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Research Article

Incidence and Severity of Maize Streak Virus Disease on Maize (*Zea mays* L.) in Kano State, Nigeria

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ABSTRACT
Maize is one of the world's most productive cereal crops and plays a vital role in meeting global food demand. This study investigated the incidence and severity of Maize Streak Virus Disease (MSVD) across five Local Government Areas (LGAs) in Kano State—Garum Mallam, Kura, Dawakin Kudu, Madobi, and Tudun Wada—during the dry and rainy seasons of 2018 (April and August). Field assessments were conducted in farmers' fields using diagonal (X-pattern) sampling based on the West African Virus Epidemiology (WAVE) survey protocol. Both symptomatic and asymptomatic plants were evaluated, and data on disease incidence and severity were processed using Microsoft Excel and illustrated with bar charts. Results revealed a marked difference in MSVD incidence between the two seasons. Incidence in Garum Mallam was 21.7% (dry season) and 64.2% (rainy season); Tudun Wada, 21.2% and 63.5%; Kura, 15.5% and 62.0%; Madobi, 15.6% and 61.6%; and Dawakin Kudu, 10.7% and 70.5%, respectively. Disease severity was low during the dry season but increased to moderate levels in the rainy season.This study provides a baseline understanding of MSVD distribution in selected LGAs of Kano State. The findings are valuable to virologists, entomologists, and agricultural stakeholders, and can guide the development of effective management strategies to enhance maize productivity in the state.

Keywords: Hopper; Incidence; Maize; Severity; Streak

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INTRODUCTION

Maize is one of the important cereal crops in Nigeria, not only based on its cultivation and consumption, but also due to its economic value (Iken and Amusa, 2004). It constitutes a staple food in many regions of the world and has been of great importance in providing food for man, feed for livestock, and raw materials for agro-based industries (Soyoye *et al*., 2016). Annual maize production in the world was estimated at one billion metric tonnes, and Nigeria contributes 1% of the total world production, which is 10 million metric tonnes. Nigeria was ranked among the top 10maize producing countries in the world as at 2015, dropped to 13th position in 2016, yet the country maintains first position in maize production in Africa (FAOSTAT, 2018).

In Nigeria, virtually all tribes consume maize. The fresh maize cobs are boiled or roasted and consumed locally, while the dry grains are grounded into flour to prepare various food items such as solid food called

'*tuwo'* (hausa) or semi-solid food called *'pap'*. Corn-oil, a high-quality oil (cholesterol-free) is also extracted from the grain and the grain can be processed into industrial starch and cosmetics (Toungos *et al.,* 2016). Despite increase in maize utilization, increases in the production of the crop was thought to be due to increase in area under cultivation rather than increase in yield (Fasu-mensah *et al.,* 2012).

The yield potential for Sub-Saharan Africa (SSA) was estimated at five tonnes/ha, compared to the current yield of 1.7 tons /ha (CCAFS, 2019). This large yield gap was attributed to both abiotic and biotic constraints (Zerihun, 2017). The major abiotic constraint is drought that causes an annual yield loss of about 15% (Kamara *et al.,* 2003), while other important constraints are nutrients deficiencies (Nziguheba *et al.,* 2002). The most important biotic factors that are detrimental to maize production in Africa are insect pests, especially borers, parasitic weeds and disease pathogens, of which viral diseases are the most important (Mandefro *et al.,* 2002). Up to 100% maize yield loss was reported by Alegbejo *et al.* (2002).

Several species of Leafhoppers such as *Cicadulina arachidis, C. bipunctelata, C. bipunctella, C. chinae, C. fijiensis, C. fieneralis, C. ghuri, C. lateens, C. mbila, C. niger, C. parazeae, C. pastusae, C. similes, C. storeyi, C. tortilla, C. triangular,* and *C. vescula* transmit MSV and the virus has a broad host range including*Avena sativa, Axonopus compressus, Brachiaria lata, B. deflexa, B. distichophylla, B. erusaeformis, B. repens, B. uniloides, Calamagrostis canadensis, C. echinatus, C. argentina, C. radiata, C. gayana, C. submutica, C. virgata, Chloris gayana, Coix lachyma-jobi, Cymbopogon* spp*., Cynodon dactylon, Cyperus esculentus, C. rotudus, Dactyloctenium aegyptium, Digitaria enantha, D. horizantalis, D. marginata, Digitaria* spp. *Eleusine indica, Echinocloa colonum, E. tagnina, Eragrostis maxicana, Fustuca* spp., *Glyceria* spp., *Heteropogon* spp., *Holcuslanata, Hyparrhenia* spp*., Imperata* spp. *Leptochloa* spp., *Lolium* spp. *Pennisetum americannum, Paspalum conjugatum, Paspalum* spp. *Rhynchelytrum* spp., *Rottboellia cochinchinensis, Schedonnardus* spp*., Schizachrium* spp. *Setaria* spp., *Trichloris* spp., *Urochloa* spp., *Vaseyochloa* spp., and *Zea mays* (Alegbejo, 2015).

In SSA, MSVD is causing losses of $480 million USD annually, which is equivalent to 172.8 billion naira (Charles, 2014). Out-breaks of Maize streak virus disease are often associated with drought conditions or irregular early rains, especially in the savanna ecological zones (Alegbojo, 2015). Kano State is within the savanna zone of Nigeria, and is one the major maize producing States in the country, which in recent years' experience irregular early rains and with current hardship and food insecurity, farmers in the state dwell on massive cereal crop production in both dry and rainy season. In addition, Salaudeen *et al.* (2017) reported that out of 41 MSV positive samples diagnosed from four States of Nigeria, Kano State recorded 21 (51.2%). Although, the researchers collected samples from seven Local Government Areas of Kano State, incidence, severity and distribution of MSVD in the State were not evaluated. Hence, the present study aimed at determining the incidence, severity of maize streak virus disease in Kano State.

However, the study revealed that there is incidence and severity of MSV, transmitted mainly by the leafhopper *Cicadulina spp.*, functions as an agricultural pest threat in selected farm's fields of Kano State, this may cause recurring yield losses in maize.

However, understanding its biology and spread dynamics also aligns with principles of quarantine pest management, since preventing the movement of infested plant materials and vectors is critical in strategy in preventing the spread of such disease within unaffected areas. Furthermore, the research work may be of great benefits in justifying the need for surveillance, early detection, and targeted control measures, which collectively support effective disease management and protect maize production in the State.

MATERIALS AND METHODS

Field survey

Field Survey was conducted during the dry and rainy (April and August) farming seasons of 2018. Five maize growing Local Government Areas in Kano State of Nigeria were surveyed. The surveyed Local Government Areas were; Garum Mallam, Tudun Wada, Kura, Dawakin Kudu, and Madobi, in each Local Government Area, two Villages/farms were randomly selected, surveyed and maize leaf samples were collected. Moreover, the coordinates of each farm was collected using an android phone; Dakasoye

and Garim Babba **(**11°43' N, 80°25' S, 468 m and11°36' N, 80°27' S, 491 m**)** in Garum Mallam Local Government Area, Karfi and Imawa (11°50' N, 80°29' S, 448 m and11°48' N, 80°28' S, 452 m) in Kura local government Area, two farms in Hausawar Kaba (11°52' N, 80°30' S 434 m and 11°53' N, 80°32' S 438m) in Dawakin Kudu Local Government Area, Kubarachi and Chindo (11°46' N, 436 m and 8°23'S, 439m) in Madobi Local Government Area, and Yaryasa Gada and Yaryasa Magami (11°20'N,522m and 8°18'S, 509m)

Survey and Field assessment of Maize Streak Virus Disease

Assessment of Maize Streak Virus Disease were carried out in the farmers' fields diagonally (X) according to the cassava viruses survey protocol designed by West African Virus Epidemiology (WAVE) for roots and tuber crops project (Sseruwagi *et al.,* 2004). The survey was carried out during 2018 dry and rainy seasons. Five Local Government Areas of Kano State were selected while two maize growing locations were randomly selected in each Local Government Area, giving a total number of ten locations surveyed. Four leaves were assessed on each eight maize plants per location along each diagonal. The assessments and sample collection were done on symptomatic and asymptomatic maize plants. The total number 160 leaf samples were collected for both dry and rainy seasons. Samples were labelled and stored in a herbarium prior to analysis.

Sample processing and preservation

Fresh leaf samples were collected, cut into portable sizes using scissors. The samples were also pasted on a plane sheet (herbarium) appropriately labelled using masking tape. The samples were stored at room temperature at the Abdullahi Fodio University of Science and Technology, Aliero (AFUSTA) Molecular Biology Laboratory for DNA extraction, PCR amplification and Gel Electrophoresis.

Disease incidence

MSV Disease incidence was calculated using the formula given below:

Disease incidence (%) $= \frac{\text{No. of plants with symptoms}}{\text{Total no. of plants assessed}}$ x 100. (Sseruwagi *et al.,* 2004)

Disease Severity

Leaf symptoms severity was scored using a scale of 1-5, where 1 = no visible disease symptoms/symptomless, 2 = mild symptoms, 3 = pronounced foliar symptoms, 4 = severe symptoms, and 5 = very severe foliar symptoms (Gwandu *et al.,* 2015).

Data Analysis

Data collected for the incidence and severity were subjected to Microsoft Excel 2023 version while bar charts were used to present data.

RESULTS

The incidence of MSD during the dry season is presented in Figure 1. Garum Mallam local government area recorded the highest disease incidence with (21.7%), followed by Tudun Wada Local Government area with (21.2%), Kura and Madobi were ranked third and fourth (15.6% and 15.5%) Dawakin Kudu Local Government Area had the least, with (10.7%) MSVD among the local government areas during the field survey Figure 1.

The results on severity status of Maize Streak Virus Disease during the 2018 dry season is presented in figure 2. Garum Mallam and Madobi (1.25) revealed same and highest severity score, which is significantly higher than that of Tudun Wada and Kura (1.44) Local Government Area of Kano State. The least severity status was recorded by Dawakin Kudu Local Government Area with (1.06) Figure 2.

The incidence of MSD recorded during the rainy season is presented in Figure 2, up to 70.5% of disease incidence was recorded in Dawakin Kudu Local Government Area. Garum Mallam, (64.2%) was ranked second, followed by Tudun Wada with disease severity status of (64.2%), Kura Local Government Area (62.0%) was ranked forth. The least disease incidence was recorded in Madobi Local Government Area of Kano State Figure 3.

The study revealed that, there is higher disease severity of MSVD during the rainy season across selected Local Government Areas of Kao State where the surveys were conducted. Garum Mallam and Madobi (2.82) had the same and highest severity, followed by Dawakin Kudu (2.63), Tudun Wada and Kura (2.50) Local Government Areas were ranked forthwith same severity status, and the least was recorded in Figure 4.

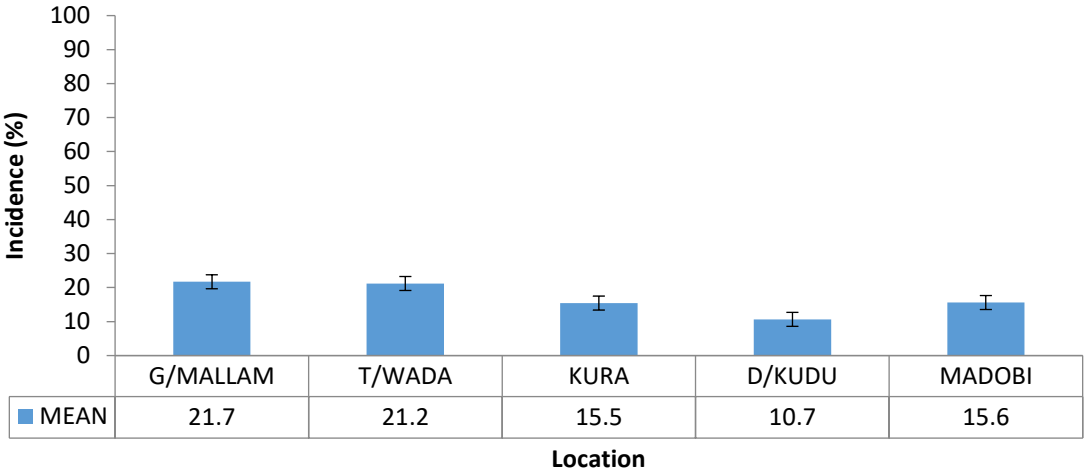

Figure 1: Incidence of MSD on maize fields in 5 local government areas in Kano state during dry season of 2018

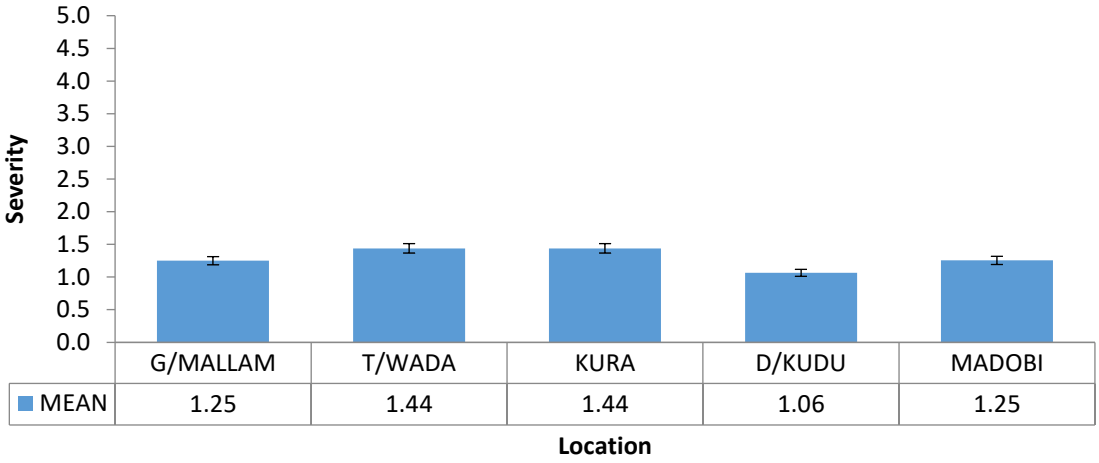

Figure 2: Severity of MSD on maize fields in 5 local government areas in Kano State during dry season of 2018

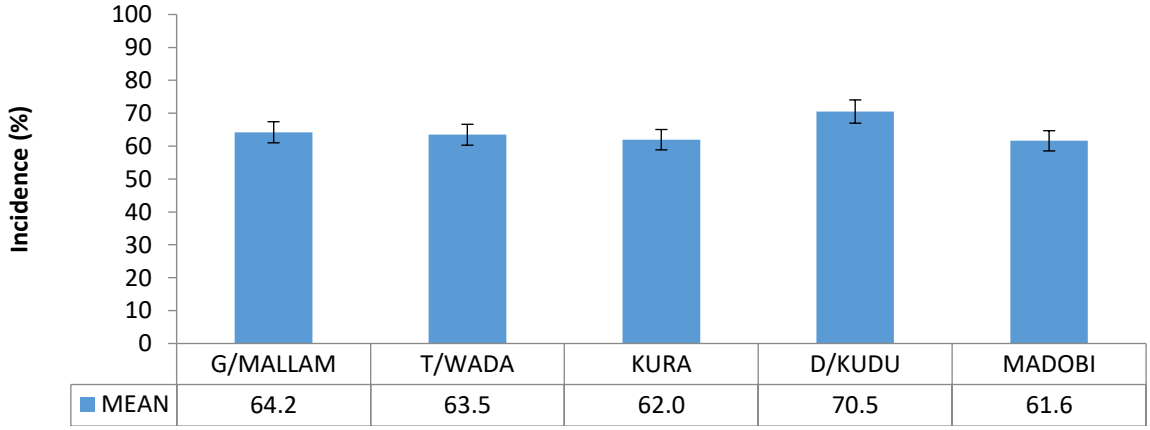

Figure 3: Level of Incidence of virus symptoms on maize fields in 5 local government areas in Kano State during the rainy season of 2018

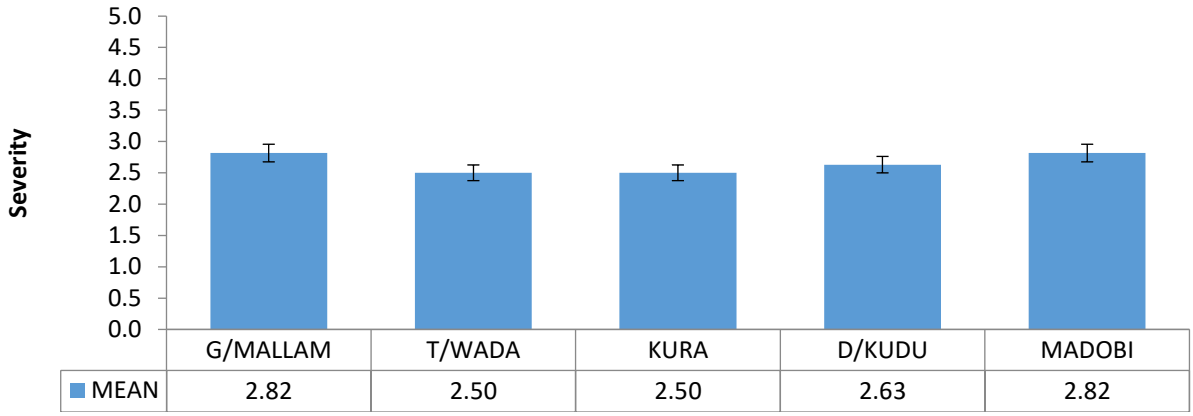

Figure 4: Level of severity of the virus disease symptoms on maize fields in 5 local government areas in Kano state during the rainy season of 2018

DISCUSSION

The survey carried out in five Local government areas of Kano State in dry season of 2018 revealed that MSVD occurs in all the study areas. Disease incidence was generally low during the dry season. Garum Mallam having the highest (21.7%), followed by Tudun Wada (21.2%) could probably be due to intense cultivation of maize in both dry and rainy seasons in 2018 which made the vector more prevalent in the study locations. This affirmed the findings of Salaudeen *et al.* (2017) which stated that incidence of streak disease was high in Kano partly because of the intensive maize cultivation. Dawakin Kudu was the least with only 10.7% incidence, Kura and Madobi Local Government Areas recorded incidences of only 15.5 and 15.6% respectively. In general, the incidence of the disease was very low during the dry season, and this is in line with the findings of Alegbejo and Banwo (2005) which stated that *Cicadulina* population builds up with rain.

The level of disease severity in the dry season which showed that Tudun Wada and Kura local government areas both recorded 1.44 indicating mild severity, Garum Mallam and Madobi local government areas both recorded 1.25 while Dawakin kudu local Government Area recorded only 1.06. This shows that the disease exists at a very low severity scale in dry season in the study locations. This agrees with the findings of Alegbejo and Banwo (2005) which stated that, Leafhopper incidence was highest in the months of September and October for three years (2000-2002) of their studies at Samaru Zaria. This may be attributed to the sampling period during the dry season (April, 2018) which did not coincide with the peak period of vector population due low relative humidity (29.5%) and high mean temperature (32^0C).The temperature and relative humidity that enhances the survival of eggs and nymphs were 25.3^0C and 70%, respectively, where the developmental periods of eggs and nymphs were significantly shortened as the temperature increased to 34.0^0C (Mesfin *et al.,* 1995; Tokudo and Matsumuru 2005). Also, Alegbejo and Banwo (2005) affirmed that MSV incidence was closely associated with vector population dynamics which in turn, was influenced by rainfall, temperature and availability of alternate hosts. Later, Nilsa *et al.* (2013) added that MSV epidemics occur only in years when weather conditions allow vector survival and build-up, and where maize-competent strains were present in other hosts.

The disease incidence during the rainy season was generally high as the study revealed that Dawakin Kudu recorded the lowest incidence (10.7%) during the dry season but had the highest incidence (70.5%) during the rainy season. This could probably be due to micro climate created by many mango trees in the sampling units and this corroborates with the findings of Asare-Bediako *et al.* (2017), which reported that higher incidence of MSD in maize plants growing under tree shade than those in open parts of maize field. Findings by earlier workers (Kyerete *et al.,* 1999) have reported greater incidence of MSVD in shade than in the open parts of the field due to the vector

preference for the shade. The disease incidence recorded in Garum Mallam (64.2%), Tudun wada (63.5%), Kura (62.0%) and Madobi (61.6%) could probably be a true indication that the disease existed moderately in all the study locations during the rainy season. This could be attributed to the optimum temperature and adequate rainfall that enhanced the vector (*Cicadulina* spp) population observed at that period (August, 2018) unlike in dry season. A similar report was made by Alegbejo and Banwo (2005), that there was a significant positive correlation between the following factors: number of leafhoppers caught per week and incidence of MSV; number of leafhoppers caught and mean temperature; number of leafhoppers caught and sun- shine hours; MSV incidence and age of plants; MSV incidence and mean temperature. Added to these, Kano State belong to Savanna agro-ecology, which is generally home to grass plants that enable leafhopper vectors to survive between seasons (Salahuddeen *et al.,* 2017).

From the severity result in rainy season, Garum Mallam and Madobi recorded highest mean severity of 2.82 (Pronounced folia symptoms) probably due to high percentage of positive samples (87.5% and 82.5% respectively) identified in two local government areas during the rainy season. This corroborates with the findings of Salahudden *et al.* (2017) that mean incidence of MSD as recorded in a season was positively and significantly correlated with the mean of disease severity scored. That aside, the severity was usually at its peak as the rainy season progresses indicating that the proportion of viruliferous leafhoppers increased as the season progressed Shepherd *et al.* (2009). Dawakin Kudu recorded severity of 2.63 while each of Tudun Wada and Kura had a severity of 2.50 indicating the existence of MSD in the study areas. Salaudeen *et al.* (2017) stated that of the 41 samples that tested positive, the incidence of MSV disease was highest (51.2 %) in Kano.

CONCLUSION

This study confirms the presence of Maize Streak Virus Disease (MSVD) in selected Local Government Areas of Kano State, with results indicating that both incidence and severity are considerably higher during the rainy season than the dry season. The increased disease pressure observed during the rainy period is critical, particularly where infection occurs at the early growth stages of maize, leading to significant yield loss. Given that viral diseases have no direct curative measures, preventive and management strategies remain the most effective approach.

To reduce the incidence and severity of MSVD and safeguard maize productivity in Kano State, farmers should plant maize early in the season to help the crop escape peak virus infection periods associated with high vector activity. Regular monitoring of MSV and its leafhopper vectors (*Cicadulina* spp.) should be carried out in farmers' fields to guide timely control measures. Repeated cultivation of maize on the same field across seasons should be discouraged to break disease and vector cycles. Integrated pest management (IPM) strategies targeting leafhopper vectors should be encouraged to reduce disease transmission. Farmers should be sensitized on MSVD symptoms, causes, and preventive practices to enhance early detection and proper field management.

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