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Research Paper

Serological Detection and Distribution of Eggplant Mosaic and Eggplant Mottled Dwarf Viruses in Kano State of Nigeria

[1]Agbala C. C., [1]Kashina B. D.,[1]Banwo O. O., [2]Abdulmalik I. O., [3]Chukwu P. U., [4]Aminu Saleh and [3]Amonye M. C.

[1]*Department of Crop Protection, Faculty of Agriculture, Ahmadu Bello University, Zaria,Nigeria*
[2]*Hydraulic equipment Development Institute (HEDI), Kano*
[3]*National Board for Technology Incubation (NBTI), Federal Secretariat Phase II, Abuja.*
[4]*Department of Agricultural and Bio-Resources Engineering, Ahmadu Bello University, Zaria.*

Abstract: *Eggplant (S. melongena) is an important and popular vegetable crop which is commonly grown in Nigeria and other parts of the world. It is affected by several viruses among them Eggplant mosaic virus (EMV) and Eggplant mottled dwarf virus (EMDV) are two of the important destructive viruses causing considerable yield loss. Eggplantproduction has a huge impact on the cultural, economic, nutritional and environmental lives of people especially in Kano State as one of the major producers of the crop in Nigeria. The need to guide the farmers through scientific information and technology suggested this targeted study on two most prominent viruses affecting the plant. There are insufficient information pertaining to the crop and works on eggplant viruses and their alternative hosts in Kano State are not available. This research was carried out in order to evaluate the presence and distribution of the two viruses within the major eggplant farming communities in Kano State of Nigeria. Most infected plants in the areas surveyed showed virus-like symptoms consisting predominantly of mottling, chlorotic, leaf distortion and stunted growth. A total of two hundred and seventy both of symptomatic and asymptomatic eggplant leaf samples were collected from the state. Twenty-one weed samples were also collected. The samples were screened using the Double Antibody Sandwich Enzyme linked Immunosorbent Assay (DAS-ELISA) for the presence of Eggplant mosaic virus (EMV) and Eggplant mottled dwarf virus (EMDV). Results showed that EMV and EMDV were detected in some of the samples. EMV and EMDV were detected in single infection (EMV 33.33%, EMDV 8.33%). A single case of mixed infection was detected (8.33%). Axonopus compressus(Goat weed)tested positive for EMDV. The study provides informationfor farmers to constructively develop a framework for protection of eggplant from EMV and EMDV attack.*

Keywords: *Eggplant, Kano, Virus, EMV, EMDV, Incidence*

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I. Introduction

There are three common species of eggplant. Solanum melongena which originated from India (Shenia and Gangshuana (2018). Solanum macrocarpon) and Solanum aethiopicum which originated from West Africa (Arogundade et al., 2018). Solanum macrocarpon) and Solanum aethiopicum collectively called African eggplants have been domesticated and are grown predominantly in Africa and are important especially in Central and West Africa. Both species are found throughout the tropical Africa (Lester and Seck, 2004). Eggplant is a highly branching plant which can grow up to 2 m in height. The leaves of the plant are arranged alternately on the stems and have smooth or lobed margins. The leaf petioles are oval or elliptical in shape, reaching up to 11cm in length. S. *macrocarpon* can grow up to 1-1.5m in height. It has an alternate leaf pattern, the width of the blade ranges from 4-15cm and the height is 10-30cm. the leaves are oval in shape, lobed with a wavy margin (Ibeawuchi et al., 2015). The different species and varieties of eggplant vary particularly with respect to their morphology (plant growth habit, vigour, hairiness, fruit shape, fruit size, fruit colour and yield potential), physiology (flowering pattern and water use) and biochemical properties (fruit bitterness and glycoalkaloid content. The most obvious characters that vary among the different varieties of garden egg include the fruit size, fruit shape, fruit colour and taste (Oso and Borishade, 2017). The fruits may be pear shaped,

round, long or cylindrical depending on the variety (Degri, 2014) , and with different colours ranging from white, yellow, green, purple to almost black (Aminifard et al., 2010).

The African eggplant ranges from white to green in colour while, its Asian counterpart is large and purple in colour (Sifau et al., 2014). At full maturity, the fruits of the African eggplant turn yellow, orange or brown (Lester and Seck, 2004). The Brinjal eggplant (*Solanummelongena*) has hairy leaves, purple flowers and a yellow fruit when ripe; the Scarlet eggplant (*Solanumaethiopicum*) has hairy or glabrous leaves, white flowers and the fruit colour ranges from orange to red when ripe while the Gboma eggplant (*Solanummacrocarpon*) has glabrous leaves, large purple or white flowers and fruits which are yellow or brown when ripe (Schippers, 2000). *Solanumaethiopicum* L, the bitter tomato also known as the Ethiopian eggplant or akati has yellow or white flower with yellow stamen, and fruits with white red or yellow rind sometimes stripes. The shape can be round or round lobed while the inside of the fruit is white or light green. The highly variable fruit of the plant is eaten both raw and cooked, some with a sweet flavor and others very bitter. It is sometimes used to make a tomato based sauce which can be used to eat yam (USDA, 2015). S. *macrocarpon* L has oval shaped fruits which are green when young or purple and white colour with dark stripes and ripens to yellow or a yellow-brown. The fruits and young leaves of S. *macrocarpon* taste very bitter and are consumed for their high nutrient yield (Oso and Borisade, 2017)

Eggplants are widely distributed in Asia, Africa and South America (Doijode, 2001). In Africa, they can be found in Southern Senegal, Nigeria, Central Africa across to Eastern Africa, and from Central Africa south to Angola, Zimbabwe, and Mozambique (Chadha and Mndiga, 2007), Northern Ghana and Burkina Faso (Ibeawuchi et al.,2015). They are especially important in Southeastern Nigeria, Cameroon and Uganda (Chadha and Mndiga, 2007). They are occasionally grown in southern France and Italy. S. *aethiopicum* has also been introduced into the Caribbean and South America and is grown in some parts of southern Italy. (FAO, 2017). Eggplant *(Solanum* spp.*)* is one of the most important vegetable crops in Nigeria and other West African nations. It is one of the top ten vegetables in the world and the sixth most widely grown vegetable produced in the world after tomato, watermelon, cabbage, onion and cucumber (USAID and PDBA, 2006). Eggplant is second to tomato as the most important *Solanaceae* fruit crop (David *et al.,* 2018). It is an economic flowering plant belonging to the family *Solanaceae* (Pessarakli and Dris, 2003), mostly cultivated in Asia with about 74% of the world's production (Shenia and Gangshuana 2018).

It is an economically important crop in Asia, Africa and sub-tropical countries like India and Central America (Aminifard *et al*., 2010). Eggplant is perennial in nature but it is cultivated commercially as an annual crop (Elettа*et al.*, 2017). The specie, *Solanum melongena* L (Brinjal, aubergine or the common eggplant) is the most popular specie and it is cultivated worldwide (Aliero, 2007, Knapp *et al.*, 2013). *Solanum aethiopicum* L (Scarlet eggplant) and *Solanum macrocarpon* L (Gboma eggplant) are the two horticultural important eggplant species indigenous to Africa (Schippers, 2000). Eggplant is a vegetable with increasing popularity in the world (Pessarakli and Dris, 2003). It is widely cultivated across most of the African continent but more intensively in East and West Africa (Nwaiwu *et al*., 2012). Eggplant vegetables are mostly annual crops which belongs to the group of plants called horticultural crops (Omotesho *et al*., 2017). It is an indigenous tropical African crop grown for its nutritional, medicinal and economic values of the leaves and fruits, with various varieties of economic importance commonly produced in Nigeria. Eggplant is mainly grown in mixed cropping system. It is usually grown in compound or backyard farms using householdorganic refuse or farm yard manure (Oso and Borisade, 2017). The production and consumption of *S. melongena* is on the increase in East Africa although it is popular in South Africa. (Adeniji and Aloyce, 2012). The name "Garden egg" was derived from the shape of the fruits of some varieties which are white and shaped like chicken eggs (Chen *et al*., 2001; Anyaegbu *et al*., 2013). It is called Brinjal in India while Europeans call it Aubergine (Doijode, 2001). In Nigeria, it is commonly called 'Garden egg'; the Igbos call it anara or Afufa (David *et al.,* 2018); the Yorubas call it ikan while the Hausas call it yalo (Schippers, 2000; Ndagana *et al*, 2020).

The four cultivar groups of *S. aethiopicum* are the shum group, the kumba group, the Gilo group and the aculeatum group (Schippers, 2000). The Gilo, Kumba and Shum groups are the most important groups in Africa. The Gilo and Kumba groups are cultivated for their fruits particularly in the humid zone of West Africa while the Shum group is produced for its leaves in the savannah area (Nwaiwu *et al*., 2012). Although excessive rainfall affects both vegetative growth and flower formation, the plant is well adapted to both wet and dry season cultivation (Degri, 2014). It is one of the most traded indigenous vegetables in the local markets (Majubwa *et al*., 2015). It also offers gainful employment among the rural households and its cultivation is not limited to any age or sex (Anuebunwa, 2007).

A number of pests and diseases attack eggplants in the field (Horna and Gruere, 2006). The damage drastically reduces yields and affects the quality and quantity of the produce (Onu *et al*., 2016). In order to obtain high yield of this crop in Nigeria, there is a great need to work together for the development of Eggplant varieties that can meet the challenges of the present and the future. An understanding of the viruses that infect Eggplants is a pre-requisite for formulating effective control measures. Disease management relies strongly on a

fast and accurate identification of the causal agent. This study carried out serological detection and distribution of two very destructive viruses attacking eggplants in some local government areas in Kano State with a view to appraising the methodology of infections and formulate strategies for combating the viruses and proffering solutions for protecting the crop.

For optimum growth and development of eggplant, soil and climatic should be relatively high temperatures. It requires optimum day temperature of 25-35ºC and optimum night temperature of 20 - 27ºC (Norman, 1992; Obeng-Ofori et al; 2007). A well-drained soil rich in organic manure and pH ranging from 5.5-6.5 is suitable for its production (Rice et al; 1993, Nwaiwu et al., 2012). Eggplant is well adapted to high rainfall and high temperatures, and is among the few vegetables capable of high yields in hot-wet environments (Hanson et al 2006). According to Nwaiwu *et al.,* (2012), the root system is sensitive to high temperature and excess water, deep cultivation prior to planting is required. NPK fertilizer 15-15-15 or 10-10-20 should be applied at 150 kg per hectare days after transplanting and at 50 kg per hectare at the initial flowering and subsequently at monthly intervals (PROTA, 2004)

II. Materials and Methods

SurveyandSample collection: Surveys wereconducted in the 2017/2018 and 2020/2021dryseasons to determine the incidence of *Eggplant mosaic virus* (EMV) and *Eggplant mottled dwarf virus* (EMDV) on eggplants and weeds in Kano state.Three Local Government Areas (LGAs) known for cultivation of Eggplant were selected from the State. Three farms fromeach of the three LGAs were surveyed in the state. Kura, Kumbotso and Makoda LGAs were surveyed. During the survey, data on age of plants, crop protection measures taken, cultivar type, cropping pattern, history of cultivation, surrounding crops and source of seed were taken by the use of a questionnaire. The co-ordinates and elevation were recorded with the use of a Global Positioning system (GPS). The disease incidence was recorded as a percentage of the number of diseasedplants to the total number of plants examined as shown in the formula below

$$\text{Disease incidence (\%)} = \frac{\text{Number of diseased plants}}{\text{Total number of plants examined}} \times 100$$

In each field, 3×3 m^2 sized-quadrat was set up at four corners and atthe center of the field. Six leafsamples were collected from each quadrat; four symptomatic and two asymptomatic per quadrat making a total of thirty samples from each farm (twenty symptomatic and ten asymptomatic). Ninety eggplant leaf samples were collected perLGA; making a total of two hundred and seventy eggplant leaf samples.The sampleswere carefully labeled, wrapped in polyethylene bags, placed in an ice chest and transported to the Virology Laboratory of the Department of Crop Protection, Ahmadu Bello University, Zaria. Twenty-one weed leaf samples were collected within each farm and about 2 meters around the farms. The weed samples were also labeled, wrapped and placed in an ice chest alongside the eggplant leaf samples.The weed species were identified at the Herbarium in the Department of Botany, Ahmadu Bello University, Zaria.

III. Result and Discussion

The two viruses, *Eggplant mosaic virus* (EMV)and *Eggplant mottled dwarf virus* (EMDV) were detected in Kura LGA in both years. *Eggplant mottleddwarf virus*was not detected in Kumbotso in 2018 but was recorded in 2021 while in Makoda LGA none of the viruses was detected in 2018 although EMV was recorded in 2021. Agronomic practices such as cropping pattern, nature of surrounding crops in some of the LGAs may have contributed to low or no disease incidence. In Kumbotso LGA in 2018, farmers intercropping eggplant with crops of a different family like sugarcane, and with the surrounding crops namely maize, cowpea and onion which are from a different family as observed in Kumbotso LGA canlower the spread of the viruses. Sugarcane and maize act as tall barrier crops.Cowpea, onion and maize are non-hosts of the viruses. Majority of the farms in Makoda LGA were regularly weeded which could be the reason why none of the viruses was detected in Makoda LGA asregular weeding helps to prevent disease build-up by eliminating plants that harbor disease organisms. Farmers in Makoda LGA in 2018, intercropped eggplant with crops of different families. In 2021, EMV was detected in Makoda LGA contrary to a no disease record in 2018, this could be attributed to the fact that eggplant was cultivated as a sole crop in the location. A *solanaceous* crop (pepper) was also grown as a surrounding crop. The practice of growing non solanaceous crops (maize and millet) in rotation during the previous growing season could lead to the reduction of the vector population as infections in susceptible crops largely depend on the presence and activity of insect vectors.

In some other farms within the locality, nothing was previously planted in the field. This is shown in the low percentage incidence of EMV in Makoda LGA compared to Kura and Kumbotso LGAs in 2021. In contrast, farmers in Kumbotso LGA grew Solanaceouscrops (pepper and tomato) in previous season as well as surrounding crops. A number of factors could have led to the high percentage incidence of viruses in some

LGAs namely Kura and Kumbotso. Among such factors include uncertified seeds as seed borne infection could arise from uncertified seeds as many of the farmers sourced their seeds from previous harvests (Ayo-John and Odedara, 2014). There is also the cropping pattern and nature of surrounding crops. In some farmers' fields it was observed that eggplant was inter-planted with crops of the *Solanaceae* family like pepper and tomato. According to Ayo-John and Hughes (2014), mixed cropping system practiced by some subsistent farmers in Nigeria enhances virus spread. Continuous cropping may lead to disease build-up (Ayo-John and Odedara, 2014). Monoculture has been reported to increase inoculum build-up (Taiwo *et al.*, 2017). Figure 1 depicts the incidences of the viruses in the three selected Local government areas of Kano State in 2018 during the dry season while figure 2 shows the incidences in 2021 during the dry season.

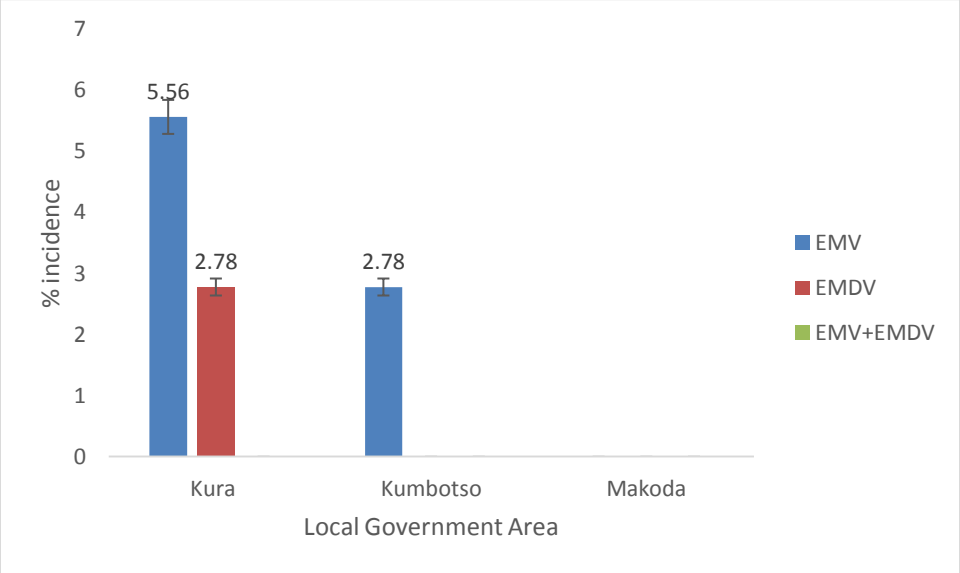

Figure 1: Incidence of viruses in Kano state during the 2018 dry season

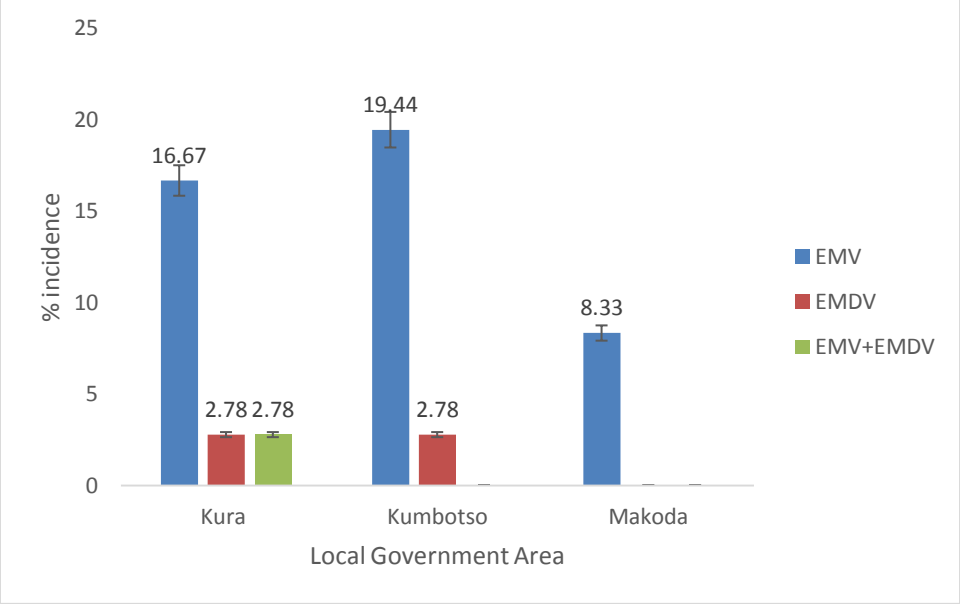

Figure 2: Incidence of viruses in Kano state during the 2021 dry season

Infection ofviruses as detected in Kura LGA (Figure 2) have biological, epidemiological and economic implications. Viruses can react synergistically to create pathogenic effects which could lead to severe symptoms on eggplants (Taiwo *et al.*, 2007).In the absence of control measures, severe virus infections and yield losses can occur.*Axonopus compressus*, (carpet grass) tested positive for EMDV.According to Hancisky *et al*., (2020), weed species can harbour plant viruses. When present in or around farms, weeds can be harmful especially when they are carriers of viruses with a wide host range (Khan and Dijkstra, 2006). This is due to the fact that

they contribute to the occurrence and dissemination of virus during the growing season. Insect vectors acquire viruses when feeding on infected weeds and can transmit them to healthy plants (Goyal *et al*.,2012).

IV. Conclusion

The study showed for the first time the occurrence and distribution of two pertinent economic viruses of eggplant-*Eggplant mosaic virus* and *Eggplant mottle dwarf virus*associated with eggplant production in KanoState. The viruses were found in the various locations visited. A total of two hundred and seventy, both of symptomatic and asymptomatic eggplant leaf samples were collected from the state. Twenty-one weed samples were also collected. The samples were screened using the Double Antibody Sandwich Enzyme linked Immunosorbent Assay (DAS-ELISA) for the presence of Eggplant mosaic virus (EMV) and Eggplant mottled dwarf virus (EMDV). Results showed that EMV and EMDV were detected in some of the samples. EMV and EMDV were detected in single infection (EMV 33.33%, EMDV 8.33%). A single case of mixed infection was detected (8.33%). Axonopus compressus (Goat weed) tested positive for EMDV. The study provides a platform to farmers to constructively develop a framework for protection of eggplant from EMV and EVDV attack.The study successfully determined the occurrence and distribution of Eggplant mosaic virus and Eggplant mottle dwarf virus associated with garden egg in Kano State. The survey shows an incidence of the two viruses with higher incidence of Eggplant mosaic virus (EMV) than Eggplant mottled dwarf virus (EMDV).The survey and information obtained enables scientific advice to eggplant farmers in Kano for greater quality and quantitative productivity in the sector.

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