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Evaluation of insecticides for their efficacy at different doses against onion thrips, *Thrips tabaci* (Thysanoptera: Thripidae) on onion

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Abstract
Onion is considered as one of the most important vegetable crops produced on large scale in Ethiopia. Onion thrips, *Thrips tabaci* is a pest of economically important crops of onion (*Allium cepa*) and causes significant yield loss globally. The present study was aimed to evaluate the efficacy of insecticides for the control of *Thrips tabaci* on yield and yield component of onion. The experiment was laid out as a randomized complete block design with four replications. The study was conducted on farmer's fields at three districts of West Shoa Zone, Oromia Regional state, Ethiopia during October 2018 to March 2019. The Experiment was conducted on farmers' field at two different districts of West Shoa Zone, Oromia Regional state, Ethiopia, such as Ambo and Toke Kutaye districts. After the infestation of thrips pre and post spray and yield parameters were taken. The tested insecticides caused mortality of onion thrips at various degrees of significance over untreated control. The result of the research revealed that the Sivanto Energy EC 85 at rate of 1200ml ha^{-1} gave promising mortality percent and significantly ($P<0.05$) different from untreated control. Sivanto Energy EC 85 insecticide has effective percent mortality to control onion thrips, in open field conditions. Therefore, Sivanto Energy EC 85 insecticide is recommended at a rate of 1200ml ha^{-1} to control onion thrips on onion field conditions.

Keywords: Efficacy, infestation, insecticide, onion, *Thrips tabaci*, yield

Introduction
Onion (*Allium cepa* L.) belongs to the family Alliaceae which was originated in south western Asia, being the centre of domestication and variability, from where it was spread first across the world and has been cultivated for over 4700 years as annuals for bulb crop production purposes (Brewster, 2008) [6]. Onion is considered as medicinal and health benefits to fight different diseases including cancer, heart and diabetic diseases (Goldman, 2011) [8]. Due to these considerable benefits, the onion production is become increasing in different parts of Ethiopia in small-scale farmers. It has grown mainly as a food source and used as cousins and value addition for different dishes. Though, its production status is not well-developed and organized despite to all the available opportunities. This might be due to the lack of improved verities that are well resistant or tolerant the infestation by insect pests that take the highest share of low productivity. Onion is considered as one of the most important vegetable crops produced on large scale in Ethiopia and occupies economically important place among vegetables in the country (MoARD, 2009) [13].

Onion thrips, *Thrips tabaci* (Thysanoptera: Thripidae) (Lindman) is a key insect pest in most onion production regions of the world including Ethiopia. Thrips populations increase rapidly under hot, arid conditions and can lead to economic crop loss. The early bulb enlargement stage of onion growth is the most sensitive to thrips feeding (Alson and Drost, 2008) [4]. Onion thrips (*T. tabaci*) is a polyphagous insect that has spread to all continents and is recognized as an economically harmful pest of cultivated plants (Liu and Sparks, 2003) [11]. Alson and Drost (2008) [4] reported that thrips prefer to feed on the newly emerged leaves in the centre of onion necks; the majority of thrips will be at the base of the youngest leaves in the lower centre of the neck.

Insecticides are still one of the most important control options that have been used by stake holders and farmers to manage onion thrips in onion corps. Several authors have been evaluated the effect of insecticides against *T. tabaci* in laboratory and field conditions (Bhargava 2010; Patil *et al,* 2010; Ullah *et al*, 2010 and Waters & Walsh, 2010) [5, 15, 21, 22]. Despite its importance, scanty literature is available to determine the effect of insecticides against *T. tabaci* in western Shoa of Ethiopia. The growth of the bulb onion is subject to significant stress and yield reduction caused by sap feeding onion thrips.

The primary effect of inappropriate use of insecticides are the negative effect on natural enemies and insecticides resistance development in most onion growing areas of Ethiopia. In Ethiopia, particularly in West Shoa onion growers are typically the general control recommendation is to spray the crop with insecticides as soon as the pest appears and to continue thereafter, throughout the crop, but it is now apparent that there are widespread ecological consequences such as soil and ground water contamination, impacts on the food chain and potential health concerns. As a result, persistent chemical insecticides are now prohibited in most countries and replaced by less persistent insecticide. Therefore, it was desired to study the effect of two insecticides on different rates on the management of onion thrips, *T. tabaci* under open field conditions.

Materials and Methods

Description of the study area

The Experiment was conducted on farmers' field at two districts of West Shoa Zone, Oromia Regional State in Ethiopia, such as Ambo and Toke Kutaye Districts. Ambo is at geographical coordinate of 858'59.988"N latitude and 3751'0.000"E longitude with an altitude of 2076 meter above sea level (Briggs, 2012). Toke Kutaye Districts is located at 126 km west of Addis Ababa having an altitude of 1990 meter above sea level, latitude of 0859' 01.100" N and longitude of 3746'27.600"E. The average annual rainfall is 1028.7 mm and maximum and minimum temperatures of the area are 29.6°C and 11.8°C, respectively.

Crop establishment and data records

Field experiment was conducted between November, 2018 and March, 2019 under irrigation water. A total of eight treatments including standard check and untreated control were used. The experiment was laid out in a randomized complete block design in four replications with two new insecticides at three different rates namely: Sivanto Energy EC 85 and Titan 25 WDG, the rates are listed in (Table 1).

A seed of Koshoro variety was sown in seedling beds (1 x 3m) in the beginning of September and adopted standard agronomic practices for commercial onion cultivation. The seedlings were transplanted after 60 days in the plots having a size of 3m x 4m plot at spacing 20cm x 10cm between row to row and plant to plant, respectively. When on adequate population of onion thrips appeared, the chemical were sprayed with knapsack sprayer as specific rates. In both locations insecticide spray was under taken when the population number of onion thrips reach the economic threshold level (5 thrips / plant) were observed (Abate, 1985) [1].

Table 1: List of experimental treatments

S. N.	Common name	Trade name	Dose ha^{-1}
	Flupyradifurone + Deltametrin		1000ml
		Sivanto Energy EC 85	1100ml
			1200ml
	Thiamethoxam		1000gm
		Titan 25 WDG	1250gm
			1500gm
	Diazinon	Diazinon 60 E.C	1000ml
	Control		

For data recording, five plants were selected randomly from each treatment and tagged. Inspections were done every week for the presence of onion thrips, symptoms and damages. Pre-spray count was taken prior to each spray and subsequent counts were recorded after application of 48 hours. Observations were recorded early in the morning before 8.00 a.m. as suggested by Mote (1977) [14] and Wagh *et al*., (2017) [23]. Yield of marketable onion bulb gains due to the application of the protection regimes were recorded separately for each treatment and computed yield and yield components. The total number of leaves per plant, and leaf length were counted and recorded 30 days after transplanting and at maturity. The bulb diameter of the average radial width was also measured by using veneer caliper and expressed in centimeter after harvest.

Data analysis

Analysis of variance (ANOVA) was conducted using Statistical Analysis Software (SAS, 2009) and compared treatment effects. The mean comparisons were carried out using Duncan's Multiple Range Test (DMRT). Obtained data were transformed using Arcsine transformed and analysis of variance was computed using SAS program version 9.1 (SAS, 2009). The mean percent mortality was corrected using Abbott's formula (Abbott, 1925) and Efficacy analysis was done based on data transformation to Arcsine $\sqrt{x+0.5}$ when necessary according to Gomez and Gomez (1984):

$$\text{CM}(\%) \quad \frac{[T(\%)-C(\%)]}{[100-C(\%)]} X100 \quad =$$

Where: CM (%) - Corrected mortality
T- Mortality in treated insects
C- Mortality in untreated insects

Results

Effect of insecticides on onion thrips

The experiment was conducted at two different onion growing potential areas of Western Shoa, Oromia Regional State in Ethiopia viz. Ambo and Toke Kutaye Districts. Results revealed that there was a significant reduction on thrips population after application of insecticides on all observation dates except untreated control. The results in (Table 2) shown that significant (P<0.05) differences were observed among the treatments. Numbers of onion thrips per plant and their respective percent mortality caused by insecticides after 48 hours.

All the rates of the insecticides evaluated against *Thrips tabaci* on onion crop were significantly better than the control plots. After 48 hrs of spray, Sivanto Energy 185 at rate of 1200ml/ha 97.68% mortality followed by Sivanto EC Energy 185 at rate of 1100ml/ha (81.27%), Sivanto Energy EC 185 at rate of 1000ml/ha (68.28%). After 48 hours highest percent mortality was recorded for Sivanto Energy EC 185 at rate of 1200ml/ha while the lowest percent mortality was recorded for Titan 25 WDG (1000gm/ha). As increased rates per hectare, percent mortality of onion thrips also increased. The percentage mortality of onion thrips increased with increase in rates of application per hectare. The presented results agrees with the previous work of Shafiq and Maher (2016) [19] who reported that Deltamethrin caused significant reduction of thrips populations as compared to the untreated control.

The effectiveness of insecticides against onion thrips have beenpreviously reported by various researchers. The results of the current study are in conformity with those of Worthing (1987) [24] who reported that Deltamethrin has very good residual activity for outdoor and indoor insect pests. The results also confirm the work of Haug and Hoffman (1990) [10]. In this work it was reported that Deltamethrin is a synthetic insecticide based structurally on natural pyrethrins, which rapidly paralyze the insect nervous system giving a quick knockdown effect.
Mandi and Senapati (2009) [12] concluded that Thiamethoxam was found most effective to minimize the chillithrips, *Scirtothrips dorsalis* population by 89.93% on chilli but in this study it was found to minimize the total population of onion thrips by 68.67% even at highest rate of application. There are also studies reporting the effectiveness of Thiamethoxam as seedling root dip against chillithrips (Sarangi and Panda, 2004; Reddy *et al.*, 2005) [17, 16]. However, in foliar application the percent efficacy of this insecticide was low as compared to the standard check and the other treatments. Agale *et al.* (2010) [3] found that Thiamethoxam 25 WG 125 g.a.i./ha was best for control of onion thrips. In this study, the findings are in close association and supported the present study.

Table 2: Mean percent mortality insecticides at different rates on onion thrips, *Thrips tabaci*

Treatments	Rate ha^{-1}	Percent mortality (%)
T_1	(1000ml)	68.28^{c}
T_2 (Sivanto Energy EC 85)	(1100ml)	81.27^{b}
T_3	(1200ml)	97.68^{a}
T_4	(1000gm)	52.67^{d}
T_5 (Titan 25 WDG)	(1250gm)	63.14^{c}
T_6	(1500gm)	68.67^{c}
T_7 (Diazinon 60 E.C)	(1000ml)	89.42^{ab}
T_8 (Control)		8.37^{d}
LSD at 0.05		9.12
CV (%)		17.34
SE ±		5.64

Phytotoxicity of insecticides against onion crops

Physical observations indicate that there are no phytotoxic symptoms like yellowing and scorching observed on crops after spray with all the rates of insecticides used.

Effect of insecticides on yield and yield components

There was a significant difference between treated insecticides and untreated check but no significant (P>0.05) difference when compared to the standard check (Diazinon 60 E.C). The yield results indicated that yield bulb in the treatment Sivanto Energy E.C 85 and Diazinon 60 E.C gave high yield in both locations compared to untreated plot (Table 3).

Table 3: Effect of insecticides on onion mean bulb weight, bulb diameter, and yield

Treatments	Rate ha^{-1}	Yield and yield components		
		Mean bulb weight (g)	Mean Bulb diameter in (cm)	Marketable Yield t/ha
T_1	(1000ml)	35.14^{b}	3.92^{a}	36.34^{a}
T_2 (Sivanto Energy EC 85)	(1100ml)	34.93^{b}	3.81^{a}	36.98^{a}
T_3	(1200ml)	38.34^{a}	3.97^{a}	38.27^{a}
T_4	(1000gm)	34.58^{b}	3.32^{b}	32.37^{b}
T_5 (Titan 25 WDG)	(1250gm)	35.67^{ab}	3.69^{b}	31.08^{b}
T_6	(1500gm)	35.58^{ab}	3.41^{b}	33.25^{b}
T_7 Diazinon 60 E.C	(1000ml)	37.29^{a}	3.23^{a}	37.56^{a}
T_8 Control		24.69^{c}	2.14^{c}	27.24^{c}
LSD at 0.05		2.32	1.06	3.24
CV (%)		1.85	5.67	11.67
SE ±		4.62	0.56	2.22

Number of leaf per plant and Leaf length

Leaf number per plant at physiological maturity was no significant (P>0.05) difference among the treatments. Insecticide application at different rates showed no significant (P>0.05) difference in the mean leaf length per plant (Table 4). The plots that were applied with the maximum rate of insecticides ha-1 showed no difference from the untreated control.

Bulb diameter

The result showed that all parameters were found to be statistically significant, Sivanto Energy EC 185 at 1200ml ha-1 rate of application showed statistically significant (P<0.05) difference on the mean bulb diameter of onion. The highest mean bulb diameters were observed in plot sprayed by Sivanto Energy EC 185 and the standard check (Diazinon 60 EC). On the other hand the lowest records were observed in the untreated plot (Table 3).

Bulb weight

There was statistically significant (P<0.05) difference encountered in mean bulb weight due to application of insecticides at different rates. Among all rates considered in the study, application of Sivanto Energy EC 185 at a rate of 1200ml ha-1 increased the mean bulb weight values by about 35.6% over control treatments (38.34g). The increase in mean bulb weight with the application of insecticides could be due to more ample growth, more foliage and leaf area and higher supply of photosynthetic which helped in producing bigger bulb, hence resulting in higher yields.

Table 4: Mean effect of insecticides on mean leaf number, mean plant height, and mean leaf length

Treatments	Rate ha^{-1}	Leaf No./plant	Plant height (cm)	Mean Leaf length (cm)
T_1	(1000ml)	7.53^a	44.25^{ab}	26.24^a
T_2 (Sivanto Energy EC 85)	(1100ml)	7 7.56^a	44.39^{ab}	25.67^a
T_3	(1200ml)	7.29^a	46.45^a	26.28^a
T_4	(1000gm)	7.46^a	43.65^b	27.21^a
T_5 (Titan 25 WDG)	(1250gm)	7.55^a	42.69^b	26.35^a
T_6	(1500gm)	7.39^a	43.67^b	26.87^a
T_7 (Diazinon 60 E.C)	(1000ml)	7.56^a	45.93^a	26.22^a
T_8 (Control)		7.38^a	40.2^c	25.69^a
LSD at 0.05		1.22	1.24	2.57
CV (%)		8.87	6.28	18.27
SE ±		0.36	0.67	0.18

Conclusion and Recommendation

The experimental results indicated in both locations that the percent mortality rate of the newly introduced insecticide (Sivanto Energy EC 85) was comparable and effective to the standard check (Diazinon 60 E.C) in controlling onion thrips, *Thrips tabaci* (L.) population. Therefore, based on this study it was recommended that Sivanto Energy EC 85 at rate of 1200ml/ha are used as a control option of *Thrips tabaci* on field conditions.

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