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Evaluating Sorghum Stem Borer *Chilo partellus* (Swinhoe) Lepidoptera: Crambidae) Management Alternatives in Eastern Ethiopia

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Abstract

The study was conducted to find out best sorghum stem borer management option for agro-pastoralist in eastern Ethiopia. Treatments were T1 (no management), T2 (foliar spray of Karate 5 EC at 30 and 60 DAE), T3 (only sorghum intercropping with cowpea), T4 (foliar spray of Karate 5 EC at 50 DAE + intercropping with cowpea), T5 (Push-pull), T6 (Diazinon 10 G at 50 DAE + intercropping with cowpea) and T7 (Diazinon 10 G at 30 and 60 DAE). Treatments were arranged in RCBD design and replicated in three. The result showed that stem borer infestation significantly decreased in all treatments compared to the control (T1) at P<0.05. The number of larvae/plants decreased across treatments 83.8, 81.73, 40.17, 69.21 30.95, 74.26% on T7, T6, T5, T4, T3 and T2. Tunnel length also reduced by 55 and 65% in T7 and T6 also 25 to 39 % in T3 and T5 respectively. The number of non-productive tillers/plants was decreased by 83.25, 91.75, 66.75 and 58.75% on T7, T6, T2 and T4 respectively. Foliar damage indices reduced by 74.4, 55.13, 11.21, 70.16, and 61.3 % in T7, T6, T5, T4 and T2 respectively compared to the control. Grain yield increased by 70.96 and 68.69% respectively in T7 and T6 were as in T2 and T4 increased by 67 and 59% respectively compared to the control.

Keywords: Sorghum; Stem borer; Insecticide; Push-pull; Infestation; Grain yield

Introduction

Cereals, especially sorghum is the most important field crops grown in resource-poor small-scale farmers in Eastern Ethiopia [1]. The yield and quality of these crops are affected by a wide array of biotic (pests and diseases) and drought stresses. Of the various insect pests attacking cereal including sorghum in Africa, lepidopteran stem borers are by far the most injurious on cultivated maize and sorghum [2,3]. They are generally considered to be the most damaging insect pests of maize and sorghum in Africa [4]. Stem borers can cause severe damage at different growth stages of the crop from seedling to maturity. When infestation is severe, there is a physiological disruption of plant growth, and panicle emergence and grain formation are severely affected, resulting in reduction in kernel number and mass.

Seventeen species of stem borers in two families Pyralidae and Noctuidae have been found to attack sorghum and maize in various parts of the country [2]. Feeding and stem tunneling by borer larvae on plants results in crop losses as a consequence of the destruction of the growing point. Yield losses in areas with severe borer problems vary between 10-70% [2]. Up to 80% yield loss in sorghum by *Chilo partellus* were also reported in sorghum growing localities in eastern Ethiopia [1].

According to studies made on management of cereal stem borer, manipulation of crop ecosystem can significantly reduce infestation and increase crop yield [5]. There are also numerous reports indicating that using different insecticide resulted in good control of stem borer increased grain yield [5-7].

Currently no easily applicable means for sorghum stem borer management technique is available in eastern Ethiopia to recommend to the sorghum farming community [1]. Else were different sorghum stem borer management techniques have been reported including intercropping [6], use of insecticide and push-pull reported to be effective [5,8,9]. Therefore, it is important to evaluate different stem borer management approaches that had been reported to be effective elsewhere before recommending to the farming community in the current study area. Therefore, the study was conducted to find out best management approaches for stem borer occurring in sorghum in a Fafen administrative zone of East Ethiopia.

Material and Method

Description of study area

A field experiment was conducted in a district located in the Ethiopian Somali region Fafen administrative namely

Tulugulled were sorghum is grown as the primary crop. This area is characterized traditional sorghum production area as mono cropping by Agro pastoralist. The climate of the study area is a bimodal rainfall pattern and it is characterized by quasi double maxima with a small peak in April and the main peak in August. It belongs to the warm semi-arid to cool and humid agro-climatic zone with the altitude of 1550m.a.s.l. The average annual temperature ranges from 18-27.5 0C. The average annual rainfall ranges from 200 to 1400mm. It is bounded between the geographical coordinates of 912,270–1,058,809.8 UTM north and 877,449.1-975,927.2 UTM East [1].

Treatment and experimental design

Seven different cereal stem borer management approaches were evaluated in farmers' field with a high infestation history of stem borer. Each seven treatments were replicated in three and arranged in RCBD. There were 1 and 1.5m between plots and blocks and each plot had a size of 12m2, sorghum seeds variety Teshale planted on plots prepared in 30cm x 70cm spacing in 6 rows/plot.

Method of data collection and data analysis

Sampling of stem borer infestation was started at fourth weeks after emergence and was repeated every two weeks interval until physiological maturity of the plants. Prior to data collection 10 plants from two central rows were randomly selected and tagged. All necessary data were collected from pre tagged ten plants. During the final stage, destructive sampling was made on ten plants/plot to measure and count tunnel length, number holes/stalk, percent of plants with dead heart and number of larvae (Table 1).

Table 1: Detail of treatments tasted against sorghum stem borer.

Treatments Detail
T1: Control no management
T2: lambda-cyhalotrin (Karate 5 EC) applied at 30 and 60 days after emergence in the rate of 300ml/ha
T3: Intercropping sorghum with cowpea in 2:1 planting in alternate rows pattern
T4: Intercropping sorghum with cowpea 2:1 pattern and insecticides Karate 5 EC applied at 55 days after emergence in the rate of 300l/ha.
T5: Push-pull
T6: Intercropping sorghum with cowpea 2:1 and insecticides Diazinon 10 G applied at 30 days and 70 day after emergence at the rate of (20kg/ha)
T7: Diazinon G10% applied at 30 and 60 days after emergence at the rate of 20kg/ha

The data on yield and stem borer infestation were analyzed using Analysis of Variance (ANOVA). Treatment effects and treatment means were separated using Least Significant Difference (LSD) sing SAS ver.9 computer packages at P<0.05 level of significance.

Result and Discussion

Table 2: Effect of different sorghum stem borer management methods on crop performance against stemborer infestation.

Treatments	NNPT/P	NL/P	NEH	NEB	NE/EB	TL.	%PDH	FDI	PH
T1	4.00^{a}	5.75^{a}	3.71^{a}	5.30^{ac}	4.66^{ab}	9.60^{a}	36.62^{a}	4.19^{a}	0.79^{a}
T2	1.33^{b}	1.48^{b}	1.08^{b}	1.12^{b}	2.04^{bc}	5.04^{bc}	19.78^{b}	1.62^{b}	1.03^{b}
T3	2.67^{a}	3.97^{ac}	2.02^{a}	3.67^{c}	3.67^{d}	7.61^{a}	27.53^{c}	2.90^{a}	0.85^{c}
T4	$1.65b^{c}$	1.77^{b}	0.93^{cb}	2.83^{d}	2.31^{c}	5.23^{bc}	17.26^{bd}	1.22^{b}	0.95^{bc}
T5	2.57^{a}	3.44^{ac}	2.22^{a}	3.37^{b}	3.00^{a}	7.50^{ab}	27.02^{c}	2.72^{a}	0.88^{c}
T6	0.33^{d}	1.05^{d}	0.51^{c}	3.43^{d}	1.66^{c}	4.35^{db}	13.47^{d}	1.88^{b}	1.31^{e}
T7	0.67^{d}	0.93^{bd}	0.56^{c}	1.09^{de}	1.66^{c}	2.44^{e}	14.22^{d}	1.07^{b}	1.51^{ef}
LSD	1.62	1.1742	0.67	3.96	1.94	2.51	4.74	1.515	0.24
CV	38.12	0.67	0.38	1.86	1.11	1.19	22.15	0.87	0.75

PH plant height. NNPT/P number of nonproductive tiller/plants. NL/P number of larvae/plants. NEH number of exit hole. NEB Number of Egg batch. NE/EB number of egg/egg batch. TL tunnel length. % PPDH plants with dead heart. FDI foliar damage index. Means followed by the same letters are not statistically significant at P<0.05.

The result revealed that all the treatments were found significantly superior over the untreated control in reducing the infestation of *C. partellus.* The result from the study indicated that all insect pest infestation parameters significantly responded to the treatment at (P<0.05). According to the result in (Table 2) there were significant difference in number of larvae/plant (NL/P), plant height (PH), tunnel length (TL) and number of non-productive tillers/plant (NNPT/P) at (P<0.05). Similarly, percent of plants with dead heart (PPDH), number of eggs/egg bache (NE/EB) and number of exit hole/plant (NEH) also significantly affected by treatments effect.

Effect of treatments against pest population

According to the result in the (Table 2) the highest number of larvae/plant (NL/P) was recovered from control treatment (T1) followed by T3 and T5. The lowest NL/P was recorded from those treatments received insecticide Karate 5 EC and Diazinon 10G with or without intercropping (T7 and T2). Compared to control and

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other treatments the NL/P reduced by 83.8% in T7 followed by T2 74.26%. There were also remarkable NL/P reduction on T6 and T4 in these treatments it was reduced by 81.73, 69.21% respectively. NL/P reduction observed on T5 and T3 were moderate and found to be 40.17, 30.95% respectively. The decrease in larval number/each plant in T2, T4, T6 and T7 could be attributed to the insecticide along with habitat management. Similar result was reported by Neupane et al. [10] indicted that conventional insecticide significantly reduced infestation compared to control stem borer in maize.

The number of egg batch (NEB) and number eggs/egg batch (NE/EB) over the season showed significant variations at P<0.05 among treatments. Lowest egg batch was recorded on T2 and T7 in these treatments number of egg batches reduced by 79.4 and 78.86% similarly number of eggs/egg batch reduced by 64.33 and 56.2% respectively. The reduction in the NEB and NE/EB could be due to the deleterious effect of insecticide and pest confusion due to habitat manipulation resulted from intercropping and push-pull. The present findings can also be compared with those of [8,11,12]. When single round insecticide application integrated with intercropping (T6 and T4) reduced NEB by 35.28 and 49.4% as well as NE/EB batch 64.37, 50.4% respectively. Push-pull and intercropping (T5 and T3) resulted in 36.42% reduction in number of egg batches compared to the control treatment.

Effect treatments against crop damage

According to the result in (Table 2) there were significance difference at P<0.05 among treatments on foliar damage indices (FDI), number of exit holes/stem (NEH), number of non-productive tillers/plant (NPT/P) and percent of plants with dead herart (%PDH). Significant reduction in the FDI, NEH, NPT/P and %PDH was recorded from T6, T7 and T4 and T2. Compared to the T1 FDI reduced by 74.4 and 70.88% in T7 and T4 flowed by T6 55.13% and T4 60.33%. There was also moderate reduction in T5 and T3 the FDI amounted to be 35.08, 30.78% respectively. Maximum NEH was recorded from T1 and the minimum was recorded from T7. NEH also moderately reduced in T5 and T3 reduction was found to be 40.11 and 45.55% respectively. Kavita and Manjunatha [13] reported les number exit holes/plant when sorghum intercropped with cowpea.

The lowest tunnel length was recorded from insecticide treated plots T2, T4, T6 and T7 respectively. Tunnel length reduced by 69.5 and 65% in T7, T6 respectively and also 25 to 39 % in T3 and T5 compared to the control. Conformity with [7], reported lowest foliar damage and stem tunneling on plots treated with insecticide compared to control. Average number of non-productive tillers/plant (NPT/P) were significantly higher in control treatment T1 followed by T3 and T5. The same finding was confirmed by [7] that successful infestation of stem borers into plants, and their feeding may cause death of growing points reduction in number of harvestable ears.

Insecticide received treatment (T2, T4, T6 and T7) produced less NPT/P. The result in the (Table 2) showed that higher proportion of plants with dead heart was recorded from T1, followed by T3 and T5. All treatments received insecticides had resulted in low %PDH. Similar result was reported by [11] indicting insecticides showed better control of maize stem borer and reduction of dead heart in maize stem borer. Accordingly, treatments received Diazinon 10 G (T6 and T7) resulted in significantly low %PDH 13.47 and 14.22%. Similarly, Karate 5 EC treated plots (T2 and T4) showed reduction 19.78 and 17.26% respectively compared to the control but it was not effective as Dizinone 10 G. this could be due to the fact that foliar insecticide are not effective as the granular insecticide [6,7]. The result may also corroborate with Manzooret et al. [14] whom indicated that compared to the check, insecticide treated plots showed reduce infestation and crop damage. In this study manipulating crop environment using intercropping and push-pull showed remarkable reduction on infestation though the result is not comparable with insecticides treatment. Current finding is in agreement with Degri et al. [5] whom reported that intercropping pattern of 1:2 ratio and 1:1 ratio had significantly lowered number of infested plants than the sole crop (1:0 ratio).

Effect of different sorghum stem borer management methods on grain yield

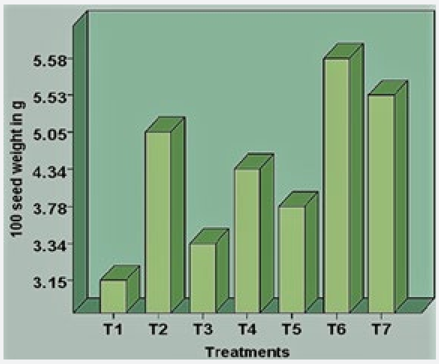

Figure 1: Effect of different sorghum stem borer management options on 100 seed weight.

The result in (Figure 1) revealed that there were significant differences on total grain yield and 100 seed weight at P<0.05. Accordingly compared to all treatment, those plots treated with insecticide (T2, T6 and T7) had relatively higher 100 seed weight. The lowest seed weight was recorded from T1 were as the highest was recorded from T7 followed by T6. Compared to control treatment, T7 and T6 increased 100 seed weight by 67.0, 62.0% respectively. Similarly, T2 and T4 resulted in 58.74 and 55.1 % seed weight increment. Both sorghum intercropping (T3) and push pull (T5) increased 100 seed weight by 35.71% on average. Hegde et al. [13] found that maximum grain and fodder yield when maize intercropped with cowpea compared to sole crop on maize infested with stem borer.

Maximum grain yield was obtained when sorghum treated with insecticide (T7, T6 and T2) and followed by the T5 and T3 (Figure 2). Compared to insecticide treatment (T2, T4, T6 and T7) push-pull (T5) and intercropping (T3) showed reduced

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grain yield. According to the result in there was no statistically significance differences were observed between intercropping and push pull treatments. Total grain yield increased by 70.96 and 68.69% respectively in T7 and T6 compared to the control. Were as Karate 5 EC application twice (T2) and intercropping + Karate 5 EC once foliar spray (T4) increased grain yield by 67 and 59% respectively compared to control (T1). Effectiveness of insecticide treatment against stem borer reported on maize and sorghum in several areas. According Adamu et al. [7] insecticide treated maize plants recorded the highest grain weigh. Compared to control T1 sorghum intercropping with cowpea T3 and push pull (T5) also resulted in grain yield increment amounted to be 35.17% for both treatments on average.

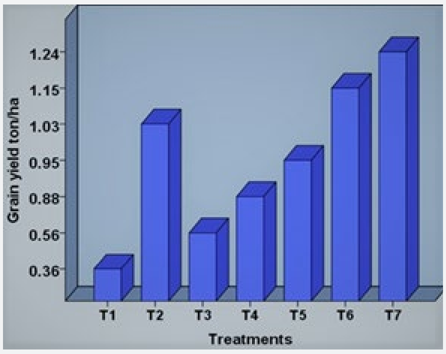

Figure 2: Effect of different sorghum stem borer management options on grain yield.

A number of study report indicated that intercropping cereal and legume can reduce the pest infestation and increase grain yield. Ayisi et al. [15] reported that intercropping reduced *C. partelus* infestation and increased grain yield in mixed and alternate intercropping systems, relative to the sole cultures. Similarly, Ampong et al. [16] indicted that when sorghum planted in intercropping manner with cowpea resulted in reduced stem borer infestations and increased grain yield compared to the sole sorghum.

Conclusion

Among all tested treatments against stem borer insecticide application found to supper effective in reducing infestations and increasing grain yield. Moreover, the finding also revealed that by integrating reduced insecticide application frequency + intercropping produced comparable result with repeated insecticide use. Accordingly, the result obtained from push-pull treatment showed appropriate grain yield increment. Though grain yield obtained from insecticide treated plots had wide yield gap it may not be reasonable to relay on insecticide completely. Therefore, we recommend push-pull approaches for sustainable stem borer management by putting insecticide + intercropping option on the table as alternative strategy.

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