

Damage and insecticidal control of stem borer (*Busseola fusca* L; Lepidoptera: Noctuidae) on maize in Halhal Begoss

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Summary

A maize stem borer (*Busseola fusca* L) control study was conducted in Halhal Begos with the objectives of assessing the damage caused by the pest and identifying the simple method of control. The treatments used were Furadan 1G, Carbaryl 85%WP, Cymbush 1G and control. The data collected were larval count, dead heart count, tunnel length, per cent infestation at 30 and 45 days after emergency. The larval count was taken from the border rows, and yield was taken from the central row at harvest. All agronomic data, like the date to the heading plant height etc were taken on time. The results of the study showed that all the pesticides used gave good control of the larvae. Furadan gave the highest yield benefit and monetary value compared to the check.

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Introduction

Maize (*Zea mays* L.) belongs to the family Poaceae and is the most important crop, and its production covers about 30,000 ha in Eritrea. Maize is mainly cultivated in the country for human food, and its stalk is used as animal feed. The grain of maize is a rich source of carbohydrates, protein, oil, minerals and various value chains. The production and productivity of maize in Eritrea are affected by different insect pests both under field and storage conditions. Some of the most important pests of this crop in Eritrea are stem borers of different species, African bollworm, Fall Armyworm, African Armyworm, chafers, aphids, thrips and storage pests like weevils and moths (De Lotto 1947; Aduugna & Trond 2001; Veerana et al. 2023). Lepidopterous stem borers are serious pests of maize and sorghum in sub-Sahara Africa (Seshu Reddy 1983). Ogendo et al. (2004) reported that maize production is affected by field and storage pests in Africa. In West Africa, maize and sorghum are severely damaged by the stem borer *B. fusca* and *Eldana saccharina* (Walker), causing yield loss of 30-81% (Egwuatu & Ita 1982). Likewise, Getu (1996) in Ethiopia reported that stem borer *B. fusca* caused yield loss of 50-80 per cent. Malgwi & Adamu (2012) reported that maize stem borer can cause serious damage to maize varieties that are not resistant and cause colossal loss of up to 40% damage. Mailafiya & Degri (2012) also reported that stem borer infestation is a constraint and a threat to maize production in maize-producing countries of West Africa. Bosque-Perez & Schulthess (1998) reported that maize stem borer (*Busseola fusca*) has caused serious damage to maize plants and grains in the field. It also

predisposes the plant to diseases through the bored holes created and subsequently causing maize stem lodging and breakage (Bosque-Perez & Mareck 1991; Sosan & Daramola 1999; Parmar et al. 2023). Similarly, Aduugna et al. (2001) reported that stem borer, especially *B. fusca*, causes yield reduction of over 50% in sorghum in Eritrea.

The stem borer attacks maize plants from the vegetative stage through maturity. Stem borers affect maize and sorghum crops at the larval stage. Eggs are laid under a sheath of young maize plants; on emergence, the young larvae migrate to the top of the plant, enter the whorl and begin feeding on the newly emerging leaves. Later larvae bore into the stalk, causing the appearance of dead hearts in young plants, whereas in old plants, dead hearts are not produced. Feeding in the stem disrupts the transportation of water and nutrients, causes lodging or stunting, and sometimes kills the plant. A study on stem borer was conducted to study its nature of damage and crop loss in Halhal Begos, where the pest population is very high, with the objectives to assess the damage caused by the pest and identify the method of control of the pest.

Materials and Methods

The study was conducted during the cropping seasons of 2011 to 2013 in Halhal Begos at an altitude of 1960m with rainfall of 465mm; Halhal Begos is about 40 Km Northwest of Keren on the road Keren to Zara. The plot size was 4.5 by 5 meters, the spacing between rows and plants was 75 and 25 cm, respectively, and the spacing between plots and replication was 1 and 1.5 meters. The experimental design used was a randomized complete block design (RCBD) in four replications. All agronomic practices recommended for the crop, such as fertilizer, weeding, sowing and cultivation, were done on time. The treatments used were: Untreated control, Carbaryl 85% WP, Cymbush 1%G, and Furadan 5G. Carbaryl spray was

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done using a knapsack sprayer at 30 and 45 days after germination of the crop, while Cymbush and Furadan granules were applied in the furrow during seeding of the crop and the whorl of the seedling at 30 to 45 days after crop emergency.

Data were collected on the number of larvae per plant at 30 and 45 days after germination from the border rows of each plot. Per cent, infestation and the number of dead heart plants were calculated by counting infested and/or dead hearts and uninfested plants from the central row of each plot. For measuring the length of the tunnel and counting the number of holes per plant, about 10 maize stalks were selected randomly from each plot after harvest. Randomly selected stalks with holes were

split with a knife, and then tunnel length was measured with a ruler of 1 meter in length. Days to heading, maturity and plant height were recorded on time. Yield was taken from the central three rows of each plot. All data collected were subjected to analysis.

Results and Discussion

All the insecticides used gave a significantly lower count of stem borer larvae both at 30- and 45-day counts than the control plots during the study period. Both Furadan and Cymbush gave significantly lower counts than Carbaryl and control treatments. Likewise, all the chemical-treated plots had significantly lower counts of dead heart plants than the control plot Table 1-3.

Table 1. Larval count, day tasselling, day maturity, plant height and yield Q/ha at Halhal Begos

Treatment	Rate Kg/ha	No larvae 30 days	No larvae 45 days	Day tassel	Date maturity	Plant ht cm	Yield Q/ha
Furadan	2.0	2.6	3.0	80	117.7	176.0	36.7
Cymbush	2.0	4.7	4.5	86	115.3	175.0	32.6
Carbaryl	1.5	14.6	17.3	91	126.0	179.7	24.8
Control		43.2	45.7	117	130.0	145.7	12.3
LSD		3.41	4.8	7.0	8.3	5.3	6.7

The control plot had a significantly longer date of tasseling as well as days to maturity than the pesticide-treated plots. The days to tasseling for the insecticide-treated plots ranged from 80 to 91 days, while for the control plot, it was 117 days. Similarly, the days to maturity for the insecticide-treated plot ranges from 77 to 126 days, while for the control plot, the maturity date

varies from 130 to 138 days Tables 1 and 2. The plant height of the control plot was significantly shorter than the chemical-treated plots throughout the study period, ranging from 140 to 170 cm, whereas the plant height for the insecticide-treated plot ranged from 175 to 280 cm Table 1-3.

Table 2. Larval count, date tasseling, day maturity, plant height and yield Q/ha at Halhal Begos

Treatment	Rate Kg/ha	No larvae 30 days	No larvae 45 days	Dead heart	Date maturity	Plant ht cm	Yield Q/ha
Furadan	2.0	4.7	2.3	4.5	112.0	227.7	49.7
Cymbush	2.0	6.5	3.7	6.2	115.7	223.0	42.3
Carbaryl	1.5	16.3	16.0	8.5	122.7	196.0	32.6
Control		31.0	39.5	18.1	138.0	140.7	18.2
LSD		8.1	3.4	2.5	7.0	24.3	5.6

The yields of maize vary from year to year and from treatment to treatment. All the insecticide-treated plots gave significantly higher yields than the control plots during the study period. Furadan and Cymbush gave significantly higher yields than the control plot and

Carbaryl-treated plots. The yield of Furadan and Cymbush varies from 31.5 to 49.7 Q/ha while the yield for the control ranges from 12.3 to 18.2 Q/ha which is much lower than chemical treated plots Table 1-3.

Table 3. Larval count, day tasselling, day maturity, plant height and yield Q/ha at Halhal Begos

Treatment	Rate Kg/ha	No larvae 30 days	No larvae 45 days	Dead heart	Date maturity	Plant ht cm	Yield Q/ha
Furadan	2.0	9.3	6.0	1.3	72.7	282.0	36.1
Cymbush	2.0	10.5	8.3	2.0	75.0	270.0	31.5
Carbaryl	1.5	19.0	22.5	5.7	77.7	237.3	22.3
Control		62.7	51.5	16.3	81.0	170.7	12.5
LSD		3.6	5.2	1.8	4.2	47.5	5.5

Correlation/combined analysis for the three years showed that there was a strong correlation between

yields of maize, number of larvae, maturity and plant height, respectively Table 4.

Table 4. Correlation between larval population and plant data

Characters	Larvae 30	Larvae 45	Maturity	Plant ht
Larvae 30 days				
Larvae 45 days	0.88**			
Maturity	-0.037ns	0.038ns		
Plant height	-0.48ns	0.49ns	0.05ns	
Yield Q/ha	0.71**	0.85**	-0.64**	0.51**

Benefits due to the use of chemicals were calculated using the rate and cost of insecticides, labour costs for spraying and water fetching, and market value of grains per quintal (1 quintal is 100kg). All the pesticides used gave higher yield and income than the control plot (Table

Table 5. Cost and rate of insecticides, labor wage, yield increase over control price of grain and benefit due to the use of insecticides

Treatment	Rate Kg/ha	Cost of insecticide/lt	Labor cost/ha		Yield increase	Price of grain	benefit
			water	spraying			
Furadan 5G	2.0	600		785	26.5	15900	14515
Cymbush 1%G	2.0	720		785	21.2	12720	11215
Carbaryl85%WP	1.5	210	90	475	12.3	7380	6605

*wage man-day=20Nakfa, 1USD=15 nakfa, price of 1quintal maize=600.00nakfa

All the insecticides used significantly reduced the stem bore damage and increased the grain yield compared to the control treatment. Furadan and Cymbush were the most effective with lower infestation and damage than the rest of the treatments. Likewise, Carbaryl significantly lower stem borer infestation but was less effective than Furadan and Cymbush in reducing the pest damage. The final benefit was very high in terms of yield and monetary value. More benefit was obtained from Furadan and Cymbush treated plots with 14515 and 11215 nakfa per ha. Similar work done in Kenya showed that carbofuran, cypermethrin, and deltamethrin were more effective than aldicarb in the control of stem borer and gave higher yields (Egwuatu & Ita1982; Getu 996; Das et al. 2023).

The high yield in the Furadan and Cymbush treatment could be due to the granular formulation that was applied to the soil at planting, which gave the plant a long protection period of 40 to 60 days after application. This is in line with van Rensburg and Walter's 1979 result, where the soil application of carbofuran for control of the stem borer resulted in protecting the crop for 30-47 days. The granule protects the seedling from germination of the crop resulting in lower infestation and minimum dead heart-damaged plants. This is because the effect of the stem borer on maize is very high when the pest attacks the crop at an early stage, 20-30 days after germination (Macfarlane 1990). Granules are easy and safe to apply with gloves by farmers. Spraying pesticides for stem borer control has a disadvantage in that they require a timely and regular application, especially during the most sensitive stage of the development of the crops (Sithole 2001). This is especially difficult for resource-poor farmers who cannot afford regular spraying because it is very expensive. In addition, a delay of 3-5 days will encourage the pest to get into the stem of the plant, where it will be very difficult to control the pest by foliar application (Sithole 1990). Once the pest is inside the stem, it is difficult to control it with a chemical spray such as Carbaryl. A study on the correlation between different characters showed that the yield is directly correlated with larval density and per cent of dead hearts (Table 4). These results are similar to the findings of Medvecky (1992), who reported that damage by the stem borer had a positive correlation with the number of larvae and percentage of dead hearts.

Conclusion

In conclusion, the yield loss due to the stem borer (*B. fusca*) is very high. The yield advantage due to the use of

4). The highest benefit, 14515 Nakfa, was obtained from the use of Furadan 5G. Cymbush 1%G and Carbaryl 85% WP gave a benefit of 12720 and 6605 Nakfa, respectively over the control plot Table 5

insecticide ranges from 12.3 to 26.5 Q/ha and the net benefit ranges from 6605 to 14515 nakfa/ha over the untreated plot. This yield reduction is very high, especially in arid and semi-arid areas like Eritrea. To reduce the yield loss, an integrated pest management approach to stem borer control should be used that includes biological control, resistant varieties, proper cultural practices, planting of repellent plants (molasses), selecting the best sowing time, intercropping such as disodium and wise use of pesticide with safe handling.

Declaration of interests

The authors have no conflict of interest to declare.

Data Sharing

All relevant data are within the manuscript

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