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Evaluation of different insecticides against onion thrips, *Thrips tabaci* (Thysanoptera: Thripidae) in two selected districts of West Shoa Zone, Oromia Regional State, Ethiopia

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Abstract
Onion Thrips, *Thrips tabaci* (Thysanoptera: Thripidae), is the major pest of onion crops causing losses to the farmers and its control has been an issue of significance in the pest control strategies. The objective of this study was to evaluate different commercial chemical insecticides in farmer's fields. Based on the laboratory results the toxic effect was evaluated in the field after one 1day and 3 days of the application of insecticides. The highest mortalities were recorded by Profenofos 720 EC (90.33-99.67%), the mixture of Profenofos 720 EC + Deltamethrin (93.47-99.67%), and Profenofos 720 EC + Emamectin benzoate (93.13-99.67% in the first season in both locations after 1 to 3 days of treatment exposure) while in the second season in both locations the percent mortalities were slightly declining as compared to the first season. Similarly, Yield loss due to onion thrips recorded 2.47 to 22.09% recorded in the second season. Based on these results it was recommended that Profenofos 720 EC alone and the mixture of other chemical insecticides (Deltamethrin and Emamectin benzoate) be effective for the management of onion thrips under field conditions. The study revealed that the mentioned insecticides were highly effective in minimizing onion thrips population and insecticide mixtures were effective in reducing onion thrips density. The study emphasizes the use of such insecticide mixture to develop a better management strategy for onion thrips populations attacking onion plants. However, the effects of such insecticide mixture on other organisms and biological control agents should be checked in a similar manner.

Keywords: efficacy, insecticides, mortality, onion, *Thrips tabaci*, yield

Introduction
Onion (*Allium cepa* L.) is an important vegetable produced across a wide range of latitudes in the world. Allium crops are the most indispensable vegetable crops used as condiments in most Ethiopian cuisine. Among them, onion (*Allium cepa* L.) is one of the oldest known and important bulbous vegetable crops are grown in Ethiopia. It is used in the preparation of different foods and in therapeutic medicine in the country. It has a great potential to produce every year for both local consumption and export with an average yield of 9.279 tons per hectare (CSA, 2018) [6].

Ambo and Toke Kutaye districts, West Shawa Zone, Oromia Regional State, Ethiopia has a high potential for onion cultivation due to the availability of ample irrigated farmlands and the presence of relatively better market access as compared to other districts of West Showa Zone. Currently, farmers in the study areas are growing the varieties of Adama red and Bombe red. However, both varieties are susceptible to onion thrips but are high-yielders.

In many areas of the country, the offseason crop (under irrigation) constitutes much of the area under onion production. Despite areas increasing, the productivity of onions is much lower than in other African countries. The low productivity could be attributed to poor insect pest and disease management and other problems.

Onion Thrips, *Thrips tabaci* (Thysanoptera: Thripidae), has been one of the most economically important devastating sap-sucking pests of onion crops. Infestation of onion thrips results in silvering leaves and stunting growth of onion. In Ethiopia, particularly in West Shoa yearly damages caused by onion thrips and its control are very high as compared to other regions of the country. It is a key insect pest of onion (Alston and Drost, 2008) [2]. They have been recorded on more than 300 species of plants (Straub and Emmett, 1992) [16]. Foliar insecticides should be applied to insufficient water, and with a spray, additive to achieve penetration into the plant. Insecticide resistance is a primary concern, severely limiting the choice of insecticides. In Ethiopia, it is an important insect pest that affects 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 (Abate, 1985). Onion fields can be destroyed by onion thrips, especially in dry seasons, and are the major problem for onion crops in West Shao of Ethiopia. Shiberu *et al*. (2013) [15] reported that onion bulb yield losses of 36.44%, recorded in West Shao of Ethiopia.

Different commercial insecticides were evaluated against onion thrips different parts of the world and have been found effective in minimizing insect pest populations when applied at various concentrations (Anonymous. 1996; Sanon *et al.,* 2002) [3, 14]. The new chemistry insecticides are specific for particular insects. Thus, to maximize crop productivity with more than one pest situation, more than one insecticide in mixtures should be used. Such mixtures can delay the development of insecticide resistance in insect pests and in this way can deal with a resistant population of some insect pests (Desneux *et al.,* 2004) [7]. The concentration of insecticides and application methods have been a concern in the control strategies of onion thrips, thus requiring regular experiments for the evaluation of conventional and novel insecticides with the approach of being less hazardous against non-target organisms and environmentally friendly.

The present study was accomplished in an effort to sketch out the best insecticide and most effective concentration for controlling onion thrips. They were used alone and in the form of mixture against onion thrips. The study was conducted in the laboratory and field conditions to determine the effect of insecticides on the management of onion thrips.

Materials and Methods

The experiment was carried out to evaluate the insecticidal activity of different new commercial insecticides. The preliminary screening of selected pesticides was carried out to find out the efficacy of the control of onion thrips for the first season. Thus, three different concentrations were prepared for all the treatments, and efficacy was verified on these concentrations. The efficacy of three insecticides in three different concentrations was determined against onion thrips under field conditions.

Study Areas and Experimental Design

The study was conducted from January 2021 to June 2021 and October 2021 to March 2022 for two consecutive seasons at two potential areas of Ambo and Toke kutaye Districts of West Shoa Zone Oromia Regional State, Ethiopian. Ambo is a geographical coordinate of 858'59.988"N latitude and 3751'0.000"E longitude with an altitude of 2076 meters above sea level (Briggs, 2012). Toke Kutaye district is located 126 km west of Addis Ababa having an altitude of 1990 meters above sea level, a latitude of 0859' 01.100" N, and a longitude of 3746'27.600"E. The experimental design was a Completely Randomized Block Design (CRBD) with ten treatments and four replications (Table 1).

Table 1: List of treatments of concentrations against onion thrips in laboratory

Trade name	Common name	Conc. (%) (V/V)	Rate (ml/ha)
Profen 72% EC	Profenofos 720 EC	0.015	750
		0.010	800
		0.020	900
Delta 2.5% EC	Deltamethrin	0.0038	125
		0.0025	150
		0.0058	175
Prove 1.9 E.C	Emamectin benzoate	0.0025	250.0
		0.005	500.0
		0.0075	750.0
		0.0075	437.5
	Profenofos 720 EC+ Deltamethrin	0.0069	475.0
		0.0088	537.5
	Profenofos 720 EC+ Emamectin benzoate	0.0063	500.0
		0.0104	650.0
		0.0138	825.0
	Emamectin benzoate+ Deltamethrin	0.0032	187.5
		0.0038	325.5
		0.0067	462.5
	Untreated control	0.00	

Preparation of Concentrations

The required volume of each insecticide was obtained by putting the required quantity of formulation in the beaker and adding water to make the volume 1 liter. This procedure was repeated for all the insecticides to make concentrations of all insecticides. Six different insecticide mixtures were prepared by selecting one insecticide as standard and mixing it with the other insecticides in 1:1 (Khan *et al.,* 2012) [11]. Different concentrations of insecticides were prepared by using the following method (Pal and Gupta, 1994) [2].

$$\text{Volume of insecticide (ml)} = \frac{\text{Total volume (L)} \times \text{Percentage of insecticide required (\%)}}{\text{Formulation of insecticide}}$$

Laboratory Evaluation

The infested onion plants were collected from the unsprayed field for laboratory bioassay and brought to the plant science laboratory, college of Agriculture, Guder Mamo Mezemir Campus, Ambo University of Ethiopia. The experiment was conducted for 48 h under laboratory conditions at room temperature of 22 - 25°C. A number of Nymph and adults were inserted in an open jar with having 10 cm diameter within the whole plants and provided with coated cotton moist that is kept as fresh leaves of onion that were collected from the field.

All chemical insecticides were prepared in three doses according to company recommendation one step dawn and one step up from the prepared concentration as follows: Profenofos 720 EC, Emamectin benzoate, Deltamethrin, and the mixture of Profenofos 720 EC+ Deltamethrin, Profenofos 720 EC+ Emamectin benzoate, and Emamectin benzoate+ Deltamethrin were sprayed on *onion thrips nymph and adults in each* jar micropipette. After 24 and 48 h of exposure, the mortality rates at different concentrations were counted. The bioassay studies were conducted based on the procedure described by Khan *et al*. (2012) [11] with some modifications.

Field Evaluation

Experimental design and data collections

The seed of 'Bombay' cultivar was planted on September first week in the nursery site. The plants were transplanted into the experimental fields after two months. The experiment was laid in a randomized completely block design (RCBD) with three replications. Hence, plants were infested under natural conditions. The onion thrips were monitored every week when reaching the economic threshold level of 5 thrips/plant. After reaching the economic thresh hold level pre-spray ray counts were performed in each plot then the plants were sprayed with chemical insecticides at a recommended rate from laboratory studies. Mortality data was recorded after treatment application on 1st and 3rd days of treatment exposure.

Table 2: List of Field treatments

Trade name	Common name	Rate (ml/ha)
Profen 72% EC	Profenofos 720 EC	800.0
Prove 1.9 E.C	Emamectin benzoate	500.0
Delta 2.5% EC	Deltamethrin	175.0
	Profenofos 720 EC + Deltamethrin	475.5
	Profenofos 720 EC + Emamectin benzoate	650.0
	Emamectin benzoate + Deltamethrin	462.5
	Untreated control	0.00

Data Analysis

The data on mortality (Onion thrips not moving when touched with a fine brush were considered dead) was recorded after 24 and 48h of application. Such individuals were also exposed to sunlight to confirm their death if not responding to the heat exposure. Yield data were subjected to statistical analysis using a T-test from which percentage yield loss was estimated. The obtained all data were analyzed by using analysis of variance (ANOVA) and the means were compared by using the Least Significant Difference (LSD) T-test (Han *et al*., 2010) [9].

Result and Discussions

Results

Laboratory Evaluation

The laboratory evaluation showed that Profenofos 720 EC. The mixture of Profenofos 720 EC + Deltamethrin, and Profenofos 720 EC + Emamectin benzoate caused the highest adult and nymph mortality in both locations (96.13±2.03; 98.25±1.85), (96.13±2.03; 98.25±1.85), and (99.58±1.67; 99.33±0.98) at maximum concentration, respectively, whereas Emamectin benzoate, Deltamethrin, and the mixture of both caused least percent mortality. data on percent mortality revealed that adult and nymphal sensitivity to Profenofos 720 EC + Deltamethrin, and Profenofos 720 EC + Emamectin benzoate were the highest followed by Emamectin benzoate, Deltamethrin, and the mixture of both. Even though the toxicity level of Profenofos 720 EC + Deltamethrin, and Profenofos 720 EC + Emamectin benzoate insecticides were in the safe range, the results revealed that the percent mortality of Profenofos 720 EC and its mixture was significantly higher ($P<0.05$) than that of Emamectin benzoate, Deltamethrin, and their mixture (Table 3).

Table 3: Percentage mortality of *Thrips tabaci* after treatment exposure and its toxicity during 2021 under Laboratory

Treatment	Conc. (%) V/V	Rate (ml)/ha	Time of Exposure	
			24 h	48 h
Profenofos 720 EC	0.015	750	92.95 ± 2.34^{ab}	91.58 ± 1.39^{b}
	0.010	800	93.58 ± 1.67^{ab}	94.33 ± 0.98^{b}

	0.020	900	96.13±2.03[a]	98.25±1.85[a]
Deltamethrin	0.0038	125	83.20±2.75[c]	82.33±1.36[d]
	0.0025	150	86.17±1.25[c]	88.35±1.69[bc]
	0.0058	175	88.27±2.69[bc]	91.33±1.56[b]
Emamectin benzoate	0.0025	250	75.39±3.01[d]	73.75±1.94[e]
	0.005	500	77.33±2.86[d]	80.25±2.08[d]
	0.0075	750	82.75±2.63[c]	83.67±2.11[cd]
Profenofos 720 EC + Deltamethrin	0.0075	437.5	89.35±1.78[b]	93.67±0.87[ab]
	0.0069	475.0	93.58±1.67[bc]	94.33±0.98[b]
	0.0088	537.5	96.13±2.03[a]	98.25±1.85[a]
Profenofos 720 EC + Emamectin benzoate	0.0063	500	93.20±2.75[ab]	92.33±1.36[b]
	0.0104	650	96.17±1.25[a]	98.35±1.69[a]
	0.0138	825	99.58±1.67[a]	99.33±0.98[a]
Emamectin benzoate + Deltamethrin	0.0032	187.5	86.13±2.03[bc]	88.25±1.85[bc]
	0.0038	325.5	83.20±2.75[c]	82.33±1.36[cd]
	0.0067	462.5	86.17±1.25[b]	88.35±1.69[bc]
Untreated control			0.00[e]	0.00[f]
LSD at 0.05			4.26	3.97
CV (%)			18.37	17.64
SE ±			5.43	4.86

Note: Means with the same letter(s) in the same columns are not significantly different for each other. All treatment effects were significant at P<0.05 (LSD)

Field infestation

Mean weekly onion thrips infestation count/plant after treatment application of the first week in treatments for the first to 8th weeks varied between 0 to 63.25 in the first season while 0 to 53.12 in the second season at Ambo. Similarly, 0 to 62.67 and 0 to 67.67 onion thrips were observed in the first and second seasons in Toke kutaye district, respectively (Figure 1a, b, c, d). The maximum infestation number was observed in untreated control in all locations followed by the mixture of Emamectin benzoate + Deltamethrin.

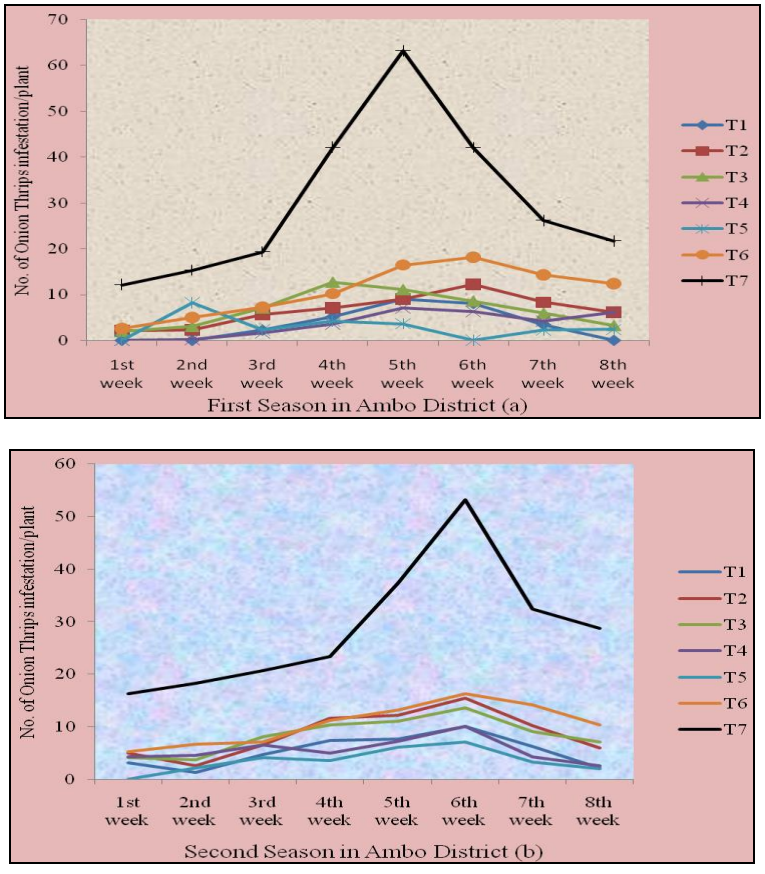

Fig 1: a and b: Effect of insecticides on infestation level of onion thrips in Ambo District during 2021/22

Note: T1= Profenofos 720 EC, T2= Emamectin benzoate T3= Deltamethrin T4= Profenofos 720 EC + Deltamethrin T5= Profenofos 720 EC + Emamectin benzoate T6= Emamectin benzoate + Deltamethrin T7= Untreated control

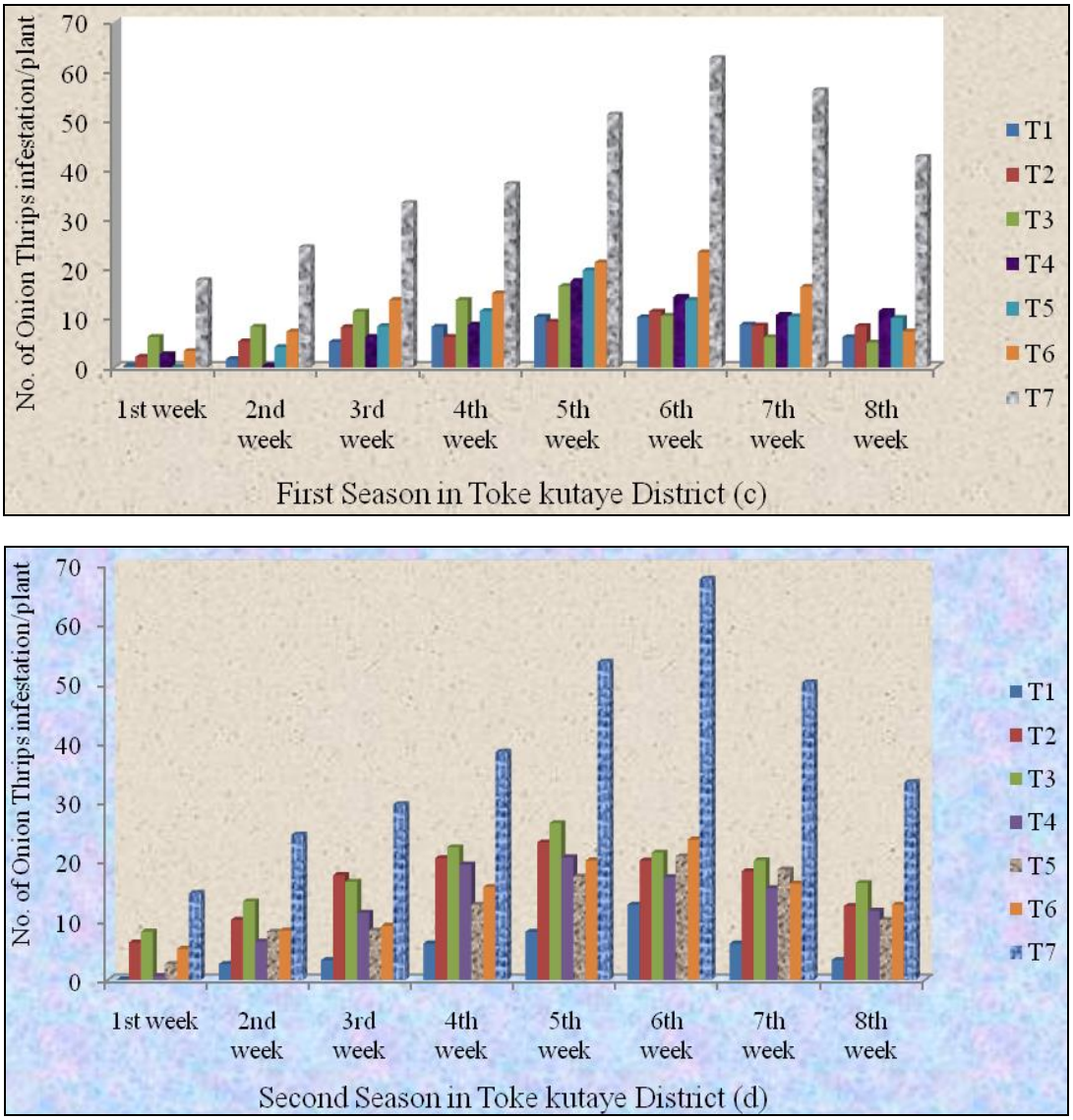

Fig 1: c and d: Effect of insecticides on infestation level of onion thrips in Toke kutaye District during 2021/22

Note: T1= Profenofos 720 EC, T2= Emamectin benzoate T3= Deltamethrin T4= Profenofos 720 EC + Deltamethrin T5= Profenofos 720 EC + Emamectin benzoate T6= Emamectin benzoate + Deltamethrin T7= Untreated control

First Season Application

Insecticide treatments had a significant effect on onion thrips infestation and damage in the first season. All variable measures were significantly ($P<0.05$) influenced by season and time. Data on mortality of onion thrips infestation is presented in Tables 4 and 5. At both locations and first season, and 1st and 3rd days of application significantly higher percent mortality were observed in the first season from Profenofos 720 EC alone, the mixture of Profenofos 720 EC with Deltamethrin, and Profenofos 720 EC with Emamectin benzoate, [(90.33±1.36, 94.64±1.08; 97.25±1.67, 99.67±0.89), (93.47±1.89, 95.13±1.69; 98.25±1.67, 99.67±0.8), and (93.13±1.58, 96.00±0.67; 97.60±1.57, 99.13±0.78)], respectively. In Contrast, at both locations and the second season, the percent mortalities declined (Table 4). There were significant differences between the results of percent mortality of onion thrips in different seasons and times. The lowest mortality [(79.13±1.58, 83.87±0.67; 80.67±1.57, 85.13±0.78)] was observed with the mixture of Emamectin benzoate with Deltamethrin followed by Emamectin benzoate alone and Deltamethrin alone (Table 4). All the treatments showed significant differences with respect to control, as no mortality was observed in the control treatment.

Field Evaluation of Second Season Application

A similar trend was observed in the results shown after 1st and 3rd days of spray, in the case of The treatments Emamectin benzoate and Deltamethrin, when applied mixed with Profenofos 720 EC they caused higher mortality than their single application (Tables 4 and 5). The descending order for the percent mortality of other treatments in causing mortality was Profenofos 720 EC > Profenofos 720 EC + Deltamethrin > Profenofos 720 EC + Emamectin benzoate > Deltamethrin > Emamectin benzoate against onion thrips at laboratory recommended rate after application of 3 days.

In the second season, among insecticide mixtures, the highest mortality (89.77±1.52 and 89.33±1.45) was shown by Profenofos 720 EC + Deltamethrin and Profenofos 720 EC + Emamectin benzoate. However, all the insecticide mixtures showed significant differences from each other (Table 5).

Table 4: Analysis of variance of different parameters on onion plant 'Bombay' variety for insecticide percentage efficacy at two locations in the first season during 2021/22

Treatment	Rate (ml)/ha	1st season			
		Percent Mortality after 1 day of treatment exposure		Percent Mortality after 3 days of treatment exposure	
		Ambo	Toke Kutaye	Ambo	Toke Kutaye
Profenofos 720 EC	800.0	90.33±1.36^{a}	94.64±1.08^{b}	97.25±1.67^{a}	99.67±0.89^{a}
Emamectin benzoate	500.0	79.55±1.88^{b}	81.13±1.58^{c}	84.45±1.58^{b}	91.67±1.87^{bc}
Deltamethrin	175.0	81.67±1.57^{b}	88.13±0.78^{b}	88.81±1.87^{b}	89.25±0.97^{bc}
Profenofos 720 EC + Deltamethrin	475.5	93.47±1.89^{a}	95.13±1.69^{a}	98.25±1.67^{a}	99.67±0.89^{a}
Profenofos 720 EC + Emamectin benzoate	650.0	93.13±1.58^{a}	96.00±0.67^{a}	97.60±1.57^{a}	99.13±0.78^{a}
Emamectin benzoate + Deltamethrin	462.5	79.13±1.58^{b}	83.87±0.67^{c}	80.67±1.57^{c}	85.13±0.78^{c}
Untreated control	0.00	0.00 ±00^{c}	0.00±00^{d}	0.00±00^{c}	0.00±00^{c}
LSD at 0.05		5.37	6.81	7.05	5.57
CV (%)		22.18	19.58	20.33	17.92
SE ±		3.68	3.55	3.87	3.28

Note: Means with the same letter(s) in the same columns are not significantly different from each other. All treatment effects were significant at P<0.05 (LSD)

Table 5: Analysis of variance of different parameters on onion plant 'Bombay' variety for insecticide percentage efficacy at two locations in second season during 2021/22

Treatment	Rate (ml)/ha	2nd season			
		Percent Mortality after 1-day treatment exposure		Percent Mortality after 3 days treatment exposure	
		Ambo	Toke Kutaye	Ambo	Toke Kutaye
Profenofos 720 EC	800.0	87.28±1.51^{a}	86.52±1.08^{a}	90.25±1.49^{a}	90.67±1.36^{a}
Emamectin benzoate	500.0	76.32±1.29^{b}	73.66±1.58^{c}	80.45±1.62^{b}	80.84±1.91^{b}
Deltamethrin	175.0	78.67±1.38^{b}	80.45±1.62^{b}	83.81±1.72^{b}	81.29±1.28^{b}
Profenofos 720 EC + Deltamethrin	475.5	90.47±1.49^{a}	87.57±1.63^{a}	90.25±1.49^{a}	89.77±1.52^{a}
Profenofos 720 EC + Emamectin benzoate	650.0	90.13±1.53^{a}	88.00±1.17^{a}	89.60±1.39^{a}	89.33±1.45^{a}
Emamectin benzoate + Deltamethrin	462.5	76.13±1.51^{b}	83.87±0.67^{b}	80.67±1.61^{b}	83.60±1.338^{b}
Untreated control	0.00	0.00 ±00^{c}	0.00±00^{d}	0.00±00^{c}	0.00±00^{c}
LSD at 0.05		6.42	5.11	5.25	5.78
CV (%)		21.08	17.91	20.57	19.18
SE ±		3.59	3.81	3.67	3.49

Note: Means with the same letter(s) in the same columns are not significantly different from each other. All treatment effects were significant at P<0.05 (LSD)

There was significant and positive relationship estimated linear relationship between mean percent efficacy, between season-1, season-2, and time of exposure at both locations (Figure 2 and Table 6). But highly significant and positive correlation (r^2=0.366, 0.406, 0.364 and, 0.388) in season-1 1DATE, season-1 2DATE, season-2 1DATE, and season-2 2DATE, respectively. From linear analysis of percent mortality with time indicated that all treatments except untreated control showed that when the time of exposure extended to 3 days the percent mortality slightly positively correlated to each other (Figure 2 and Table 6).

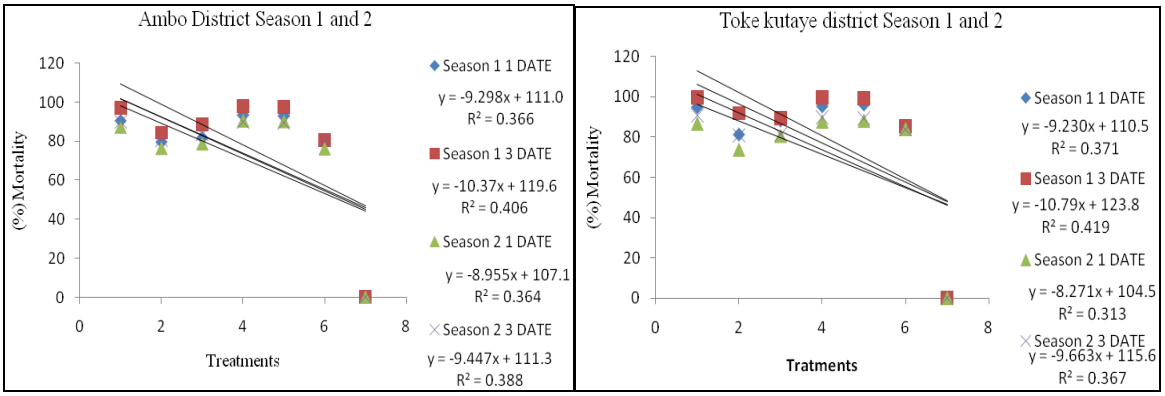

Fig 2: Estimated linear relationship between mean percent efficacy, between Season-1, season-2, and time of exposure (1 and 3 Day ATE).

Note: ATE= After Treatment Exposure

Table 6: Regression Analysis and R^2 percent mortality with time

Season 1	Ambo District		Toke kutaye District	
	R^2	Linear Regression	R^2	Regression
1 day ATE	0.406	Y= -10.37x+119.6	0.367	Y= -9.663x+115.6
3 days ATE	0.366	Y= -9.298x+111.0	0.419	Y= -10.79x+123.8
Season 2				
1 day ATE	0.364	Y=-8.955x+107.1	0.313	Y= -8.270x+104.5
3 days ATE	0.388	Y= -9.447x+111.3	0.371	Y= -9.230x+110.5

Note: ATE= After Treatment Exposure

Effect of Insecticides against Onon thrips on Yield of Onion

The low yield in both locations was recorded from the untreated control treatment (Table 7). High yield was recorded from Profenofos 720 EC and the mixture of Profenofos 720 EC + Deltamethrin in the first season in the Toke Kutaye district (29.92 t/ha) followed by Deltamethrin (29.18 t/ha)in the first season in Ambo district. Of the two seasons onion thrips were observed in this experiment it was the onion thrip's infestation responsible for the observed yield difference between the seasons; the relationship between thrips infestation and yield level was strongly negative and significant in both seasons. While the relationship between yield and locations was not significant in both two seasons. The yield loss level was observed by comparing the untreated control with the best treatment.

Table 7: Effect of insecticides against onion thrips on yield of onion in (ton/ha) during 2021/22

Treatments	Rate (ml)/ha	1st season		2nd season	
		Ambo	Toke Kutaye	Ambo	Toke Kutaye
Profenofos 720 EC	800.0	28.36^{a}	29.18^{a}	26.55^{a}	27.43^{a}
Emamectin benzoate	500.0	27.85^{a}	26.87^{bc}	25.64^{b}	26.25^{a}
Deltamethrin	175.0	28.59^{a}	27.66^{b}	27.17^{a}	25.83^{a}
Profenofos 720 EC + Deltamethrin	475.5	29.92^{a}	28.47^{a}	27.02^{a}	25.59^{a}
Profenofos 720 EC + Emamectin benzoate	650.0	28.14^{a}	27.94^{b}	25.68^{b}	26.05^{a}
Emamectin benzoate + Deltamethrin	462.5	26.58^{b}	26.97^{b}	24.71^{bc}	25.14^{a}
Untreated control	0.00	24.84^{c}	25.33^{c}	23.85^{c}	23.31^{b}
LSD at 0.05		1.40	1.55	1.58	1.67
CV (%)		17.67	15.33	19.51	16.55
SE ±		0.38	0.42	0.39	0.50

Note: Means with the same letter(s) in the same columns are not significantly different from each other. All treatment effects were significant at P<0.05 (LSD)

Yield Loss Estimation

Infestation number of onion thrips varied from 0 to 18.67with an average of 9.34 per plant in protected treatments. On the other hand, it varied from 12.25 to 67.67 with an average of 39.96 per plant in unprotected treatments. The average increase of infestation of plants, overprotected treatments, in unprotected plots was computed to be 23.38 percent.

The reduction in onion bulb weight per hectare because of onion thrips in untreated treatments is significantly ($P < 0.05$) different from treated treatments. Onion bulb yield loss was estimated to be about 22.09 percent (Figure 3). This indicated that the direct effect of insects on the leaf resulting from feeding on the leaf causes the

reduction of bulb weight which is important as evident from significant differences between percent yields loss in protected and unprotected treatments. Thus, the onion thrips attack the leaf of the onion during the vegetative stage of the crop reduced the size of onion bulbs. Therefore, effective control methods should be implemented during the vegetative stage of the crop for better economic return.

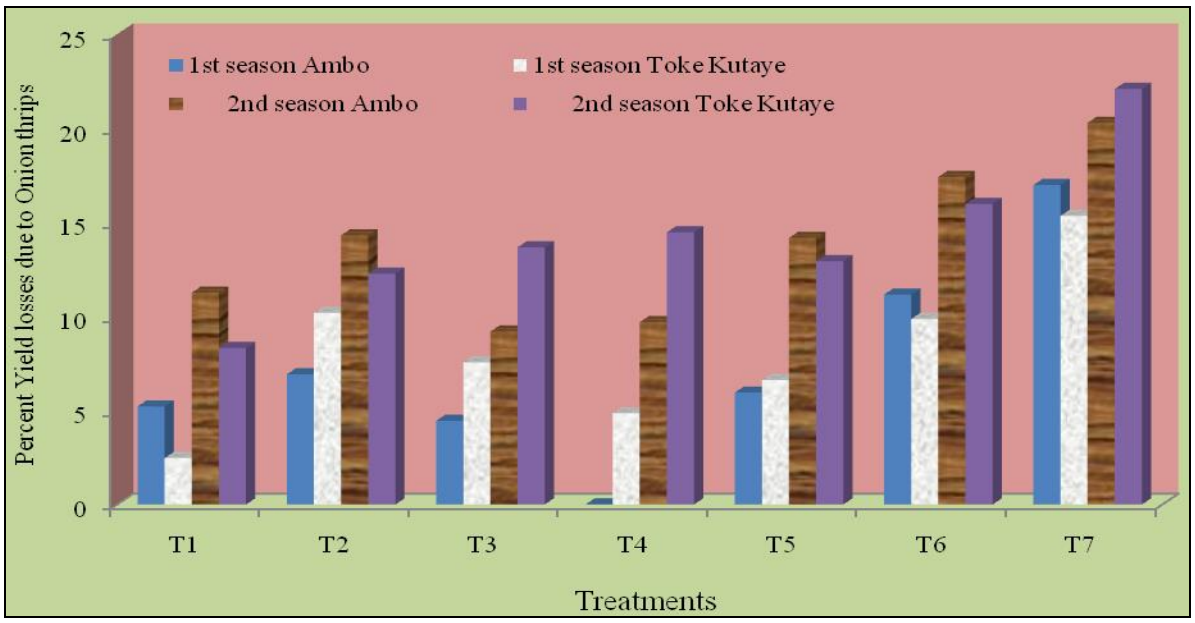

Fig 3: Effect of insecticides against onion thrips on yield losses of onion during 2021/22

Note: T1= Profenofos 720 EC, T2= Emamectin benzoate T3= Deltamethrin T4= Profenofos 720 EC + Deltamethrin T5= Profenofos 720 EC + Emamectin benzoate T6= Emamectin benzoate + Deltamethrin T7= Untreated control

Discussions

The results of the experiments were showed that insecticides reduced the infestation of onion thrips and increased the yield of onion by competing with untreated control. The Profen 72% EC (Profenofos 720 EC), Prove 1.9 EC (Emamectin benzoate), and Delta 2.5% EC (Deltamethrin) more effect on control of onion thrips. The higher reduction effect of the onion thrips could be attributed to a similar reduction on number of damage of onion crops.

According to Gashawbeza and Ferdu (2019) many chemical insecticides from different chemical classes have been selected for registration and use against the onion thrips in recent years in Ethiopia. Nowadays profenofos insecticide found in the market with different trade names such as Selecron, Danefos, Girgit plus, and Golbe has been used (Gashawbeza and Ferdu, 2019). Bekele *et al*. (2018) reported failure of profenofos has been reported in several onion fields. In contrast of this report, some newly registered insecticides were evaluated for their efficacy against onion thrips alone and mixed together namely Profen 72% EC (Profenofos 720 EC), Prove 1.9 EC (Emamectin benzoate), and Delta 2.5% EC (Deltamethrin). Among the evaluated insecticides Profen 72% EC alone and mixed with Prove 1.9 EC, and Delta 2.5% EC were effective insecticides for the management of onion thrips under field conditions. Pathak *et al*. (2018) also reported that Profenofos 720 EC reduced the thrips infestation severity and increased the onion bulb yield, this work was support the present findings of our work. Similarly, Indu (2015) reported that Deltamethrin may also be used for controlling onion thrips under field conditions.

Conclusion and Recommendation

The study revealed that the infestation of the onion crops by onion thrips is significantly different between treated and untreated treatments during both seasons. The result on mortality of onion thrips indicated effectiveness of different insecticides and their mixtures in decreasing the onion thrips population. Profenofos 720 E.C the mixture of Profenofos 720 E.C + Deltamethrin, and Profenofos 720 E.C + Emamectin benzoate in the first season in both locations after 1 to 3 days of treatment exposure while in the second season in both locations the percent mortalities were slightly declining as compared to the first season.

In general, insecticides showed increasing trend in the mortality with increased concentrations. The present study suggests that Profenofos 720 E.C the mixture of Profenofos 720 E.C + Deltamethrin, and Profenofos 720 E.C + Emamectin benzoate are effective pesticides against onion thrips in field conditions and can act as better tools in onion thrips management for better economic return. The studies also give emphasis to checking the side effect on non-target insects, and residual toxicity of these insecticide mixtures under field conditions. A mixture different insecticides of control methods delineated above should not only assist in reducing damage caused by

onion thrips, but can minimize the infestation level of onion thrips and mitigate the development of pesticide resistance.

Conflict of Interest

The author declares that he has no conflict of interest

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