The Relationship between Grassland Composition on Stemborer Abundance on Grasses Surrounding Maize Farms

Nelima Maryselah
International Centre of Insect Physiology and Ecology, Kenya

Mutyambai M. Daniel
International Centre of Insect Physiology and Ecology, Kenya

Kuyah Shem
Jomo Kenyatta University of Agriculture and Technology, Kenya

Netondo Godfrey
Maseno University, Kenya

Mattias Jonsons
Swedish University of Agricultural Sciences, Sweden

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Nelima Maryselah[1, 4], Mutyambai M. Daniel[1, 2], Kuyah Shem[3], Netondo Godfrey[4], Mattias Jonsons[5]
1International Centre of Insect Physiology and Ecology, P.O Box 30772-00100 Nairobi, Kenya.
2 South Eastern Kenya University, P.O Box 170-90200 Kitui, Kenya.
3 Jomo Kenyatta University of Agriculture and Technology, P.O Box 62000-00200 Nairobi, Kenya.
4 Maseno University, P.O Private Bag, Kenya.
5 Swedish University of Agricultural Sciences, P.O. Box 7070, SE-750 07 Uppsala, Sweden

Abstract:
Grasslands are known to host crop pests and may act as the reservoir of pests affecting maize production. This research aimed at determining the effect of grassland composition on abundance of stemborers on grasses sorrouding maize farms in western Kenya. The experimental set up followed a complete random block design (CRBD); with four elevations at Lambwe, Homabay, Luanda and Mt. Elgon assigned as blocks based on different altitudes. Sampling was done in two seasons, during the short rain season of 2019 and the long rain season of 2020. Grasslands surrounding four pairs of push-pull and non-push-pull maize farms were assessed. Data on grass species diversity and the corresponding number of stemborers were collected from five quadrates per transect of 500m, for 4 transects per farm. The four transects originated from the midpoint of push-pull and non-push pull maize farm. A mixed design analysis of variance was used to test for variance within the elevation's variability. The most common types of grasses surrounding most of the maize farms were mainly *Cynadon dactylon* and *Immensis spp*. These results point at the role of grasslands surrounding maize farms as reservoirs for the stem borers which need to be managed to reduce stem borer and fall armyworm infestations in the surrounding maize farms.
Key words: Grasslands; maize; push-pull cropping system; stem borer

Introduction

Lepidopteron stem borers attack maize, they are poly/oligo-phagous and feed on both cultivated and wild plants such maize and grasses. Larvae of these stem borers cause damage by feeding on all parts of maize plant except roots and feed on almost 82% of maize plants in the field (Mwalusepo *et al*., 2015). Additionally, larvae feed on immature cobs, silks and tassel (Reddy *et al*., 2003) causing high yield losses.

The original hosts for cereal stem borers are the wild grasses and sedges and the pest species have maintained a close association with their wild habitats (Haile and Hofsvang 2001). The density, abundance and diversity of grasses in a landscape may affect the occurrence and abundance of lepidopteran pests through providing them a habitat and favoring oviposition by lepidopteran moths (Kfir *et al*., 2002). A previous study recommended that grasses surrounding maize farms should be destroyed to reduce stem borer infestation on the main crops (Ingram, 1958). However, this recommendation was made without showing how the wild grasses determine the abundance of the stem borers in the maize farm. There was a need to understand the relationship between abundance and species richness biomass of grasslands in a landscape context on the abundance of stem borers and fall armyworm pests and the severity of their attack in surrounding maize plantations. Therefore, the objectives of this study were to 1) determine the relationship between grass composition, abundance and biomass with stem borer and fall armyworm numbers, and 2) determine effect of grasslands disturbance on the number of stem borers and fall armyworm in grasslands surrounding maize farms.

Materials and methods:

Study site

This study was carried out in Western Kenya region at four different sites, namely; Lambwe, Homabay, Luanda/Vihiga, and Mt. Elgon. These sites have maize as the predominant cereal crop and lie within different elevations above sea level as follows: Lambwe (1000-1200 meters above sea level (masl)), Homabay (1200-1400 masl), Luanda (1400-1600 masl) and Mt. Elgon (1600-1800 masl).

Experimental design

This study followed a complete random block design (CRBD); the four elevations were assigned to blocks based on different altitudes. The study was done in two seasons, during the short rain season of 2019 and the long rain season of 2020. Four categories of elevation, Lambwe, Homabay, Luanda and Mt. Elgon were studied: A total of 16 pairs of farms were used (push-pull and non-push pull fields).

Sampling procedure

Sampling methods was use of plot-less sampling procedures described by Cox (1990), Barbour *et al*. (1987) and Knapp (1984). The geographical coordinates of each maize field site were obtained using a handheld GIS product (Model "MG768"). After identifying the starting point, four transects were established to the East, West, North and South from that point right in the middle between the two fields in a pair (push-pull and non-push-pull). In each direction from the starting point, five quadrates were established at 100 m, 200 m, 300 m, 400 m, and 500 m along the transect. The centre between push-pull and non-push-pull plots were located and the GPS location of the centre was recorded. On a 500 m transect line, five quadrates at 100 m interval was determined. The location for setting up the quadrates was selected according to the highest abundance of grasses. A 0.25 square meter (0.5mx0.5m) quadrate was made using a sampling frame. Beginning in one corner of the quadrate, the number of species of grasses in the quadrate were identified and recorded. The percentage grass cover was also determined. The grass sample was collected for biomass estimation. Then walking back to the centre and taking the direction perpendicular to the first transect line was done while repeating with other four quadrates at an interval of 100m on a 500m transect line. This was repeated in the directions at right angles to the latter so that all the four radii of the area were sampled.

Determination of grass biomass

All the grasses in the sampling frame were cut off; removing forbs where applicable and placed in marked bag weighing directly to get fresh weight in the field (g/0.25m2) chopping all samples and mixing them well before taking sub-samples. About 50g was weighed as a sub sample and placed in a marked paper bag. The sub-sample was placed in an oven and dried to a constant weight at 85°C for 48 hours. The oven dried sample was weighed to get its dry weight. The total dry weight of the grasses sampled in $0.25m^2$ was determined.

Estimation of stem borer and fall armyworm abundance in the grasslands surrounding maize farms.

Stem borer and fall armyworm abundance and incidences was determined by trapping adult moths using sweep net and incidences assessed based on dead hearts and white head on maize farms whenever the quadrates on the transect were found on the maize farms. The larvae of stem borers and fall armyworm were picked using forceps into Eppendorf containers with 70% alcohol.

Statistical Analysis

Analysis of variance (ANOVA) using a mixed model (SAS, 1997) was used to assess the effects of grasses composition, biomass and abundance on the abundance of the stem borers and fall armyworm on the grasslands surrounding maize farms. ANOVA was used again to see the differences in biomass, species richness and species abundance across different elevations. Multiple paired T-test was used to find out the comparisons of species richness, abundance and biomass between Vihiga and Mt. Elgon and Lambwe and Homabay.

Results;

Grass composition, abundance, biomass and grass percentage cover in grasslands surrounding maize farms

A total of 61 different species were identified in 2019 during the short rain season across the four elevations. A total of 75 different species were identified in 2020 during the long rain season. There were three dominant grass species and majority in abundance across the four elevation both in 2019 and 2020 seasons.*Cynadon dactylon(227), Immensis spp(178), and Cymbogon nardus(154)* in 2019.*Cynadon dactylon (291),Immensis spp (181)* then followed by *Cymbogon nardus* in 2020. The minority of grass species in 2019 were *Digitaria scalarum(1), Brizantha spp(1) and Chloris gayana (1)* and for 2020 minority being *Hyparrhenia pilgerana (1), Sorghum arundinaceum(1) and Melinis minuteflora (1).*

There was significance difference in the abundance of grass species, (p=.000) for both 2019 and 2020. The abundance of grasses species in Vihiga, Mt. Elgon, Homabay and Lambwe was 307,243,253,and 215 grasses respectively in 2019. In 2020, the abundance of grass species for Vihiga, Mt. Elgon,Homabay and Lambwe being 264,236,220,198 grasses respectively.

Grass percentage cover was different across the four elevations during 2019 with a p value of .020. There was much significant difference between Vihiga and Lambwe for both 2019 2020. In 2020 season there was different percentage cover across the four elevations with a p value of .032.There was significant difference on the amount of biomass distribution across the four elevations (p=.000) for both 2019 and 2020 seasons.

Relationship between grass composition, abundance and biomass with stem borer and fall armyworm numbers

All the four elevations during the short rain season in 2019 didn't show any relationship between grass species, grass composition, grass percentage cover and grass biomass with the abundance/presence of the stem borer and fall armyworm. Only in Lambwe where there significant relationship between percentage grass cover with the abundance of stemborer and fall armyworm (p=.010).

There is only significant relationship between the grass species abundance and with the abundance/presence of stem borer and fall armyworm (p=.026) in Vihiga for 2020.In Mt.Elgon, statistical results weren't signicant.There was significant relationship only between the grass species abundance with the abundance/presence of stem borer and fall armyworm (p=.27) for Homabay.For Lambwe, there was no statistical significance for the relationship between grass species richness, abundance, grass percentage cover and biomass with the abundance of stemborer.

The types and abundance of borers identified were:

In Vihiga, *Chilo partellus* larvae 44, *Chilo partellus* moth 2, with a p value of .994. In Mt. Elgon *chilo partellus* larvae 24, *Chilo partellus* moth7, with a p value of .675,In Homabay *Chilo partellus* moth 4, *Chilo partellus* larvae 17, with a p value .717 and in Lambwe *Chilo partellus* larvae 4, with p=.995.In 2020, Vihiga had *Chilo partellus* larvae 41, *Chilo partellus* moth 2.In Mt. Elgon, *Chilo partellus* larvae 19.In Homabay *Chilo partellus* larvae 7, all the p values were greater than .05.

For 2019, the quadrates that had *Immensis spp* had a total of 22 borers both fall armyworm and stem borer,*Cymbogon nardus* had a total of 11 borers, *Cynadon dactylon* had a total of 25 borers. The minority species had a total of 1 borer for each across all the quadrates .For 2020, the quadrates that had *Immensis spp* had a total of 48 borers both fall armyworm and stem borer, *Cymbogon nardus* had a total of 4 borers, *Cynadon dactylon* had a total of 40 borers. The minority grass species for 2020 had no borers associated with them.

Discussion

Across the four elevations there was different composition of grasses, grass percentage cover, biomass and grass abundance and the distribution of stem borer and fall armyworm. Across the four elevations there were three majority of grass species richness both in 2019 and 2020. The grass percentage cover, grass species richness, abundance and biomass affects stemborer in the grasses surrounding maize farms, thus grasses acting as reservoirs.

The difference in grass percentage cover, abundance and biomass in 2019 and 2020, is highly related with the different seasons of rainfall. For 2019 sampling was during the short rain season and during 2020 there was high amount of rainfall which led to even many numbers of species richness. *Imensis spp, Cynadon dactylon* and *Cymbogon nardus* are the most appearing in numbers in both seasons because they are well adapted during the both seasons. For biomass in 2019, Lambwe had the highest mean and species numbers, followed by Homabay, Mt. Elgon and then Vihiga. Mostly because in Vihiga there is high population of people, thus little space left for grass to grow. In 2020, Lambwe had the highest mean of biomass, followed by Homabay, Vihiga and then Mt.Elgon, this because Lambwe is semi-arid, sparsely populated with people with large space being left fallow, thus a lot of grasses growing in the area. Vihiga having the highest amount of grass biomass than Mt.Elgon in 2020 was contributed by high amount of rainfall in Vihiga during this season that made Vihiga had the highest mean of biomass than Mt. Elgon. In 2020, Homabay had the highest species numbers followed by Lambwe, Mt. Elgon and then Vihiga.

There is no relationship between grass species, grass biomass and abundance with the abundance or presence of stem borer during the season of 2019 for the four elevations apart from only Lambwe where the high grass percentage cover had relation with the abundance of stemborers. The many grasses acted as reservoirs for the borers. In 2020, for Vihiga there was only relationship between grass abundance with the abundance or presence of stem borer but for the biomass, grass percentage cover and species richness there was no statistical significance. In Homabay there is only relationship between the grass species abundance with the abundance or presence of stem borer, but for grass species richness and biomass they were not significant.The many grass species also acted as reservoirs for the borers. In Mt. Elgon statistical results were not significant; all the p values were greater than .05. Thus there was no relationship between the grass species richness, abundance and biomass with the abundance of stem borer. For Lambwe, also there was no statistical significance for the relationship between grass species richness, abundance and biomass with the abundance of stem borer; the p values were greater than .05. Previous studies done by Ndemah et.,2002 and Kfir et al.,2002 indicated that the density, abundance and different diversity of grasses in a landscape affects the occurrence and abundance of the stem borers through providing with them a habitat and favoring oviposition by the stem borers.

Conclusions.

Grasslands acts as trap plants for stem borer during the off cropping season as seen from the study. There is difference in grass composition, grass percentage covers, grass abundance and biomass in the four elevations. The relationship between grass composition, grass abundance and biomass with the presence or abundance of the stem borers in the grasses is not guaranteed, although in some elevations like Vihiga and Mt. Elgon the grass species abundance had a relationship with the presence of the stem borer.

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