

Assessment of Spatial Distribution and Occurrence of Stem Borer Species in Bungoma County.

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ABSTRACT

This study was conducted to assess the spatial distribution and occurrence of stem borer species of maize in Bungoma County. The study was done in Bungoma County. The experiment was conducted during the harvesting period of the short season in December, 2024 after the field had been exposed to natural stalk borer infestation. Destructive sampling was carried out on plants randomly sampled in the field. The plants were assessed for presence of windowing on the leaves, entry and exit holes on the cobs and darkening of the stems which are indicators of stem borer infestation.

The larvae recovered from the cobs were identified using standard stem borer distinctive features. The stalks were then dissected and larvae recovered in them were identified. Stem borers were collected in the plants sampled. The African maize stalk borer, *Busseola fusca* (Fuller) was more prevalent than African Pink stalk borer, *Sesamia calamistis* (Hampson) with means of 1.49 and 0.50 respectively. The stems were the most preferred site for stem borers while the cobs were the least preferred with means of 1.286 and 0.643 respectively.

Busseola fusca (Fuller) was the dominant species in Bungoma County because the altitude which is 1200m-1800m above sea level favors the occurrence of this species. *Busseola fusca* (Fuller) also tolerates a mean temperature of 25°C. *Sesamia calamistis* (Hampson) showed spatial overlap across different ecological areas in space and time. Stems were the most preferred site for stem borers because they attacked young plants, laid eggs on the stems, hatched and larvae tunneled into the stems to feed. This was also due to both biophysical and biochemical factors. The population of the larvae was sparingly low in this study due to the cannibalistic nature of the larvae. There should be extensive field assessment on stem borer incidence and importance in farmers' fields to determine which areas are most at risk to attack by the stem borers.

Keywords: Assessment, Spatial distribution, Occurrence, Stem borer species

INTRODUCTION

Background of the Study

Maize, *Zea mays* are among the 50 biotypes cereal crops that are grown widely throughout the world in a range of agro-ecological environments. Factors that limited maize production in Kenya were described by James (2004) and he cited insect pest problems as being one of them. About 130 insect species cause varying degrees of damage to the crop in India according to Spencer et al (2008). However, only about a dozen of these are important. ICRISAT et al, 2006 cited stalk borers among the most serious insect pests of maize recorded in Kenya.

Stalk borers attack maize because of the stem morphology. The stem of the plant is solid, succulent and sweet. Under favorable conditions, more internodes develop, together with leaves, producing a longer stem. The most important alternative hosts which stem borers have found favourable are reportedly cultivated sorghum, *S. versicolor* Anderson, *S. arundinaceum* Stapf, Napier grass (*Pennisetum purpureum* Schumacher)

and *Hyperrhenia rufa* Nees, Sudan grass (*Sorghum vulgare* Sudanese) and giant *Setaria* grass, molasses grass (*Melinis minutiflora*), *desmodium* (*Desmodium uncinatum* and *D. intortum*). Mulaa et al., 2011 and Chabi-olaye et al., 2005, found out that although stem borers oviposit heavily on some grasses, only few species are favorable for them to complete their life cycles. The major insect pest of maize include lepidopteron stem borers, predominantly, the African stalk borer (*Busseola fusca*, Fuller), the Spotted stem borer (*Chilo partellus*, Swinhoe) and the Pink stem borer (*Sesamia calamistis*, Hampson).

Yield reductions occur every year across sub-Saharan Africa due to insect pests or stalk lodging. Stem borers are among the most important insect pests of maize in sub-Saharan Africa. They can cause 20-40% losses during cultivation and 30-90% losses post-harvest and during storage. Stalk borers cause serious losses when maize plants are particularly attacked at an early stage and in high densities (Amudavi et al., 2012). In East Africa, losses in cereal grain yield due to stem borers ranged from 44-50% (Mugo et al, 2005). Tabashnik, 2003, found out that when a single *B. fusca* larva developed in a healthy maize plant, it reduced its yield capacity by 28% while (Ahmed et al, 2000) found that elimination of single borers maximally enhanced yields by 351b/ha.

Kingi and Burgess (2004) in a survey of estimation of grain yield losses in cereals attributed 27% and 18% losses due to stalk borers in Tanzania and Kenya respectively. Anonymous (2005) found out that in Kenya, about 1.2% of the total yield was reduced whenever 1% of the plants were attacked. In the Kenyan Rift Valley region, Kingi and Burgess (2004) reported economic losses of Kshs.217.20 per 90kg in monetary terms. The potential yield of maize within an environment could be realized when pests are managed by scouting fields regularly and applying treatments when necessary.

Food insecurity is a chronic problem in Africa and is likely to worsen with climate change and population growth. It is largely due to poor yields of the cereal crops caused by factors including stem borer pests, degraded soils and *Striga* weed. Africa faces serious challenges in feeding its population, having reverted from being a net exporter of agricultural commodities to being a net importer for the same in the last three decades. FAO has reported that the amount imported is increasing at an almost exponential level. Decline in crop yields has been indicated over the last few decades in several places in the continent. About 33% of people in the region are undernourished, with more than 60% of the undernourished being in eastern Africa. One of the main causes of the chronic food insecurity witnessed in Africa is poor crop yields, largely caused by insect pest including the stem borers. The efficient production of cereals, per unit of input, is therefore central to the food security challenge. Therefore, this study was aimed at assessing spatial stem borer distribution and occurrence of infestation to develop a fruitful management strategy of the very important pests of maize.

LITERATURE REVIEW

Distribution of Stem Borers in the World

According to (Khan et al, 2014) small holder cereal production is severely constrained by insect pests and the parasitic weeds in the genus *Striga* (Orobanchaceae), commonly referred to as *Striga*. Among the 21 economically important lepidopteron stem borers in Africa, the indigenous *Busseola fusca* Fuller and the invasive *Chilo partellus* Swinhoe are the most devastating in sub-Saharan Africa. Damage is caused by the larval stages of the stem borers whose feeding results in yield losses of up to 88%, depending on the crop cultivar, developmental stage of the plant at infestation, infestation rate and prevailing environmental conditions, among other factors.

In their article, (Tounou et al, 2013) outlined that stem borer infestations causes losses of up to 10-70% in areas with severe borer problems. Research conducted in most West African countries has shown that lepidopteron stem borers are among the most economically important pests of maize. The most commonly reported species are the Pyralid, *Eldana saccharina* Walker, the Noctuid, *Sesamia calamistis* Hampson found in Dahomy gap and in countries such as Ghana, Nigeria and Cote d'Ivoire. In the lowland tropics of West, East and Southern Africa, the Noctuid *Busseola fusca* Fuller is generally of low importance but in central

African countries like Cameroon, it is the predominant species across all the eco-zones and altitudes. The abundance and distribution of stem borer pests and their main natural enemies, are expected to vary considerably with the current climate variability in these countries.

The major species of stem borers associated with maize in Nigeria are the *Busseola fusca* Fuller, the pink stalk borer, *Sesamia calamistis* Hampson and the African sugarcane borer, *Eldana saccharina* Walker. Others of less importance are the spotted stalk borer, *Chilo partellus* Swinhoe. *Busseola fusca* and *Sesamia calamistis* are predominant in northern and southern Nigeria respectively. *Chilo partellus* is dominant at altitude below 1200m while *B. fusca* is dominant at higher altitudes. *Sesamia calamistis* was observed to be abundant than both *B. fusca* and *C. partellus* in predominant borer species in Guinea savanna agro-ecological zones of Nigeria, followed by *S. calamistis*, *E. saccharina*, *A. ignefasalis* and *C. partellus* in early and late maize plantings (Okweche and Umoetok, 2012).

Sesamia calamistis (Hampson) occurs in most tropical Africa. Country records include South Africa, Zimbabwe, Malawi, Uganda, Tanzania, Kenya, Zanzibar, Madagascar, Mauritius, Angola, Cameroon, Gambia and Ethiopia (Mbenga, 2010).

(Hutchison et al, 2007) found out that *Chilo partellus* (Swinhoe) likely invaded Africa from India somewhat before 1930. The pest now inhabits much of eastern and southern Africa. This species is highly invasive, having partially displaced a related stem borer, *C. orichalcociliellus* in several areas including the low altitude and coastal regions of Kenya. It also co-exists in many areas with *B. fusca* particularly in the moist mid-altitude and moist transitional agro-ecological zones of Kenya.

The spotted stem borer is currently known to occur in India, Pakistan, Sri Lanka, Thailand, Laos, Vietnam, Yemen and portions of Indonesia. In Africa, it is found in most eastern and southern sub-Saharan countries including Botswana, Cameroon, Eritrea, Ethiopia, Kenya, Malawi, Tanzania, Uganda, Zambia and also Madagascar according to (CABI, 2007).

Busseola fusca occurs throughout sub-Saharan Africa, but not in Zanzibar and Madagascar. In East Africa, from 1905 until recently, it was thought to occur only at high altitudes. In West Africa, it is of minor importance in the southern humid zones, but it is the dominant species on cultivated sorghum in the northern dry savanna zones. In Central Africa, field surveys indicated that *Busseola fusca* was the dominant species of all agro-ecological zones from sea level to the highlands and from the humid forest to the dry savannah zones. Similarly, in East Africa, *B. fusca* occurs in all agro-ecological zones from low land semi-arid and arid savannahs to the highland African wet mountain forests, though it is only predominant above 1500m asl. A similar trend was observed in south Africa where *B. fusca* occurs in inland low lying areas, coastal areas as well as the mountain regions of Lesotho at an altitude of 2131m asl.



Plate 1: *Busseola fusca*



Plate 2: *Chilo partellus*



Plate 3: *Sesamia calamistis*

Distribution of Stem Borers in Kenya

(Ong'amo et al, 2006) in their article found that in Kenya, the distribution of the stem borer pest species *B.fusca*, *C.partellus*, *S.calamistis* are different but often overlap in space and time. In previous studies, distributions of these species were analyzed based on the provincial blockings which might not have real biological significance compared to agro climatic zones (ACZs). More than 10% of potential maize harvest is lost due to infestation by *B.fusca* in highland tropics, moist transitional zones and moist mid-altitude zones. About 1% is lost due to *B.fusca* infestation in low potential areas (dry mid latitude and lowland tropics) while losses associated with *S.calamistis* together accounts for less than 5% of the potential harvest. *Chilo partellus* is responsible for the bulk of losses in dry transitional (24.7%), lowland tropics (20.9%) and approximately 10% in medium potential areas (moist mid altitude and dry mid altitude. In highland tropics and moist transitional zones, *C.partellus* is responsible for less than 1% of the damage.

In Kenya, stem borer populations build during the long rains and heavily infest cultivated maize and sorghum in the subsequent short rain growing season.

Damage to Maize by Stem Borers

Maize is exotic to Africa, having been introduced from Central America approximately 500 years ago. In Africa, maize encountered a plethora of indigenous pest species that attack the crop in the field and in the store. The complex of indigenous and invasive borer species that attack cereals together causes yield losses of 20-40% in sub Saharan Africa, which could feed 27 million people. Aside from losses to maize, stem borers feeding in cobs render the grain susceptible to infections by storage molds, which produce by products such as aflatoxins that are responsible for extremely high liver cancer rates in Africa (ICIFE, 2006).

Damage to maize crop is as result of feeding activities of insect pests of which the stalk borer, *B.fusca* is the major pest species (Mugo et al, 2007) The species lays eggs within leaf sheaths which hatch in 7-12 days into young larvae which migrate up the stem into the funnel to feed on the tender, rolled up young leaf or whorl by scrapping the leaf tissue (MOARD, 2002; Mang'eni and Ogwang', 2004).

When damaged, young leaves grow out of the funnel and unfold, they exhibit characteristic lines of small holes known as 'windows'. These windows run across the leaves at right angles to the main vein which is typical of early stages of stalk borer infestation (KARI, 2004).

(MOA, 2005) found out that some larvae of the stalk borer may penetrate downwards destroying the growing point leading to death of the central shoot of the crop thus causing the 'dead heart'. According to (KARI, 2005), in cases where the plant dies, the larvae move to the other adjacent plants. If the plant survives, the mature larvae bore down into the center of the stalk where they feed until pupation. Feeding by

tunneling of the stems of growing plants by the larvae weakens plants leading to lodging according to (MOA,2005). Damaged plants often die through the reduction of transportation of water and minerals, (KARI,2003).



Plate 4: Windowing effect and tunneling effect of stem borers.

MATERIALS AND METHODOLOGY

Study Site

The study was conducted in Bungoma county, which is located in Western Kenya and runs along the Kenya-Uganda border with a population of 1630934 (KNBS, 2009). It stands at latitude 0.57 with the longitude of 34.56. It lies between 1200 and 1800 meters asl. The County has good land and soils with gently sloping terrain making it one of the most arable lands in Kenya. The soils are suitable for maize farming. Bungoma County receives bimodal type of rainfall with the average annual rainfall ranging from 1200mm to 1800mm per annum. Temperatures range from minimum of between 15-20°C to a maximum of between 22-30°C. It has two rainy seasons. Most of the rainfall is experienced in the months of April –May and July-August. The coldest months are July, August and September.

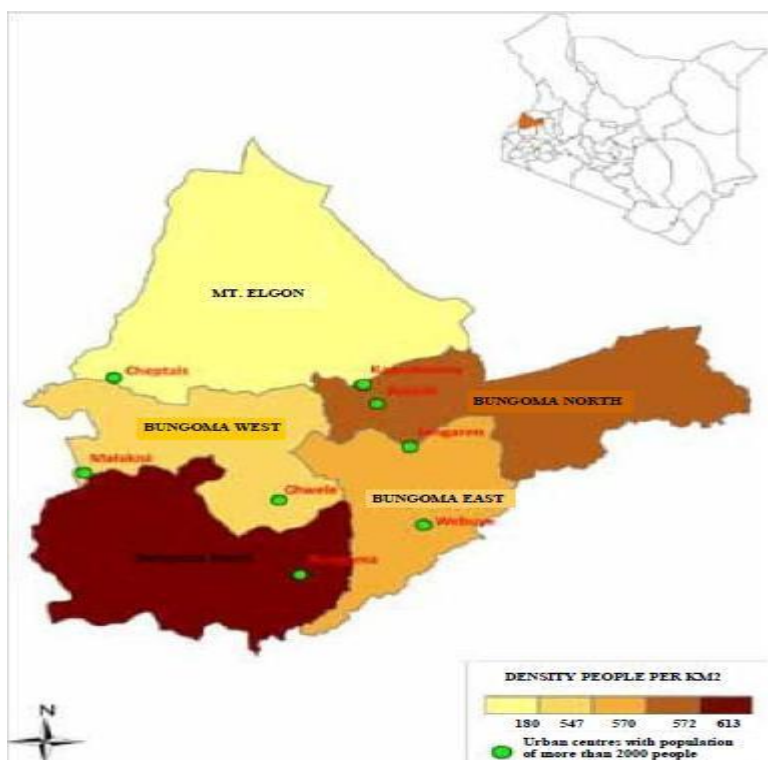


Plate 5: Bungoma County map

Experimental Design and Layout

The fields under which the studies were conducted were provided by the farmers. The experiments were conducted during the harvesting period of the short season in December after the field had been exposed to natural stalk borer infestation. At harvesting, destructive sampling was carried out on plant samples in the fields. The plants were assessed for presence of windowing on the leaves, entry and exit holes on the cobs and darkening of the stems which are indicators of stem borer infestation. Each larvae recovered from the cobs was identified using standard stalk borer distinctive features. In this regard, colour, body spotting of larvae and size were employed. In addition, the stalks of the maize sampled were dissected and larvae recovered from them for identification. The number of larvae observed in the cobs and stems was then recorded.

RESULTS

Spatial distribution and occurrence of stem borer species of maize.

Sampled stems were investigated for stem borer species infestation. From the stems, stem borers collected constituted 74% were *Busseola fusca* while 26% were *Sesamia calamistis*. Statistical analysis using t-test showed a significant difference in the distribution of stem borer species ($P > 0.05$). *Busseola fusca* was the most prevalent stem borer with a mean of 1.49 while *Sesamia calamistis* had a mean of 0.500 (**Table 1**).

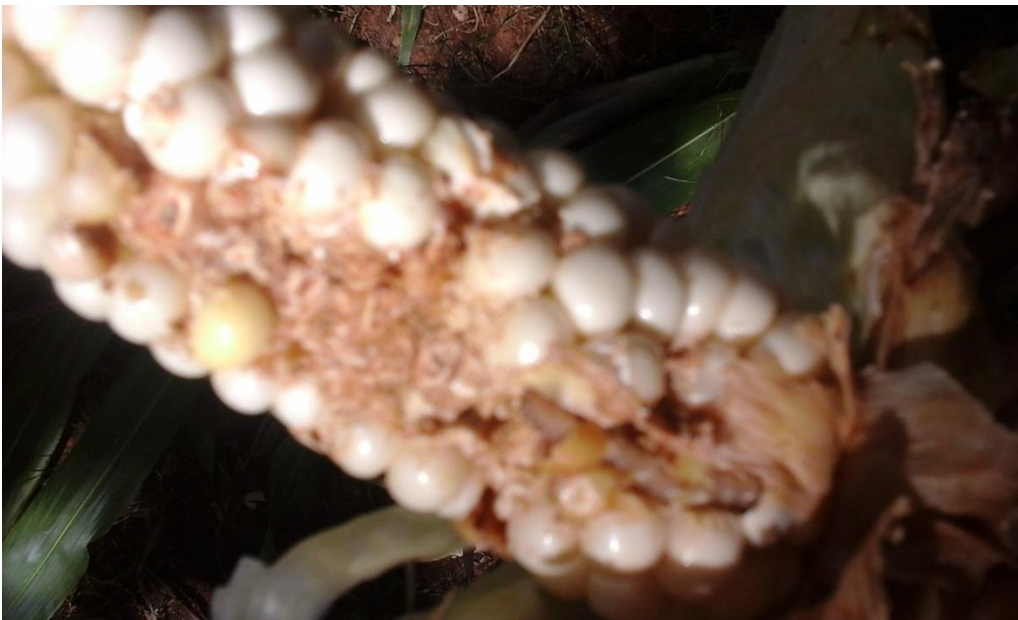


Plate 6: Stem borer feeding on maize cob

Table 1: Spatial distribution and occurrence of stem borer species of maize

Variable	Mean	Std. Dev.
B.fusca	1.42857	1.08941
S.calamistis	0.500000	0.759555

Preference Sites of Stem Borers on Maize

Two sites on maize plant were observed to determine stem borer preference. These were the cobs and stems. Statistical analysis using t-test showed a significance difference in the preference site of stem borer on maize ($P > 0.05$). Stems had the highest mean of 1.286 while cobs had the least mean of 0.643. (**Table 2**)

Table 2: The preference sites of stem borers on maize

Variable	Mean	Std. Dev.
Cobs	0.642857	0.744946
Stems	1.28571	1.06904



Plate 7: Stem borers feeding on maize cob and stalk

DISCUSSION, CONCLUSION AND RECOMMENDATION

DISCUSSION

In this study, *Busseola fusca* (Fuller) was found to be abundant in Bungoma County. It occurred between 600m -2700m above sea level and is absent from the coastal area of Kenya and Tanzania. In South Africa, it is the dominant stem borer at an elevation above 900m. It also occurs at lower altitudes in S.Africa, clearly indicating the ability of this pest to adapt to low-lying and warmer areas (Harris and Nwanze, 1992)

Sesamia calamistis (Humpson) showed a spatial overlap across different ecological areas in space and time. Climatic variability caused a considerable variation in the abundance and distribution of stem borer species.

Stem borer distribution is also influenced by the ability of the stem borers to diapause and due to the presence of stem borers during the short planting season where the stem borers from the previous long planting season had migrated to the nearby crops and had also remained on the dry stalks and hence they were able to infest maize when conditions became favorable.

A study of *B. fusca* (Fuller) using isozyme variation revealed a significant geographic differentiation between populations collected at Lake Victoria and TransNzoia in Kenya (Calatayud et al, 2014) representing lowlands and highlands. Hence altitude affects distribution of stem borers.

Stem borers were more in stems compared to the cobs due to the favorable biophysical and biochemical factors in the former sites. This is attributed to the fact that stem borers attack young plants, where they tunnel and feed because the stems are tender (Mang'eni and Ogwang', 2004) The stem of the maize is also solid, succulent and sweet and under favorable conditions, more internodes develop, together with the leaves producing a longer stem which harbors numerous larvae. (Mulaa et al, 2011).The larvae may be found in the cobs where they enter from the stems.

CONCLUSION

Busseola fusca (Fuller) was the most prevalent species in Bungoma County. This is attributed to the fact that Bungoma County has an altitude and mean temperature that is favorable for the occurrence of stem borers. The stems are the most preferred site by stem borers because the plant is usually attacked at a young age when it is tender and the larvae grow in them and remain there for a longer period hence ovipositing and pupating in them thus their enhanced abundance.

RECOMMENDATIONS

Although the ecology of stem borers has been well studied in a number of African countries, there is need for confirmatory studies in many areas and additional work needs to be done to obtain answers to the possible evolution new strains that could be Trans- boundary.

There should be extensive field assessment on stem borer incidence and importance in farmer's fields to determine which areas are most at risk to attack by the stem borers.

Most importantly, the factors that influence the spatial distribution of stem borers in Bungoma County should be determined, together with factors that determine its occurrence in higher altitudes in the country at large.

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