (Tsedeke, 1985). Onion fields can be destroyed by onion thrips, especially in dry seasons (Tadele *et al*., 2013). Tsedeke (1985) and Yeshitila (2005) reported that onion bulb yield losses of 33 and 26-57%, respectively, due to onion thrips in Ethiopia. Similar studies at Upper Awash Agro Industry Enterprises revealed yield losses of 10 to 85% due to onion thrips

in Ethiopia (Bezawork, 2006). In the study area even though the extent of damage and their abundance on onion has not been studied earlier, it is the most important pest of onion in the region. Knowledge of insect population dynamics and abundance can help to predict when and where the highest infestations will occur, how much the pest load will become and for how long they will stay. This information is very important to apply the right pest control measures at the right time. Therefore, the objective of the study was to assess the distribution, abundance and significance of thrips on onion production across duration and locations.

MATERIALS AND METHODS

Distribution and abundance of onion thrips

The distribution of thrips was assessed on irrigated onion fields of four onion producing districts in Central Zone of Tigray Region namely Ahferom, Adwa, Mereb-leke and Laelay-maychew. These areas vary from each other, in elevation (Table 3), temperature, soil type and crop cultivation practices. A field survey was conducted monthly in the dry season on irrigated onion fields from December 2015 to April 2016. Depending on availability of onion fields, fields along the main road were considered and visited for sampling. Up to ten fields were sampled per wereda by sampling fields at 5-10 km interval along the main road. Ten plants per field were sampled randomly and inspected for thrips. Samples were taken in a zigzag fashion. Thrips on each of the ten plants were counted using 10x magnifying hand lens. The mean number of thrips was calculated per plant per month in each location.

The mean number of thrips from December to April was used to determine the abundance of thrips on irrigated onion fields. Up to twenty thrips per field on each sampling occasion was collected to determine the species of thrips. Adult thrips were identified using a stereo microscope in laboratory at Axum University. Sparks *et al*. (1914) key was used for identification.

Farmers perception

The study was conducted in four weredas namely Ahferom, Adwa, Mereb-leke and Laelay-maychew by interviewing forty farmers from each using a structured questionnaire. Reports of Agriculture and Rural Development office of the weredas were used to select the farmers for the interview based on their area coverage of onion production i.e. more number of farmers was interviewed in the highest production areas and less number of farmers in low production areas. Questionnaires focused on constraints (concerning insect pests and diseases), cropping season, history of thrips in the study area, season of the year when thrips observed in onions, local name of thrips, thrips intensity on onions, other crops attacked by thrips in the area, changes occurred since known, cropping months at which thrips are serious, management practices, type and frequency of chemical application.

RESULTS AND DISCUSSION

Abundance and Distribution of thrips on onion

Onion crops are attacked by various thrips species. In Ethiopia the common species of thrips involved in onion infestation were *Thrips tabaci Lind* and Frankliniella occidentalis (Pergand) However, *Thrips tabaci* (Thysanoptera: Thripidae) was the only species found in all the surveyed areas. Results indicated that onion thrips abundance varied according to growth stage of the plant, months, locations (altitudes) and weather factors mainly (temperature and rain fall) (Figure 1). During the sampling period low number of thrips were observed during early seedling stage and increased gradually through time with growth and development of the plant. In most of the surveyed areas, less number of thrips per plant was observed during early December up to January. Most of producers transplanted their onion seedlings in these months. Similarly, at seedling stage (2-3 leaf stage) in nursery sites a few numbers of thrips (1-2 thrips per plant) were recorded. As far as the locations are concerned, the highest (61) and the lowest (37) numbers of thrips per plant were recorded at Mereb-leke and Laely-mychew, respectively in December. The highest pest load of thrips population on onion was observed during March at Mereb-leke, Ahferom, Adwa and Laely-maychew with 340, 270, 266 and 227 thrips per plant, respectively (Figure 1). This could be due to the dry weather condition of that period, which helped the buildup of thrips population. Thrips were found to be widely distributed on onion crops in all of the areas surveyed and were important insect pests of the crop.

The highest 340 onion thrips per plant was recorded at Mereb-leke lowland areas at Rama, which were

characterized by sandy to loam soil type with 1386 m.a.s.l. As compared to Mereb-leke, a lower number of thrips per plant (227) was recorded at Laelay-maychew with clay soil type with 2131 m.a.s.l. At Adwa and Ahferom thrips distribution was similar. At the end of March and early April there was unusual rainfall in all surveyed areas. As a result the thrips densities per plant decreased to low numbers per plant. Farmers in the survey areas had different management practices; some of them used good agronomic practices and others were poor in their management. In onion fields with poor managements, such as weedy fields, less irrigation water and rarely on saline soils, higher thrips population per plant was observed. On weedy onion fields with higher thrips infestation, symptoms of Iris yellow spot virus (IYSV) were observed on onion leaves at Ahferom and Mereb-leke. Similarly, at Laelay-maychew and Ahferom there was a problem of purple blotch and white rot diseases. When the plant reaches at good vegetative stage (7-10 leaves) there was a symptom of leaf blight (suddenly the leaves become brown and died) at Mereb-leke and Laely-maychew.

This study was in agreement with the results reported by different researchers. Mallinath *et al*. (2014) reported that the population of thrips occurrence on onion crop was very low during seedling stage and it was gradually increased during vegetative stage of the crop and reached a peak occurrence during physiological maturity stage. Tsedeke (1986) indicated that, thrips population remained low from June through August and started rising in September and reached its peak in April. Thrips population change mainly brought by the environmental factors such as temperature and rainfall. Similarly, from dry and rainy period observation in Indonesia, Vos *et al*. (1991) reported that thrips population was severe in dry and hot periods than the rainy season. This was due to wash off thrips by rainfall and the favorable humid conditions created for entomo-pathogenic fungi that feed on thrips. Different people reported the impacts of climatic factors on thrips. Krantz *et al*. (1978) indicated that, the number of thrips on onion crop increased rapidly during dry weather and decreased rapidly after rain. Heavy rainfall greatly reduces the population of thrips by both washing from the plant and killing those which are in the soil (Cranshaw, 1994). Similarly, Workman and Martin (2002) reported that damage and density of thrips on crops were heavier in dry and hot seasons due to their high reproduction rate and short developmental periods at such weather conditions and heavy rainfall could cause up to 70% thrips mortality.

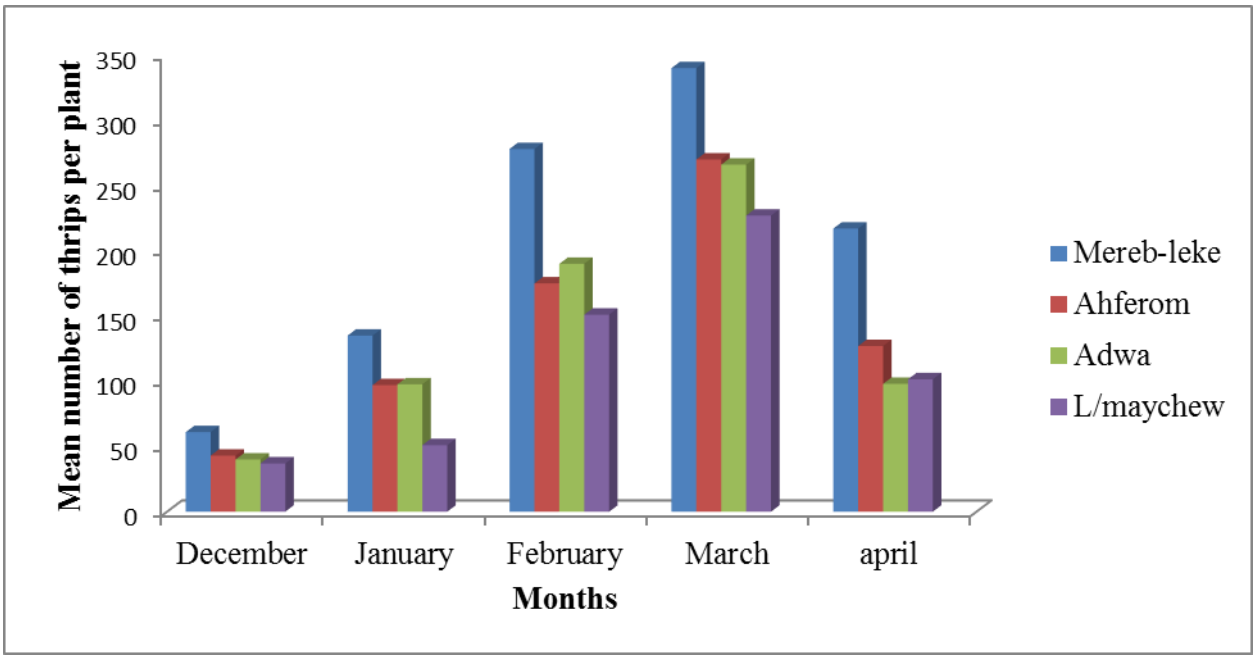

Figure 1. Onion thrips abundance across locations and months of growing season

Table 1. Farmer's responses to questionnaires during survey about thrips in onion production

No.	Questioners	Variables	Respondents (%)
1	Onion production season	1. Irrigation	100
		2. Rainfed	-
2	Onion production constraints regarding pests	1. Onion thrips	80
		2. Diseases	20
3	Observation of thrips on other crops	1. Yes	22.5
		2. No	77.5
4	Other vegetables infested by thrips	1. Tomato	-
		2. Garlic	22.5
		3. Cabbage	-
5	Duration of thrips known	1. Five years	27.5
		2. Eight years	40
		3. Ten years	32.5
6	Changes observed on thrips intensity over years	1. Increase	100
		2. Decrease	-
		3. No change	-
7	Months with the highest thrips population	1. March-April	47.5
		2. Jan-Feb.	32.5
		3. Oct-Dec	20
8	Onion yield loss due to thrips (%)	1. 20-30	22.5
		2. 30-50	50
		3. Above 50	27.5
9	Onion thrips management practices	1. Chemical	80
		2. Cultural	-
		3. No control	20
10	Type of insecticide used in thrips management	1. Karate 5%Ec.	35
		2.Malathion 50%	30
		3.Any insecticide	15
11	Frequency of spray interval	1. once in a week	20
		2. 3times a month	35
		3. If necessary	25
12	Efficacy of insecticides on thrips management	1. Very effective	-
		2. Moderately	3.1
		3. Very low	56.2
		4. Not effective	40.6
13	Price of insecticides concerning producers	1. Affordable	-
		2. Not affordable	80

Farmers' perception about onion thrips

Farmer's responses to the questionnaires are shown in (Table 1). Farmers recognized that onion production is affected by insect and disease problems 80 and 20% of the respondents, respectively. Farmers locally name onion thrips as "kunchi shigurti" or "hafo shigurti" in Tigrigna. According to farmers responses the highest thrips infestation was observed from March to April (47.5% of respondents). At higher infestation, thrips caused up to 50-75% yield loss and others observed 30-50% yield reduction when control measures are not taken 27.5 and 50% of the respondents, respectively. The majority of the farmers (80% of them) indicated that they depend on insecticides to manage onion thrips. The frequency of insecticide application was reported to vary from once per week to three times per month. However, some of the respondents (25%) responded that they apply when they observed higher infestations or if it deemed necessary. The commonly used chemical insecticides were karate 5% EC (lambda-cyhalothrin) and Malathion 50% EC. The effectiveness of the chemicals

was very low to non effective according to 56.2 and 40.6% of the respondents, respectively. The prices of the chemicals were also variable and not affordable by the onion producers.

Farmers were asked whether they observed thrips on other crops in their fields and the majority (80%) of them responded that they did not know whether thrips attack other crops rather than onions. However, 20% of the respondents answered that they observed thrips on garlic similar to onion. According to the interviewed farmers, thrips are difficult to manage, highly distributed in all onion fields and became very important pests of onion and garlic.

The problem became intensive with onion fields and increased from time to time according to all the respondents. Most of the farmers knew onion thrips before eight years and about 27.7% of the farmers knew thrips only five years ago. This may not mean that thrips were not present on their fields before five years. It may mean that the pest started causing heavy damage to the crop in the last few years. The reason for the increase of thrips problem on onions could be many, but production system changes from rainfed to irrigation, climate change effects, use of high yielding improved varieties that lack the resistance genes to thrips, and regular unwise use of insecticides could be the major ones. Hill (1994) reported that new agricultural practices, such as the use of improved varieties and use of nitrogenous fertilizer, are responsible for changing plant hoppers from minor pests to the major pest status.

Effect of weather factors on onion thrips population

Thrips population was lower during the early crop stages with lower average temperature and higher relative humidity. However, number of thrips increased gradually with increasing temperature and decreasing relative humidity (Table 2).

Table 2. Meteorological data during the growing period and the mean thrips population

Date of observation	Mean onion thrips/plant	Average temperature (^{0}C)	Average rain fall (mm)	Relative humidity (%)
04 January 2016	15.63	25.5	00	68
22 January 2016	23.18	26.0	00	59
07 February 2016	46.20	27.5	00	36
22 February 2016	92.6	29.0	00	29
07 March 2016	127.73	30.0	00	25
22 March 2016	165.50	29.0	00	27
07 April 2016	51.97	28	00	46

Source: Ethiopian Meteorological Agency Mekelle branch and Aksum airport.

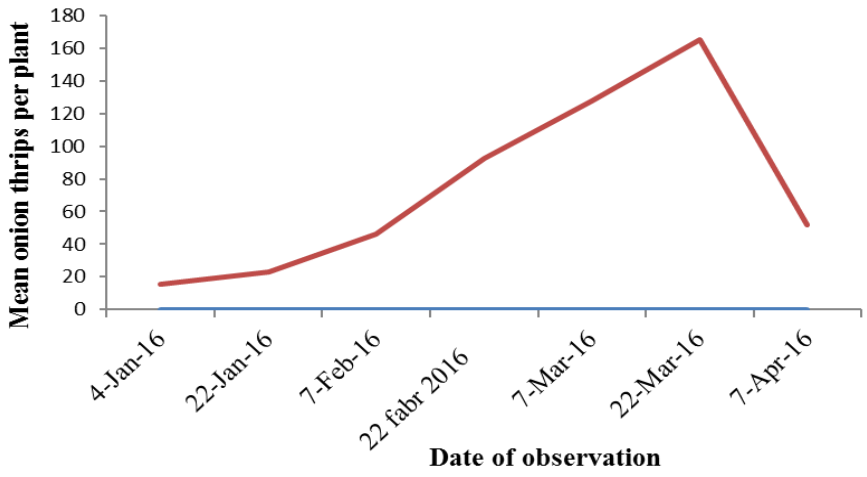

Figure 2. Mean number of thrips population /plant observed at different dates in onion

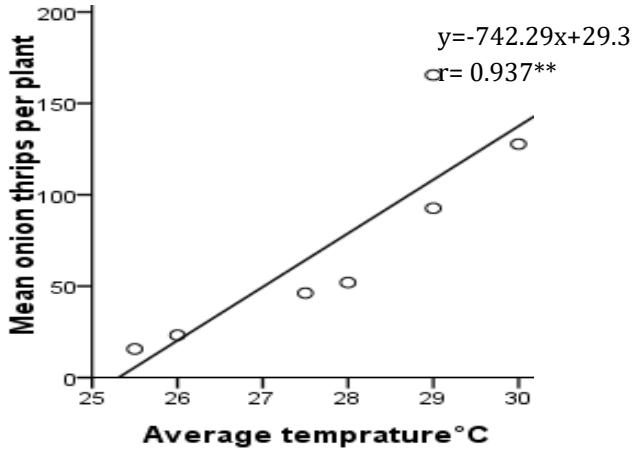

Figure 3. Relationship between average temperatures (°C) and thrips population in onion

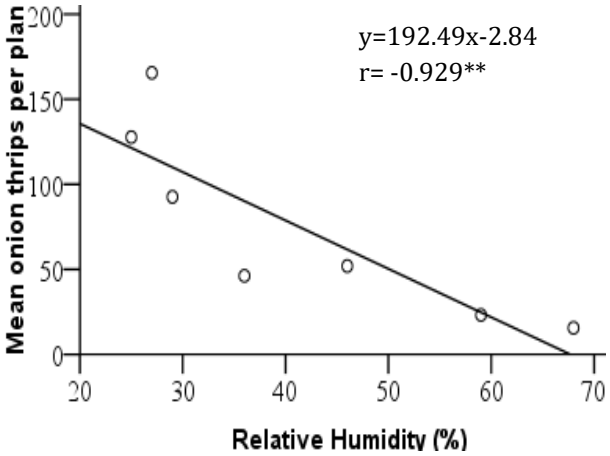

Figure 4. Relationship between relative humidity (%) and thrips population in onion

Table 3. Coordinates and elevations of the surveyed areas

Area	North	East	Altitude (m.a.s.l.)
Mereb-leke	14°22.824'	38°48.278'	1407
	14°22.916'	38°48.097'	1386
	14°22.828'	38°48.318'	1415
	14°22.847'	38°48.298'	1404
	14°23.721'	38°48.272'	1370
	14°23.665'	38°48.317'	1368
	14°23.649'	38°48.291'	1387
	14°23.736'	38°48.244'	1379
	14°23.684'	38°48.291'	1350
	14°23.652'	38°48.248'	1381
Ahferom	14°11.144'	39°04.256'	1995
	14°11.219'	39°04.197'	1999
	14°16.374'	39°03.934'	2020
	14°11.096'	39°04.225'	2007
	14°11.129'	39°04.289'	2007
	14°11.144'	39°04.030'	2004
	14°16.390'	39°30.936'	2029
	14°16.379'	39°04.330'	2006
	14°16.359'	39°04.320'	2014
	14°11.145'	39°04.248'	2005
Adwa	14°09.494'	38°51.247'	1894
	14°09.497'	38°51.251'	1897
	14°09.101'	38°51.126'	1879
	14°09.133'	38°51.096'	1876
	14°08.593'	38°52.289'	1830
	14°08792'	38°52.645'	1841
	14°08.742'	38°52.547'	1837
	14°08.318'	38°52.396'	1835
	14°08.553'	38°52.262'	1833
	14°08.667'	38°52327'	1841
Laelay-mychew	14°07.189'	38°45.809'	2088
	14°07.265'	38°45.865'	2089
	14°07.293'	38°45.885'	2082
	14°07.379'	38°45.813'	2086
	14°07.050'	38°37.182'	2131
	14°07.910'	38°46.147'	2093
	14°07.998'	38°46.087'	2102
	14°07.784'	38°46.024'	2098

There was strongly positive correlation between temperature and thrips population in onion. The regression equation was y = -742.29x+29.33 and correlation coefficient was r = 0.937**. Figure (3) indicated that thrips population was increased with the increase of temperature. However, Thrips population was negatively correlated with relative humidity in onion. The regression equation was y = 192.49x-2.84 and correlation coefficient was r = -0.929**. Figure (4) indicated that thrips population decreased with the increase of relative humidity.

Similar findings have been reported by different authors on climatic factors, including the important factors rainfall, temperature, relative humidity and wind that significantly affect thrips numbers (Kirk, 1997; Waiganjo *et al*., 2008). Relatively high temperature and lack of rainfall increased onion thrips population, while high relative humidity and rainfall reduced thrips population (Hamdy and Salem, 1994; Tadele and Amin, 2014). Effect of weather factors on thrips colonization depicted that heavy rainfall and low temperature had negative correlation with thrips abundance (Haider *et al*., 2014). Similarly, Lorini and Junior (1990) reported that high temperatures and lack of rainfall increased density of *T. tabaci* on garlic in Brazil.

SUMMARY AND CONCULSIONS

Thrips tabaci was the only species found in all the four surveyed areas. Abundance of onion thrips varied with growth stage of the plant, months, locations (altitudes), weather factors mainly temperature, relative humidity and rainfall. Onion thrips were more abundant at crop developmental stage of 7-14 leaves. The highest pest load of thrips population on onion was observed on March at Mereb-leke (340 thrips/plant) and at Ahferom (270) thrips per plant. This was due to the dry weather prevailed in March, which helped the buildup of thrips population. Thrips population also decreased to a lower number in April due to the crop maturity and unusual rainfall distribution in all the study areas. Onion thrips population was positively correlated (r = + 0.94) with increasing temperature and negatively correlated (r = - 0.93) with relative humidity. About 80% of the respondents in the study areas indicated that thrips was the most severe pest of onion. At higher infestation, thrips caused up to 50-75% yield loss and others observed 30-50% yield reduction when control measures are not taken 27.5 and 50% of the respondents, respectively. Most of the onion growers in the surveyed areas used insecticides only, particularly lambda-cyhalothrin (Karate) for onion thrips management even though it was not effective and expensive to purchase. Most onion fields need an integrated management against onion thrips for two to three months depends on the weather conditions.

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