Original Research Article

INCIDENCE OF PLANT VIRAL DISEASE SYMPTOMS AND THEIR TRANSMISSION AGENTS IN DUTSIN-MA METROPOLIS

Abstract

This work explores the incidence of plant viral disease symptoms as well as their transmission agents in Dutsin-Ma Local Government Area Katsina State, Nigeria. The studied diseased plants were identified while diseases were based on visual inspection using characteristic symptoms. Organisms associated with such symptoms were collected by handpicking, shacking/beating and tissue teasing methods. Identification was done using a standard voucher. Incidence of plants with viral symptoms was determined by plant disease index method. Chi square analysis was used to ascertain significant differences (P≥ 0.05) of plants showing viral symptoms. Results shows that plants with viral symptoms included *Amaranthus sp.* (Amaranthus), *Vigna unguiculata* (cowpea), *Zea mays* (maize), *Abelmoschus esculentus* (okra), *Carica papaya* (pawpaw) and *Capsicum sp (*pepper). Studies also reveal *Myzus persicae* (aphids), *Frankinella occidentalis* (thrips), *Bemisa tabaci* (whitefly), *Peregrinus maydis* (leafhoppers) and *Pseudococcidae* (mealy bugs) as organisms associated with diseased plants with viral symptoms. Disease index showed *Amaranthus spp*. 63%, *Vigna unguiculata* 84%, *Zea mays* 73%, *Abelmoschus esculentus*, *Carica papaya* and *Capsicum spp.* 100%. Incidence rate varied significantly (P≥ 0.05) in the various locations surveyed. Further studies need to be carried out to identify the individual viruses.

Keywords: Incidence, plant viral diseases, symptoms, transmission agents.

Introduction:

Plants have been a major source of food, fibre, medicine and shelter since their domestication several years ago (Savary *et al.*, 2006). Around 80% of agricultural activities in the world are channelled towards animal feed production and food (Bem *et al*., 2012). In the 20th century, crop production was focused on increasing productivity to meet the worlds increasing population (Evans, 1998; Smil, 2000; Nellemann *et al*., 2009). Despite these efforts, some factors have limited the achievement of this goal. Plant diseases make up one of these factors as they affect food quality and quantity (Strange and Scott, 2005). The key causative agents responsible for plant diseases are non-parasitic agents that include environmental factors such as humidity and temperature and parasitic agents consisting of fungi, parasitic nematodes, bacteria and viruses (Bem *et al.*, 2012; Walkey, 1991).

Viruses among other parasitic agents are responsible for several plant diseases thus reducing plant yield and quality universally. About one thousand (1000) of four thousand (4000) estimated viruses have been identified to be plant related. One of the key reasons for studying plant viruses is to diagnose the negative impact of the diseases caused by this organism on plants (Gergerich, 2006). The transmission of plant viruses from one host to the other is usually through tubers, bud wood or seeds (Andret-Link and Fuchs, 2016). Most viruses that cause plant disease depend on biotic vectors for their survival and transmission (Ralf *et al.*, 2016). Almost all plants cultivated by humans for fibre, livestock feed and food are affected by at least one virus. Although plant viruses do not cause immediate effect on humans as with that of human viruses, they indirectly affect food supply significantly (Gergerich and Dolji., 2006) thus, the loss of several cultivated crops in different countries of the world (Cembali *et al.*, 2003; Hull, 2002).

Despite several efforts that include quarantine (Bem *et al*., 2012), cultivation of viral free planting materials (MacFarlane *et al*., 2016) and development of transgenic resistant varieties (Sohrab *et al*., 2016) to curb the spread of plant viruses as well as their effects; the incidence and transmission of plant viruses remains an omen to plant cultivation worldwide. This study explores the incidence of plant viral disease symptoms as well as their transmission agents as a base work in Dutsin-Ma Local Government Area (DLGA) Katsina State with the following objectives include;

- To determine crop plants with viral symptoms in DLGA.
- To determine and identify insect vectors associated with the viral diseased plants.
- To determine the incidence of crop plants with viral symptoms
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Materials and Methods:

Study Area

This study was carried out in DLGA, Katsina State, Nigeria. DLGA lies on latitude 12°26'18" N and longitude 07°29'29" E with an elevation of 605m (1,985ft) above sea level. The town is bounded to the north by Kurfi and Charanchi LGAs, to the east by Kankia LGA, to the west by Safana and Dan-Musa LGAs and to the south-east by Matazu LGA. DLGA has a land area of about 552.323 km2 (203sqm).

Plant (healthy and diseased) samples were collected randomly from five different locations that include Federal University Dutsin-Ma Biological Garden, Garhi Village, Federal University Dutsin-Ma livestock farms, Sokoto Rima Farms, and Wakaji Village in DLGA for study. Crops were sampled over a period of three months from June, 2017 to August, 2017.

Visual inspection and identification of plants and viral diseases symptoms

In this study, visual inspection method with the aid of a standard voucher of plant diseases as modified from Andret-link, (2006) was used to detect plants infection by plant viruses based on the characteristic symptoms conferred on such plants. The various plants were identified using a plant identification voucher. The vegetative parts of the plants were inspected after which plant samples with anomalies such as mosaic patterns on leaves, chlorosis and yellow streaks on leaves, fruit malformations and discolouration of reproductive parts that include flowers were collected. Observed symptoms were compared to that of known viral diseases peculiar to plants sampled.

Collection and identification of vectors associated with plants showing viral symptoms.

Three main methods that include handpicking, shaking/beating and sweeping were employed to collect arthropod vectors using methods modified from Eric, (1998). In handpicking, arthropod vectors were obtained from collected samples. In shacking/beating, a tray was placed under the plant that was shacked vigorously until arthropod vectors on the diseased plant dropped. This allowed for several diseased plants to be sampled at the same time. Sweep net were used to collect arthropods vectors capable of flying. The net was used to sweep around the collected plant samples after shacking hence, capturing vectors that flew of the plants. Collected arthropod vectors were preserved using 10% ethanol solution thereafter, detailed morphological examination using a dissecting microscope. Identification of vectors was referenced to a standard voucher.

To collect and identify nematode vectors, the methods Kleynhan, (1999) was adopted. Fifty grams (50g) of the roots of infected plants was randomly selected. Samples collected included stems and leaves that appeared to be attacked by these vectors. Collected samples were placed in polythene bags and immediately labelled. Tissue teasing method was used to extract the endo nematodes in roots and stem of the diseased plants. To collect exo nematodes, the plant material was rinsed with distilled water to be free of soil thereafter, placed in a beaker top covered with a petri dish. This was left for 24 hours after which the various plant parts were removed from the beaker for examination.

Statistical Analysis:

The percentage occurrence of plant viruses based on observed symptoms were calculated thereafter, the statistical significance was accessed using chi square analysis to compare the incidence of infection amongst the five farms in DLGA.

Results:

Table 1 reports the six diseased plants identified with respect to their symptoms described by the plant colour, pattern and distribution. These include *Amaranthus sp.* (Amaranth), *Vigna unguiculata* (Cowpea), *Zea mays* (Maize), *Abelmoschus esculentus* (Okra), *Carica papaya* (Pawpaw) and *Capsicum spp.* (Pepper). Refer to plate 1 to 6 for pictograms.

Table 1: Identified plants and their disease (viral) symptoms.

Crop	**Symptoms**			**Suspected disease**
	Plant colour	**Pattern**	**Description**	
Amaranth	Plant leaves appeared yellowish green	Mosaic patterning with malformed leaves	Plants showed slight chlorosis with leaf curling	*Amaranthus mosaic disease*
Cowpea	Plant leaves appeared green yellow with chlorotic lesions	Green mottle on leaves with yellow mosaics on leaves	Plant leaves appeared deformed with yellow vines	*Cowpea mosaic disease*
Maize	Plant leaves appeared pale green with yellow streaks	Mosaic patterns with light and dark green mottles	Plants appeared stunted with yellow stripes along the midrib and chlorotic streaks on leaves	*Maize mosaic disease*
Okra	Plant appeared yellow with signs of leaf chlorosis	Yellow mosaic patterns	Plants appeared stunted showing vein clearing with alternate green and yellow patches	*Okra yellow vein mosaic disease*
Pawpaw	Plants appear dark green with yellowish lamina	Severe leaf curling, crinkling and deformation with dark green mosaic	Plants appeared stunted, with reduced leaves, vein clearing and thickening of the veins	*Papaya leaf curl disease*
Pepper	Plants appeared pale green	Yellow mosaic formations	Plants appeared stunted with vein branding	*Pepper yellow mosaic disease*

Table 2: Identified insects associated with diseased crops showing viral symptoms.

Common name of crops	**Biological name of crops**	**Insects**
Amaranth	*Amaranthus sp.*	Aphids
Cowpea	*Vigna unguiculata*	Thrips and whitefly
Maize	*Zea mays*	Aphids and leaf hoppers
Okra	*Abelmoschus esculentus*	Aphids, whitefly and mealy bugs
Pawpaw	*Carica papaya*	Aphids and whiteflies

Pepper	*Capsicum sp.*	Aphids and whiteflies

Table 3 shows the disease incidence of the crop samples in the five farms under the sample population. *Amaranthus spp*. had its highest viral incidence rate (63%) in the University livestock farm, *Vigna unguiculata* had 84% incidence in Sokoto Rima Farms, *Zea mays* had 100% in wakaji village, *Abelmoschus esculentus* recorded 100% incidence rate in both Garhi village and livestock farm and *Capsicum spp.* was found to have 100% incidence rate in Garhi village.

Table 3: Mean disease incidence values of crops with viral disease symptoms in different locations in DLGA.

Location	**Incidence rate (%)**					
	Amaranth	**Cowpea**	**Maize**	**Okra**	**Pawpaw**	**Pepper**
FUDMA Botanical Garden	47.0	37.0	46.0	45.0	100.0	0.0
Garhi Village	0.0	54.0	65.0	100.0	0.0	100.0
FUDMA livestock farm	63.0	69.0	72.0	100.0	0.0	0.0
Sokoto Rima farms	24.0	84.0	100.0	82.0	0.0	0.0
Wakaji village	0.0	34.0	0.0	0.0	0.0	78.0

X^2cal 111.237> X^2tab 13.280 so there is significant difference at P= 0.05%

Fig 1 shows the general incidence of diseased crops in Dutsin-Ma. Amaranth (*Amaranthus sp. L.*) plant has the least incidence rate of 27% while Okra (*Abelmoschus esculentus)* had an incidence rate of 65.4%.

Table 4: Incidence of crops with viral disease symptoms in Dutsinma

Crop	**Mean incidence rate (%)**
Amaranth	27.0
Cowpea	55.6
Maize	56.6
Okra	65.4
Pawpaw	20.0
Pepper	35.6

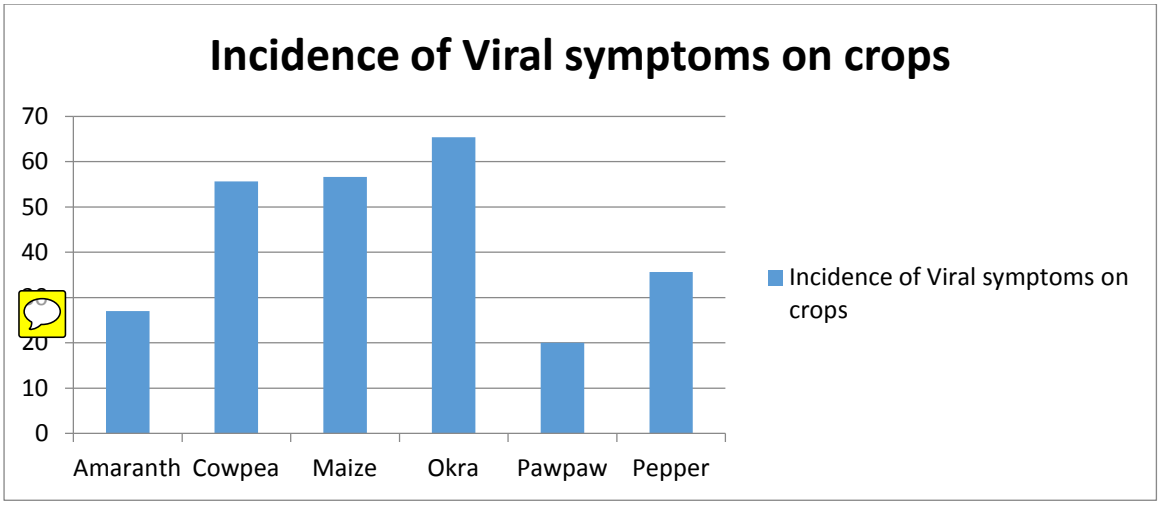

Fig 1: Quantitative comparison of viral infected crops in DLGA.

DISCUSSION

Research findings indicate that *Amaranthus sp.*, *Vigna unguiculata*, *Zea mays*, *Abelmoschus esculentus*, *Carica papya* and *Capsicum spp* are the commonly grown crops in DLGA that possess viral symptoms. This agrees with reports from Gergerich and Dolji., (2006) who identified plant viruses to confer certain characteristic symptoms as shown in table 1 on plants upon infection. Symptoms observed on *Amaranthus sp.* is consistent with that of Ehinmore, (2010) who diagnosed mosaic patterning and malformed leaves to include symptoms of *Amaranthus mosaic disease* which is virus inclined. Similarly, viral symptoms seen in cowpea is consistent with the work of Bliss and Robertson., (1971) who qualified green mottle, yellow mosaics formations associated with leaves and chlorotic lesions to be related with Cowpea mosaic disease. To further establish the results obtained in table 1, James *et al.*, (1990) described maize mosaic disease to be associated with chlorotic streaks, yellow strips and light yellow patches on leaves. In the same vain, Pradeep, (2016) observed that vein clearing, chlorosis of leaves, yellow mosaic patterning associated with okra as seen in table 1 is attributed to *mosaic disease* of okra. Vinod, (2012) reported in his work on *Carica papaya* that curling with dark green patches, severe leaf crinkling and vein clearing are viral symptoms related to leaf curl disease which can be caused by virus. Yellow mosaic formations observed on pepper as described by Inoue *et al.*, (2002) is consistent with that of pepper *yellow mosaic disease* in this research.

Table 2 presents insect vectors associated with diseased crops which imply their role in transmitting viral diseases. This agrees with Ralf *et al.*, (2016) who indicated that critical pathogenic viruses of food crops depend on vectors for transmission. This further agrees with Andret *et al.*, (2005) who observed the transmission of plant viruses to depend on vectors to ensure continuity and survival. From this research, aphids were insect vectors diagnosed on diseased Amaranth and other crops. This is consistent with the findings of Masanobu *et al.* (1994) who performed related experiment. The advent of whiteflies on diseased cowpea agrees with reports from Whitney and Gilmer, (1974) who diagnosed whiteflies to be insect vectors related to cowpea mosaic virus. The association of thrips and whiteflies with diseased cowpea is also consistent with reports from Chant, (1959) and Bock, (1971) on related experiment. The association of aphids and leafhoppers on unhealthy maize plants is consistent with Bryce Falk, (1990) and Mohammed *et al.*, (2017) who related these vectors to maize mosaic disease. Givord, (1972) identified aphids and whiteflies to be connected with diseased okra which corroborates results obtained in this work. The appearance of similar vectors on pawpaw agrees with Vinod, (2012) who related whiteflies to be accountable for transmitting leaf curl disease on pawpaw. The affiliation of aphids with diseased pepper

correlates with the work of Inoue *et al.* (2002) who observed this insect to be a transmitter of pepper yellow mottle mosaic disease.

This study report differences in the rate of viral infection among the various locations surveyed (table 3). Cowpea had a high incidence rate (84%) in Sokoto Rima farms as with 34% recorded in Wakaji village. Similar differences were noticed with Okra that had 100% incidence rate in Garhi village compared to 45% seen in FUDMA biological garden. These differences could arise from several factors that include differences in age of plants during infection, environmental factors and climatic factors such as rain and wind as described by Kym, (2010). Closely spaced plants at various locations significantly had higher incidence rate compared to plants that were well spaced which suggests the reason for variations of incidence rate at various locations. This corroborates with the findings of Have and Kauffman., (1972) who realised that bacterial leaf blight was triggered by close spacing of cultivated rice. John, (1964) also put forward that close spacing of plants favours the reception of aphids by making available a large ground cover that favours the landing of winged species. The presence of dense vegetation cover that includes weeds in Garhi village, Sokoto Rima and FUDMA livestock farm could account for the high population of aphids. This is in line with the findings of Kym, (2010) who identified that the growth and survival of aphids depends on environmental factors such as weeds and roadside vegetation.

Fig 1 reports pawpaw (100%) and pepper (89%) to have the highest incidence of viral attack. High incidence rate could be attributed to the presence of numerous alternate host plants that include several vegetables. This corroborates with the findings of Alegbejo, (1987) and Kym, (2010) who reported the spread of viral disease in some plants to be attributed to certain weeds which appear to be alternate hosts. High incidence rate of disease on pepper is consistent with finding of Olawole *et al.*, (2012) who analysed that pepper has a high susceptibility to viral diseases within Nigeria and mosaic virus infection is common to pepper among other vegetables crops.

CONCLUSION

This work is intended to place the necessary basis for future studies on plant viral diseases in DLGA, Katsina State, Nigeria. Although validating our findings to the actual viruses involved is absent to so limitations, this research reports that that there is significantly high incidence ($P \leq 0.05$) of crop plants with viral symptoms in the study area. Lastly, aphids, thrips, leafhoppers, whiteflies and mealy bugs are organisms found to be associated with crop plants exhibiting viral disease symptoms. Further studies need to be carried out to identify the individual viruses.

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