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Survey On Incidence and Severity of Ear Rot Disease of Maize in Southern Borno State, Nigeria

Usman Talba, F.K. Channya, H. Hahunnaro and B.G. Zakari
[1]College of Education Waka Biu and [2]Modibbo Adama University Yola

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ABSTRACT: *Maize ear rot disease (cob rot) may occur either as a pre-harvest (causing kernel rots) after harvest. Fusarium graminearum, have been reported to be the most common causative agents of maize ear rots. Grain losses due to these ear rots are usually in the form of reduced grain-fill and weight. Pre-harvest infection can cause significant rotting on as many as 50-75% of the ears in a field under epidemic conditions. Data obtained were analyzed statistically using SPSS. Observations were presented in tables and pictorial forms using bar charts designed in Microsoft office 2013 excel sheets. Information from the farmers indicated that the occurrence of the pathogen varied in the various areas surveyed. The frequency of the disease showed that Biu had the highest average infection of 19.78%, followed by Hawul and Askira/Uba with 15.56% each, Damboa (13.33 %), Bayo (11.11%) while Chibok, Shani and Kwaya had the least infection of 8.89. Farmers interviewed indicated they are aware of maize ear rot disease and how it compromised grain quality. It was established that maize ear rot is caused by several factors among which were the variety of maize grown and the quantity of rainfall received. It is recommended that that farmers should obtained their seeds from certified seed dealers***.**

KEYWORDS: Survey, Fungal Disease, Maize, Ear Rot,

INTRODUCTION

Fungal species belonging to the genera *Fusarium*, *Aspergillus*, *Stenocarpella* and *Penicillium* are globally some of the most common pathogens of maize (International Maize and Wheat Improvement Centre (IMWIC), 2014). These fungi are often ranked second to insect pests as the cause of deterioration in, and loss of, maize in tropical regions (Mesterházy *et al.,* 2012). They attack maize at all stages of plant growth and in all plant parts, causing poor seed germination, seedling blight, plant wilting, stalk rots and ear rots (Abad *et al.,* 2017: Cheng *et al.,* 2012).

Maize ear rot disease (cob rot) may occur either as a pre-harvest infection or as storage moulds (causing kernel rots) after harvest (Ivić *et al.*, 2018). Of these fungi, *Stenocarpella* and *Fusarium* spp, have been reported to be the two most common causative agents of maize ear rots (Ivić *et al.*, 2018). Grain losses due to these ear rots are usually in the form of reduced grain-fill and weight. Pre-harvest infection can cause significant rotting on as many as 50-75% of the ears in a field under epidemic conditions (Lipps and Mills, 2013). Reports from surveys conducted in a few sub-Saharan African countries indicate the high prevalence of the *Stenocarpella maydis*, *S. macrospora, Fusarium graminearum* and *F. moniliforme* in pre-harvest and stored maize (Bigriwa *et al.*, 2017). Schjøth *et al.* (2008) identified *F. verticllioides* and *F. graminearum* as two of the most destructive diseases of hybrid maize in Zambia. Scientists in South Africa have reported a yield reduction of up to 15% (Li *et al.*, 2011). In Zambia, though yield losses due to ear rots have not been quantified reported a 10 – 50% yield loss in central Zambia following a severe epidemic of *Fusarium* ear rot.

Even where no significant yield loss has occurred, the ear rot fungi often produce aflatoxins in their hosts, affecting the quality of yield (Shukla and Dwivedi, 2013). Worldwide, aflatoxins have been isolated from maize and maize-based food products contaminated naturally with *Fusarium*, *Aspergillus*, *Penicillium*, *Stenocarpella* and other fungi. Of the several aflatoxins currently identified (Boutigny *et al.*, 2012) fumonisins B1 (FB1), B2 (FB2), and B3 (FB3), and aflatoxins are the most frequently detected in fungal cultures or in naturally contaminated maize in many countries (Boutigny *et al.*, 2012). The aflatoxins such as fumonisins and aflatoxins have been linked to livestock diseases, pulmonary edema and diarrhoea, and reduced body weight in broiler chicks (Blandino *et al.*, 2019). Humans are also affected: epidemiological evidence suggests a correlation between the consumption of *F. verticillioides*-contaminated maize and a high incidence of human oesophageal carcinoma (Chilaka *et al.*, 2012).

The maximum levels for aflatoxins in food are very low due to their severe toxicity, for example the maximum levels for aflotoxin set by World Health Organization in grains is 0.5-15μg/kg (a μg is one billionth of a kilogram (WHO, 2016). Several control measures have been suggested (Munkvold, 2013). The general strategy for all of them has been to alter the micro-environment under which maize is grown so that pre-harvest infection by the ear rot fungi is minimized (Ivić *et al.*, 2018). The methods used include improved tillage practices, fertilization practices, crop rotation, adjustment in the planting date; improved irrigation to limit drought stress; and correct harvesting times (Ivić *et al.*, 2018). However, these methods have had little or no success, due to their ineffectiveness and high cost hence the proposal for planting resistant varieties, genetic resistance has been proposed by many scientists since the 1950s (Duncan and Howard, 2010). Inherent resistance to ear rot fungi has been shown to exist in maize, but its usual polygenic nature and the poor agronomic performance of resistance sources has led to insufficient exploitation (Ivić *et al.*, 2018). More recently, the approach has been to use genetically modified maize or transgenic bt-maize hybrids (Bakan *et al.*, 2012). However, due to the environmental and human health concerns associated with maize, conventional breeding for resistance still remains the preferred option. It would be very useful to complement every possible source of resistance to ear rots and aflatoxins whether through transgenes or conventional methods (Duncan and Howard, 2010). The development of pre-harvest host resistance is probably the most effective and economical way of reducing ear rot infection and controlling aflatoxin contamination, especially in small holder maize production (Clements and White, 2014). The majority of poor farmers are not in a position to use other control methods such as improved irrigation, improved fertilizer application methods, and early use of fungicides because of the financial implications required to implement those (Li *et al.,* 2019).

Maize ear rots are many and varied, their occurrence is a complex expression of the interaction of evolutionary origins (old associations), seasonal origins (new associations), climatic suitability, pathogen and epidemic potential on one hand and susceptible host genotypes, pathogen populations and possible alternative hosts on the other (Cao *et al.*, 2013). The reported high levels of maize ear rot infections with the occurrence of wet seasons suggest that this disease may be weather dependent in the tropics (Duncan and Howard, 2010). Thus the challenge for maize breeding is to identify sources of resistance among adapted materials, and to design and develop varieties that will suffer fewer yield penalties during a favorable wet season when multiple types of maize ear rot occur (Abbas *et al.,* 2012). The threat posed by toxigenic fungi remains a complex and challenging problem despite years of progressive research worldwide (Chisholm *et al.*, 2016). Identification of multiple resistance to ear rots is important if maize productivity has to be enhanced, to achieve this in a recurrent selection program, each cycle of the population has to be screened for all major ear rots (Prasanna *et al.,* 2018). Superior disease resistant selections would then be crossed with typical variety of parents to produce progeny from which agronomical acceptable disease resistant varieties are selected, This is evidenced by the sporadic epidemic of ear rots that have been reported in some parts of the country, especially among smallholder farmers, the more recent being in the in Nigeria, though work on identifying the different maize ear rots has been done (Duncan and Howard 2010), very little has been done to elucidate the nature and level of resistance against these pathogens and how it could be enhanced (Schjoth *et al.,* 2018). Most of the commercially available hybrids continue to lack appreciable levels of resistance to ear rots and their associated aflatoxins (Bakan *et al.*, 2012). Currently the National Maize Breeding Programme does not emphasize selection for disease and pests due to human resource limitations, breeders have only been assessing for diseases as a secondary trait (Bakan *et al*., 2012). The genetic improvement of both local and exotic populations for ear rot resistance would not only increase the frequency of genes for resistance but yield as well (Duncan and Howard, 2010). Studies at the International Maize and Wheat Improvement Centre (IMWIC, 2014) in Mexico have shown that breeding for resistance to ear rots could increase yields by up to 2% (Bakan *et al.*, 2012). Given the low maize yields already reported as well as the occurrence of damaging epidemics, it is thus important for Nigeria to develop disease resistance breeding research capacity and to design a programme that incorporates strategies that eliminate or reduce the impact of ear rots on the social and economic welfare of its people (Cao *et al.*, 2013).

MATERIALS AND METHODS

The study was conducted in the year 2019 and 2020 in the months of August and September in Biu Local Government Area of Borno State (Figures 1). Biu Local Government Area is located on (Latitude 10^0 36' 39.96"N, Longitude 12^0 11' 42.00"E) in northern Guinea savanna ecology of Nigeria. The aim of the field experiment was to examine the maize varieties in respect to susceptibility to ear rot disease of maize and agronomic performance.

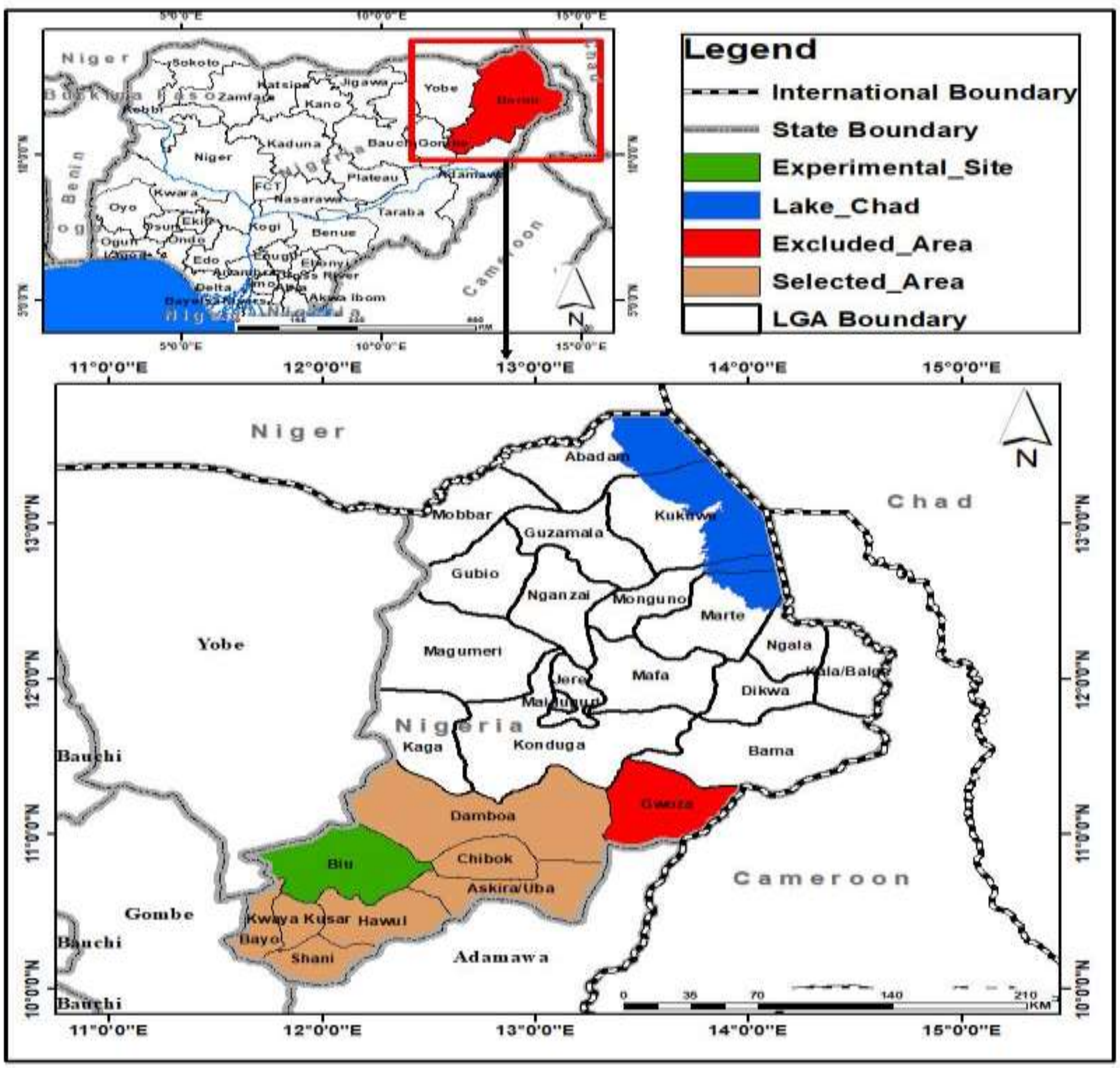

Figure 1: *Map of Borno State showing experimental site*

Source of Maize Seeds Samples

Two hundred (200) seeds each were collected from Damboa (DAM), Chibok (CBK), Askira/Uba (ASU), Hawul (HWL), Biu (BBU), Shani (SHN), Kwaya Kusar (KWY) and Bayo (BAY) Local Government Areas of Borno State after a survey was conducted and identified farmers who produce maize in each local government area were selected using simple random sampling. From each local government area, two locations (town/village) popularly known for production of maize crops were covered, and from each location two farms were identified for the seed collection, the seed samples were collected on the field.

The sample size was 160 representing 10 % of total population of 3200 maize seeds. Sunders *et al.*, (2012) reported that when the population runs into few hundred use 40 % or more, when several hundred use 20 %, when thousand use 10 % and when several thousand use 5 % or less.

RESULTS AND DICUSSIONS

Incidence of Ear Rot Disease of Maize

Incidence of rot was determined using simple percentage as was describe by Joseph (2011). Samples of maize seeds were randomly collected from farmers in the eight local government areas of Borno State namely: Damboa, Chibok, Askira/Uba, Hawul, Biu, Shani, Kwaya Kusar and Bayo. The choice of these eight local government areas was necessitated by their high maize production in the area, the samples were collected in a polythene bag, tightly sealed and labeled (CBK, DAM, ASU, HWL, BBU, SHN, KWAY and BAY) and taken to the laboratory for further studies adopting the approach of Joseph (2011).

$$\text{Percent Frequency} = \frac{\text{Total number of diseased maize seeds}}{\text{Total number of maize seeds}} \times 100$$

Table 1: Incidence of Maize Rot in Southern Borno

Location	**(%)**
Askira Uba	15.56
Bayo	11.11
Biu	19.78
Chibok	8.89
Damboa	13.33
Hawul	15.56
Kwaya Kusar	8.89
Shani	8.89
LSD=0.05	0.5

Key: ASU= Askira/Uba, BAY= Bayo, BBU= Biu, CBK= Chibok, DAM:=Damboa, HWL:=Hawul, KWY:=Kwaya, SHN: Shani

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Key
LSD: Least Significant Difference

Disease Severity
Disease severity is the percentage of relevant host tissues or organ covered by symptom or lesion or damaged by the disease. Severity results from the number and size of the lesions.

$$DS = \frac{\text{Sum of all diseases rating}}{\text{Total number of rating} \times \text{maximum disease grade}} X\ 100$$

One of the prerequisites of an efficient resistance screening system is the development of an effective and consistent disease assessment scheme. This research adopted the work of Stewart *et al.*, (2012) who found that the 7-class system, of rating kernels exhibiting visible disease symptoms (Plate I) as illustrated in Reid *et al.* (1996), provided an adequate rating scale for ear rot infection. Assessment or measurement of disease is the basis of epidemiology which is the study of disease at the level of populations of pathogens and hosts.

The rating scale is as follows:

1 = 0%	no visible symptoms
2 = 1 to 3%	esions absent or small
3 = 4 to 10%	lesions visible
4 = 11 to 25%	lesions become more visible
5 = 26 to 50%	visible lesions with black-brown colouration
6 = 51 to 75%,	lesions became prominent
7 = > 75%	kernel showing sign of disease infection.

It is also the basis of the study of the effects of disease on crop yield and of disease forecasting, which involves the prediction of the amount of disease that is likely to occur at some time in the future. It is usually not sufficient to determine whether a disease is present or absent. The critical information required is the amount of disease that is present. Disease often has to exceed a certain threshold before it reduces the yield of a crop. Small amounts have little effect on yield and the disease may not be worth controlling or the proportion of the area of a plant or plant organ (e.g. cob) that is affected.

Quantitative assessments of disease are based largely on comparisons between the yields obtained from diseased or damaged crops and those obtained from healthy or undamaged crops. Comparisons can be made between diseased and disease-free plants in the same crop or between diseased and disease-free plants or crops grown in different locations, provided that the locations have similar environmental conditions. Determining disease severity often requires estimating the proportion of the total photosynthetic area of the crop that is diseased which is often called the 'proportion of leaf area affected'. This measurement is much less precise and less controllable than measurements based on counting individual plants. Disease severity assessment relies on visual judgments which tend to be deceptive and to vary greatly from person to person. The human eye tends to detect grades of disease severity in logarithmic steps (0 to 100%). The most common method of estimating disease severity is the use of a set of diagrams (disease assessment keys) of a crop commonly leaves, but it could involve inflorescences, fruits or whole plants) showing different disease severities as blackened areas. Severity scales are adjusted to take into account the above concepts of visual perception. Samples of the crop are then compared with these diagrams to allow an assessment of severity. For common diseases it is helpful to use published keys to standardize measurements around the world.

Table 2: Severity of Fungi Isolated from Maize Seed

S/NO	Location	Percentage (%) Severity of Rot
1	Askira Uba	54
2	Bayo	56
3	Biu	61
4	Chibok	53
5	Damboa	52
6	Hawul	57
7	Kwaya Kusar	53
8	Shani	53
	Mean	54.88
	LSD	1.1

Key
LSD: Least Significant Difference

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