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Role of Intercropping on Predatory Thrips (*Aeolothrips* Spp.) for the Management of Onion Thrips (*Thrips tabaci* Lind) in Central Zone of Tigray, Ethiopia

Gebretsadkan Zereabruk[1*], Mulatu Wakgari[2] and Gashawbeza Ayalew[3]
[1]Tigray Agricultural Research Institute, Axum Research center, Ethiopia. E-mail: gebretsadkanz2007@gmail.com,
[2]College of Agriculture and Environmental Sciences, Haramaya University, Ethiopia. E-mail: mulatuwakgari@yahoo.com.
[3]Melkassa Research Center, Ethiopian Institute of Agricultural Research (EIAR). E-mail: gashawbeza@yahoo.com.

Abstract

Onion thrips, Thrips tabaci (Thysanoptera: Thripidae), is a major insect pest constraining onion production in Central Zone of Tigray Region, Ethiopia. Onion growers in this central zone rely on synthetic insecticides for the management of thrips; there was no other recommended onion trips management option for the area so far. Therefore, a field experiment was conducted in Axum Agricultural Research Center, Ethiopia from November 2015 to April 2016 to encourage the number of banded thrips (Aeolothrips sp) using intercropping and to determine their effects on onion thrips management. The experiment was laid out in a Randomized Complete Block Design (RCBD) with split plot arrangement and replicated three times. Onion cultivars Bombay Red and Nasik Red were used as main plot treatments and intercropping onion with three other vegetable crops viz. cabbage, carrot, lettuce and their combinations, as sub-plot treatments. Onion treated with the insecticide Lambda-cyhalothrin (Karate) 5%EC and untreated control was included as standard and control checks. The number of predatory thrips (Aeolothrips spp) were significantly higher in onion intercropped with cabbage (10.97) and cabbage + carrot (10.73) banded thrips per plant ,respectively, at 90 days after treatment and were absent in the insecticide treated plots. As a result, the number of onion thrips was significantly lower in these treatments and higher in onion treated with Lambda-cyhalothrin. The results showed that the resurgence of thrips pest as the insecticide had more adverse effect on the predator than the prey. Thus, encouraging natural enemies especially banded thrips is an important option of biological control of onion thrips in onion production in central zone of Tigray, Ethiopia.

Keywords: Onion thrips, banded thrips, intercropping, management

Introduction

Onion thrips (*Thrips tabaci* Lind.) is a phytophagous and most economically important pest of onion worldwide (Trdan, 2005). Onion thrips consumed mesophyll cells, which eventually results in a loss of chlorophyll and reduced photosynthetic efficiency (Boateng *et al*., 2014).

Onion thrips is not managed properly, then it may cause losses from 6 to 63% in weight depending upon genotype antibiotic characteristics with an average of 31% loss in weight (Haidar *et al*., 2014) Thrips feeding can reduce bulb yields by 30-50% and losses can be exacerbated, if thrips infect the crop with Iris yellow spot virus (IYSV) or create damage that permits other pathogens to infect the crop (Brain, 2006). 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).

Onion thrips are the most serious pest, causing considerable yield loss on onion production in central Tigray. Onion producers apply insecticides repeatedly to manage onion thrips. However, the repeated and unwise application of insecticides might have led to resistance development, resurgences of pest and reduced the natural enemies of thrips. Onion thrips management is exceedingly difficult because of the shape of onion leaves since thrips feed hidden between leaves near the base of the plants and hard to reach them with insecticides (Mau and Kessing, 1991). In addition, *Thrips tabaci* is a very prolific species with many overlapping generations (Nault and Shelton, 2010). Different studies showed that biological control methods of thrips were found effective in reducing or delaying population of thrips on onion. Fok *et al*. (2014) reported use of natural enemies, such as predatory thrips, minute pirate bugs, mites and certain parasitic wasps which were effective to manage plant feeding thrips. Adults and larvae of banded thrips, *Aeolothrips intermedius* were found as predator of 44 species of Thysanoptera order (Riudavets, 1995). In Europe, it has mentioned as a predator on *Thrips tabaci* (Bournier *et al*., 1979). Fathi et al. (2008) indicated that the combined use of *Orius niger* and *A. intermedius* in high population density of onion thrips can be applied successfully in integrated pest management. Hossain *et al*. (2015) reported that intercropping onion with carrot and tomato significantly reduced thrips population by up to 52.42 and 48.84%, respectively. Intercropping of spider plant (*Chlorophytum comosum*) and carrot significantly reduced thrips population on three onion varieties (Bombay Red, Red Creole and Orient F1), with the spider plant resulting in the highest reduction up to 45.2% (Gachu et al., 2012). The effects of these biological and cultural methods of management were not practiced in this study area and growers rely only on chemical insecticides for the management of thrips. Hence, the current study was carried out to assess the number of banded thrips (*Aeolothrips* spp.) using intercropping and to determine their effects on onion thrips management.

Materials and Methods

The experiment was conducted in Axum Agricultural Research Center (AARC) horticulture division research site which is 5 km east of Axum town. It is located in northern part of the country in Central Zone of Tigray Region in the semiarid tropical belt of Ethiopia. It lies at latitude of

14°07'86.9"N and longitude of 038°46'08.3"E with an altitude of 2101 m. a. s. l. It is characterized by low and erratic rainfall with an average annual rainfall of 750 mm. The rainy season is mono modal concentrated in one season from July to September. The long term mean maximum and minimum temperature ranges from 24.4 (May) to 31.4 °c (June) and from 13.2 (July) to 8.7 °c (December), respectively. The soil type is classified as vertisol with a characteristic feature of clay soil type, PH 7.5 to 8.3 (AARC, 2012).

The experiment was laid out in a Randomized Complete Block Design (RCBD) with split plot arrangement, replicated three times. Onion (*Allium cepa* L) varieties Bombay Red and Nasik Red were used as main plot treatments. Intercropping onion with cabbage (*Brassica oleracea* L), carrot (*Daucus carota* L), lettuce (*Lactuca sativa* L) and a combination of them (cabbage + carrot, cabbage + lettuce, carrot + lettuce) along with onion treated with the insecticide, Lambda-cyhalothrin (Karate) 5% EC @ of 1l ha^{-1} and untreated control as checks were used as subplots. The plot size was 4.3 m x 2 m, spacing between the main plots and the sub-plots were 2 and 1 m, respectively. Spacing between the furrows and ridges were 40 and 20 cm, respectively, between plants 10, 40 and 20 cm for onion, cabbage and lettuce, respectively. Carrot was sown directly by drilling on the corresponding rows in the experimental field. Each plot had 20 rows. Onion was planted in 20 rows, in the sole onion plots and in 10 alternative rows, in the intercropped plots. One side of the ridge was planted with onion and the other with the intercropped species. The field was ploughed using oxen and harrowed manually to bring the soil to fine particles (clay) and then the seedlings were transplanted to well prepared and irrigated experimental field. It was furrows irrigated twice a week in the first four weeks and weekly thereafter. Fertilizer, Diammonium Phosphate (DAP) was applied during transplanting @ 100 kg ha^{-1} (18% N: 46% P_2O_5).

Urea was applied @ 100 kg ha^{-1} (46% N ha^{-1}) in split applications at transplanting and a month after transplanting (EARO, 2004). Cultivation, weeding and all other agronomic practices, except chemical application, were performed as per recommended for onion production. Harvesting was done when plants attained physiological maturity.

Data collection

Data on number of banded thrips (*Aeolothrips* sp.) were recorded from ten randomly sampled onion plants in the entire plot at 60, 75, 90 and 115 days after transplanting (DAT). It was done by visual examining each leaf of the tagged onion plants for banded thrips. Number of onion thrips were recorded at 15 days interval starting a week after transplanting and continued until physiological maturity. Both nymphs and adults were counted by examination of the entire plant with the aid of 10x magnifying hand lens. Counting of thrips was made during wind free time of the day normally, early in the morning and late afternoon, where thrips were not moved from plant to plant. Counting was done starting from the lower leaf without disturbing the nymphs by carefully separating each leaf of the stand plant.

Data analysis

Data were subjected to Analysis of Variance (ANOVA) using the PROC-GLM procedure of SAS version 9.1.3 software (SAS, 2005). Differences among treatment means were separated using the Tukeys Studentized range test least significant difference (LSD) at 5% probability level.

Results and Discussion

Thrips population was recorded at 15, 30, 45, 60, 75 and 90 (DAT shown in Table 2). At the early crop stage (15 DAT), there was no significant difference in all treatments with regard to onion thrips density. However, from 30 DAT onwards, onion thrips population was significantly higher in onion insecticide treated plots than the intercropped treatments. The highest population of banded thrips were recorded on onion intercropping crops compared to the insecticide treated and untreated onion crops. Up to 45 DAT there was no predatory thrips recorded in all plots, this could be due to the predator assumes to have enough prey for its consumption. During 60 and 75 DAT, banded thrips density was significantly higher on onion intercropped with cabbage and onion intercropped with cabbage +carrot (Table 1).

Similarly, at 90 DAT the number of *Aeolothrips* spp was significantly ($P < 0.001$) higher on onion intercropped with cabbage and onion intercropped with cabbage + carrot 10.97 and 10.73 *Aeolothrips* per plant, respectively.

However, the number of onion thrips were significantly lower on onion intercropped with cabbage and onion intercropped with cabbage + carrot (68.73 and 59.9 thrips per plant) compared to insecticide treated onion sole plots (205.83 thrips per plant). Onion thrips was reduced by 52.29 and 54.38 % on onion intercropped with cabbage and cabbage +carrot at 75 DAT and by 58.47 and 63.81, 50.51 and 46.1 % on onion intercropped with cabbage, cabbage + carrot, cabbage + lettuce and with carrot + lettuce respectively, compared to the control plots (onion untreated sole cropping) at 90DAT (Table 3).

There was no significant difference ($P > 0.05$) between Nasik Red and Bombay Red onion varieties on both banded thrips and onion thrips population. In onion intercropped with crops, other natural enemies, such as spiders, green lacewing larvae and coccinellid beetles were also observed in a very small amount. This could be an evident for the fact that mixed cropping habitat is likely to encourage natural enemies or thrips predators. Natural enemies, particularly predatory thrips played a significant role in thrips population reduction by eating the eggs and larvae of thrips and disturbing the adult thrips to escape from onions. The effect of predatory on prey, which is one component of pest management, clearly played a significant role in the present findings. Onion leaves with banded thrips had smaller number of onion thrips. In the intercropped treatments up to 1-3 banded thrips per a single leaf of onion was recorded which indicated the reduction of onion thrips in the intercropped treatments compared to the insecticide treated treatments.

Similarly, Ramert and Lennartsson (2002) reported that natural enemies are more effective and numerous in diverse cropping systems, such as intercropping and mixed sowing (planting) of different plant species, cabbage + white clover. *Aeolothrips intermedius*, a predatory thrips, consumes about 25 *Thrips tabaci* larvae during its larval stage (Bournier *et al*., 1979). The present study results revealed with findings of Thorsten *et al*. (2003) predators showed significant differences regarding prey consumption on thrips larvae, where *A. intermedius* consumed daily a mean number of 2.26 larvae, *Franklinothrips vespiformis* consumed 4.71 larvae.

In the present study, there were no natural enemies recorded on the Lambda-cyhalothrin treated onion standard checks at 60, 75, 90 and 115 DAT (Table 1). The mean number of predatory thrips/plant was zero. Accordingly, the highest thrips population was recorded in these treatments.

This could be due to the adverse effects of the insecticide Lambda-cyhalothrin on *Aeolothrips* spp. However, onion thrips developed resistance against the insecticide Lambda-cyhalothrin. The highest number of onion thrips (205 thrips per plant) was recorded on onion treated with insecticide Lambda-cyhalothrin.
The present results revealed with findings by Gulia *et al*. (2014) who reported that the dominant zoophagous species *Aeolothrips intermedius,* was more adversely affected by treatment with Lambda-cyhalothrin confirmed by a decrease in predatory/prey ratio. Similarly, different researchers have reported the impact of insecticides on the natural enemies. Unfortunately, natural insect enemies, i.e, parasitoids and predators were the most susceptible to insecticides and were severely affected (Vickerman, 1988). The destruction of natural enemies was exacerbating pest problems as they play an important role in regulating pest population levels. According to Hammon (2000), the population of natural enemies was lower or none where there were high inputs of insecticides. Use of

persistent and broad spectrum pesticides that kills the beneficial natural enemies was thought to be the leading causes of pest resurgence, which was the rapid reappearance of a pest population in injurious numbers following pesticide application. According to Maclntyre Allen *et al.* (2005), onion thrips were collected from commercial onion fields in different seasons to assess resistance to Lambda-cyhalothrin, deltamethrin and diazinon; the diagnostic dose bioassays showed that 15 of 16 onion thrips populations were resistant to Lambda-cyhalothrin, 8 of 16 were resistant to diazinon and all were resistant to deltamethrin. These results indicated that insecticide resistance could be a wide spread problem in onion thrips.

Table 1. Effect of vegetable intercrops on the presence of banded thrips /*Aeolothrips* spp)

Intercropping /insecticide	Mean number of banded thrips per plant			
	60 DAT	75 DAT	90 DAT	115 DAT
Cabbage	4.42[a]	8.93[a]	10.97[a]	4.7[a]
Carrot + lettuce	3.8[abc]	7.33[b]	8.17[bc]	3.63[bc]
Untreated	3.22[c]	7.58[b]	9.22[b]	3.63[bc]
Lettuce	3.13[c]	7.33[b]	7.33[c]	3.07[c]
Lamda cyhalothrin	0.00[d]	0.00[c]	0.00[d]	0.00[d]
Cabbage + carrot	4.28[ab]	9.43[a]	10.73[a]	4.7[a]
Cabbage + lettuce	3.58[bc]	6.8[b]	7.92[c]	3.30[bc]
Carrot	3.5[bc]	7.17[b]	8.53[bc]	3.87[b]
LSD(P<0.05)	0.83	1.32	1.22	0.69
CV%	12.57	9.49	7.68	10.03
SE	0.19	0.41	0.48	0.21

LSD (5%) = Least significant difference at P ≤ 0.05, CV (%) = Coefficient of variation in percent. SE = Standard error. Means with the same letter(s) within a column are not significantly different at 5% level of significance using Tukeys Studentized Range Test, DAT = Days after transplanting.

Table 2. Effect of vegetable intercrops and banded thrips (Aeolothrips spp) on onion Thrips tabaci population (mean number of thrips per plant)

Intercropping /insecticide	(Days after transplanting)						
	15	30	45	60	75	90	115
Cabbage	11.62a	11.1d	29.45c	60.02e	60.93de	68.73ef	23d
Carrot + lettuce	13.47a	15.25cd	31.27bc	74.57d	67.27de	89.20d	35.60c
Untreated	15.63a	23.18b	46.20b	92.60b	127.73b	165.50b	51.97b
Lettuce	15.07a	17.08bcd	39.48bc	82.45c	94.80c	112.13c	52.37b
Lamda cyhalothrin	14.85a	32.30a	64.07a	122.60a	169.50a	205.83a	80.83a
Cabbage + carrot	11.30a	13.25dc	29.75bc	72.55d	58.27e	59.90f	21.67d
Cabbage + lettuce	12.27a	18.38bc	38.45bc	73.02d	92.43c	81.90de	35.50c
Carrot	14.70a	16.30bcd	34.67bc	77.47dc	80.07dc	118.9c	26.87dc
LSD(p≤0.05)	5.52	7.16	16.71	7.34	21.53	4.34	9.98
CV (%)	19.92	19.14	20.95	4.4	11.26	6.21	11.95
SE	0.52	1.17	1.89	2.73	5.37	7	2.93

LSD (5%) =Least significant difference at P ≤ 0.05, CV (%) = Coefficient of variation in percent. SE = Standard error. Means in columns with the same letter(s) are not significantly different at 5% level of significance using Tukeys Studentized range test.

Table 3. Onion thrips population reduction (%) over control

Intercropping /insecticide	Days after transplanting						
	15	30	45	60	75	90	115
Cabbage	26.65	52.11	36.25	35.18	52.29	58.47	55.74
Carrot + lettuce	13.82	34.21	32.32	19.47	43.33	46.1	31.49
Untreated	-	-	-	-	-	-	-
Lettuce	3.58	26.32	14.54	10.96	25.78	32.25	-
Lamda cyhalothrin	-	-	-	-	-	-	-
Cabbage + carrot	27.7	42.84	35.61	21.65	54.38	63.81	58.3
Cabbage + lettuce	21.49	20.71	16.77	21.14	27.64	50.51	31.69
Carrot	5.95	29.68	24.96	16.33	37.3	28.16	48.29

Conclusions

The present study revealed that the number of banded thrips (*Aeolothrips spp*.) was significantly ($P < 0.001$) higher on onion in the intercropped treatments compared to onion treated with insecticide. However, they were adversely affected by the insecticide *Lambda cyhalothrin* onion cultivated plots. The number of onion thrips on onion was reduced by the combined effect of intercropping and thrips natural enemies. Hence, this study recommends the application of integrated thrips management by enhancing the number of banded thrips using intercropping with selected vegetables.

Conflict of interest

The authors have no any conflict of interest.

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