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Evaluation of Insecticides for the Management of Tef Shoot Fly (*Atherigona* spp.) at Sekota, Ethiopia

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Abstract

The experiment was done for two years on tef shoot fly (*Atherigona spp.*) hot spot areas of Sekota, Ethiopia, with the objective of selecting effective and economically feasible insecticides. Five insecticides were evaluated on DZ-01-99 variety of *Eragrostis tef* in randomized complete block design with three replications. Insecticides were applied twice; seven days after emergence of *E. tef* and 10 days after first application. The result revealed that applications of insecticides were found biologically effective and economically feasible over the unsprayed control. The lowest number of dead heart of 2.82 and 3.09 were recorded on those plots treated with Lambda cyhalothrin and chlorpyrifos-ethyl which gave the highest yield 1267.59 and 1225.77 kg ha^{-1}, respectively. Therefore, we recommended judicious use of chlorpyrifos-ethyl and Lambda cyhalothrin 5% EC at a rate of 1.5 L and 0.4 L ha^{-1}, respectively, for the management of tef shoot fly.

Keywords: *Atherigona* spp; *Eragrostis tef*; Tef; Ethiopia

Introduction

Tef (*Eragrostis tef*, (Zucc.) Trotter) is a C_4, self-pollinating, chasmogamous annual cereal crop that belongs to the family Poaceae and is indigenous to Ethiopia. It is a traditional Ethiopian small cereal crop that is adapted to diverse agro-ecological zones including areas with conditions marginal to the production of the other crops [1,2]. Despite the importance of tef in the livelihood of small-scale farmers, its productivity in the country is faced with a number of constraints, as a result of which annual yields are often low and subject to extreme fluctuations. According to the Central Statistical Authority report [3] the average tef yield was 1400 kg/ha and 1170 kg/ha in Amhara Region and Wag-himra zone with 1.09 million and 0.028 million hectares coverage, respectively.

Factors contributing to low tef yields are drought, low soil fertility, soil erosion, poor crop management practices, insect pests and weeds. Insect pests are among the major factors causing low yield. Shoot fly (*Atherigona* spp.), Wello bush cricket (*Decticoides brevipennis* Ragge) and Red tef worm (*Mentaxya ignicollis* (Walker)) are the most important insect pests of tef [4]. Of the above mentioned insect pests, damage by shoot fly infestation is becoming a serious problem in tef production.

Tef shoot fly (*Atherigona* spp.) attacks tef throughout the crops active growing period. However, the seedling and panicle stage is the most critical [5]. Larvae mine in to stems of the central shoots of tef causes "dead heart" symptoms because of internal feeding caused by shoot fly larvae [6]. It caused 42-58% damage to growing panicles in different varieties of tef, which resulted in an estimated loss of 378-522 kg/ha [7]. But, Tef shoot fly (*Atherigona* spp.) is an economically important pest of tef in Wag-Lasta and in some cases can cause up to 100% yield loss.

Nowadays the distribution of rain fall is becoming very erratic due to global climatic change, which is even more dramatic in dry-land areas like Wag-Lasta and the yield loss on tef is too high. Tef shoot fly damage is higher in row-planted tef than broadcast-planted and the pest prefers the tef stalk on row planted because of the vigorous stem growth. At this time, with the expansion of tef row planting technologies, shoot fly infestation is becoming the most important production constraint, especially in dry-land areas. To minimize such serious damage on tef, screening of effective insecticides for management of shoot fly that can be used in combination with other control tactics is urgently needed. Hence, this study was conducted with the objective of selecting effective and economically feasible insecticides for the management of tef shoot fly.

Materials and Methods

This trial was conducted during the main cropping season using a commonly recommended tef variety (DZ-01- 99). Plot size was 12 m^2 with 1 m spacing between plots and 1.5 m between replicates. Urea was applied twice during the growing season; half at planting and the remaining half at the tillering stage. Weeding was carried out as needed. The experiment was laid out in a randomized complete block design (RCBD) with three replicate. The insecticides used for evaluation were carbaryl (Sevin 85% WP), chlorpyrifos-ethyl (Dursban 48% EC), endosulfan (Thiodan 35% EC), lambda cyhalothrin (Karate 5% EC), dimethote (Ethiothoate 40% E.C) at a rate of 1.5 kg/ha, 1.5 L/ha, 1 L/ha, 0.4 L/ha and 1 L/ha, respectively and they were diluted at 200 to 300 liters of water/ha. The trial was conducted in 2010 and then repeated in 2011. The insecticides were applied twice: the first spray was applied seven days after emergence of tef while the second spray was applied ten days after the first application. Shoot fly damage was recorded based on a 1-5 scale (1=0% damage, 2=25%, 3=50%, 4=75% and 5=more than 75% of total plants damaged in the plot). Data were collected on stand count, number of dead heart plants, number of panicles, damage score, number of tillers and seed yield. Effective insecticides (lambda cyhalothrin and chlorpyrifos-ethyl) selected from the evaluation trial were further verified for one year on sixteen tef

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shoot fly hot spot farmer fields across Amhara region in 2013 cropping seasons on plot size of 100 square meter using farmers as a replication.

Data analysis

Analysis of variance (ANOVA) was performed using SAS software. Treatment mean differences were tested in Duncan Multiple Range Test (DMRT). Damage score were square root transformed before analysis. The correlation between different yield related parameters and grain yield was calculated using Pearson correlation analysis technique.

Results and Discussion

The analysis of variance of the five foliar applied insecticides tested in 2010 main cropping season showed a significant difference among insecticides. Number of dead heart plants treated with chemicals were significantly lower than ($p<0.05$) that of the untreated plots. The lowest damage was recorded in the lambda cyhalothrin and dimethote treatments (Figure 1). There was significant difference in grain yield between treated and untreated plots and the lowest grain yield of 785 kg/ha was recorded from untreated plots, whereas the maximum grain yield was obtained from the plots treated with chlorpyrifos-ethyl, endosulfan, dimethote and lambda cyhalothrin, yields ranged from 1231.84 kg/ha to 1414.03 kg/ha with no statistical difference among them (Figure 2). The efficacy of some insecticides in both years were not uniform due to the variability in shoot fly infestation which was higher in the second year compared to first year (Figure 1).

In the 2011 cropping season, analysis of variance showed a significant difference ($P<0.05$) among insecticides for both dead heart count and grain yield. The lowest number of dead heart plants was found on plots treated with chlorpyrifos-ethyl and lambda cyhalothrin. The highest grain yield was obtained from plots treated with lambda cyhalothrin. However, the lowest grain yield was recorded from untreated plots (Figure 2).

The combined analysis of variance of insecticides showed a significant difference for all tested parameters. Insecticide sprayed plots had a significantly lower ($p<0.05$) number of dead heart than the untreated plots. Moreover, there were significant variations among the treated plots themselves; those plots that were sprayed with lambda cyhalothrin and chlorpyrifos-ethyl had a significantly lower number of dead heart plants. Likewise, there were significant difference in grain yield between the treated and untreated plots and the lowest yield was recorded from untreated plots. However, the highest grain yield was obtained from plots treated with lambda cyhalothrin and chlorpyrifos-ethyl with no statistical difference between them (Table 1). Similar result was obtained in 2013 from plots sprayed with lambda cyhalothrin and chlorpyrifos-ethyl compared to untreated control. Chemical controls can provide a rapid, effective and dependable means of controlling of insects [8,9].

The result of the correlation analysis indicated that grain yield had negative and significant correlation with number of dead heart plants, damage score and number of tiller and positive and significant correlation with number of panicles and stand count (Table 2). It is well known that in high rainfall areas an increase in the number of tillers can result in increased yields. On the other hand, in an area like Wag-Lasta where there is recurrent moisture stress, tillers are not productive and this results in negative correlation of grain yield with number of tillers. Similarly, the negative correlation of grain yield with dead heart count shows the need for management of tef shoot fly especially in moisture stressed areas. Finally, the partial budget analysis and sensitivity analysis were carried out for insecticides against the control and based on the input and output price the marginal rate of return for chlorpyrifos-ethyl and lambda cyhalothrin were found to be higher than the rest of insecticides (data not shown).

Conclusion and Recommendation

This study revealed that the application of insecticides was found to be biologically and economically advantageous over the untreated check in the management of tef shoot fly. In an area like Wag-Lasta and similar agro-ecological zones with recurrent tef shoot fly infestation,

Treatments	Stand count 100 cm^2	No. dead heart plants 100 cm^2	No. panicles 100 cm^2	Damage score	No. tillers	Grain yield ($kgha^{-1}$)
Carbaryl	37.55^{CD}	3.91^{C}	47.52^{A}	$2.67(1.60^{B})$	14.54^{CD}	983.77^{B}
Chlorpyrifos-ethyl	56.98^{A}	3.09^{DE}	45.30^{B}	$0.83(1.07^{D})$	11.59^{E}	1225.77^{A}
Endosulfan	35.99^{D}	4.38^{B}	47.95^{A}	$2.50(1.53^{BC})$	16.99^{B}	1035.70^{B}
Lambda- cyhalothrin	36.51^{D}	2.82^{E}	43.00^{C}	$1.17(1.18^{CD})$	15.58^{C}	1267.59^{A}
Dimethote	54.99^{A}	4.01^{BC}	45.51^{B}	$1.50(1.26^{BCD})$	18.44^{A}	1079.67^{B}
Control	39.92^{C}	5.93^{A}	42.40^{C}	$3.83(2.07^{A})$	15.20^{C}	655.97^{C}
Mean	44.07	3.91	45.71	1.47	15.08	982.71
DMRT(0.05)	**	**	**	**	**	**
CV (%)	5.13	8.23	2.87	20.14	7.57	10.17

Means followed by a common letter within a column are not significantly different with DMRT at 5%; Values in brackets are square root transformed

Table 1: The effect of different insecticide treatments on stand count, number of dead heart plants, number of panicles, damage level, number of tillers and grain yield of tef combined over two years.

	Stand count	No. dead heart plants	No. panicles	Damage score	No. tillers	Grain yield ($kgha^{-1}$)
Stand count	1	-0.296	0.316^{*}	-0.452^{*}	-0.263	0.33^{*}
No. dead heart plants		1	-0.766^{*}	0.873^{*}	0.698^{*}	-0.671^{*}
No. panicles			1	-0.66^{*}	-0.55^{*}	0.475^{*}
Damage score				1	0.67^{*}	-0.764^{*}
No. tillers					1	-0.309^{*}
Grain yield ($kgha^{-1}$)						1

*Significant at p=0.05

Table 2: Correlation coefficients of grain yield, pest damage and other agronomic parameters of tef combined over two years.

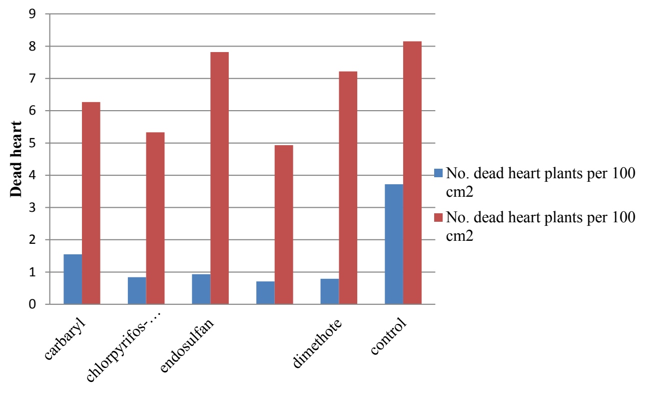

Figure 1: Effect of insecticides on number of dead heart of tef per 100 cm²; insecticides have significant difference at p=0.05.

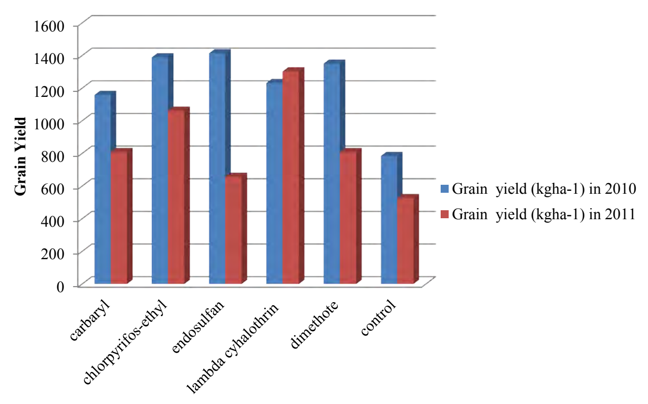

Figure 2: Effect of insecticides on the grain yield of tef in 2010 and 2011; insecticides have significant difference at p=0.05.

insecticide application seven days after tef emergence and ten days after this first application can help to achieve higher productivity through minimizing crop loss due to the tef shoot fly. Among the insecticides tested, chlorpyrifos-ethyl (1.5 L ha^{-1}) and lambda cyhalothrin (0.4 L ha^{-1}) were more profitable than the rest with the yield advantage of 81.87% and 111.63%, respectively. Therefore, we recommended judicious use of chlorpyrifos-ethyl (1.5 L ha^{-1}) and lambda cyhalothrin (0.4 L ha^{-1}) for the management of tef shoot fly.

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