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 ($P \geq 0.05$) 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 ($P \geq 0.05$) 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 thousands of years ago [1]. Around 80% of agricultural activities in the world are channelled towards animal feed production and food [2]. In the 20th century, crop production was focused on increasing productivity to meet the worlds increasing population [3,4,5]. 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 [6]. 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 [2,7].

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 [8]. The transmission of plant viruses from one host to the other is usually through tubers, bud wood or seeds [9]. Most viruses that cause plant disease depend on biotic vectors for their survival and transmission [10]. 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 [11].

Due to viral infections, losses of over $1.5 billion are reported in South-East Asia rice cultivation [12] and estimates of losses have been calculated as $63 million in apple in the

United States [13], and over $20 million in potato in the United Kingdom [12]. According to [14], plant viruses are transmitted from host to host through budwood, seeds or tubers, or by arthropods, nematodes, fungi, or plasmodiophorid vectors. The majority of plant viruses that cause disease in agricultural crops rely on biotic vectors for transmission and survival [10]. This is because viral transmission is an important step in the biological cycle of viruses as it ensures their maintenance and survival. Understanding viral transmission process is critical for the development of effective management strategies for diseases caused by plant viruses. More than half of the nearly 550 vector transmitted virus species recorded so far are disseminated by aphids (55%), 11% by leafhoppers, another 11% by beetles, 9% by whiteflies of the phylum arthropoda, others from this group are transmitted by thrips, mites, mirids, or mealybugs [15]. *Tomato spotted wilt virus* (TSWV) which is transmitted by thrips responsible for losses of over $1 billion in vegetable and ornamental crops and has the largest host range of any plant virus infecting more than a thousand plant species from 84 families. Transmission by fungi and plasmiodiophorids has also been recorded.

Despite several efforts that include quarantine [2], cultivation of viral free planting materials [16] and development of transgenic resistant varieties [17] 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 [9] 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 visually inspected and plant samples with above ground anomalies such as mosaic patterns on leaves, chlorosis and yellowing streaking of the leaves, fruit malformations and discoloration of flowering parts were sampled. The symptoms found on sampled plants were compared with the symptoms of known viral diseases peculiar to sampled plants, as presented by [9] Identification was therefore based on symptoms. This was also supported by [17].

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 [18]. 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 [19] 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).

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	*Papaya leaf curl disease*

			the veins	
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: 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: Mean 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

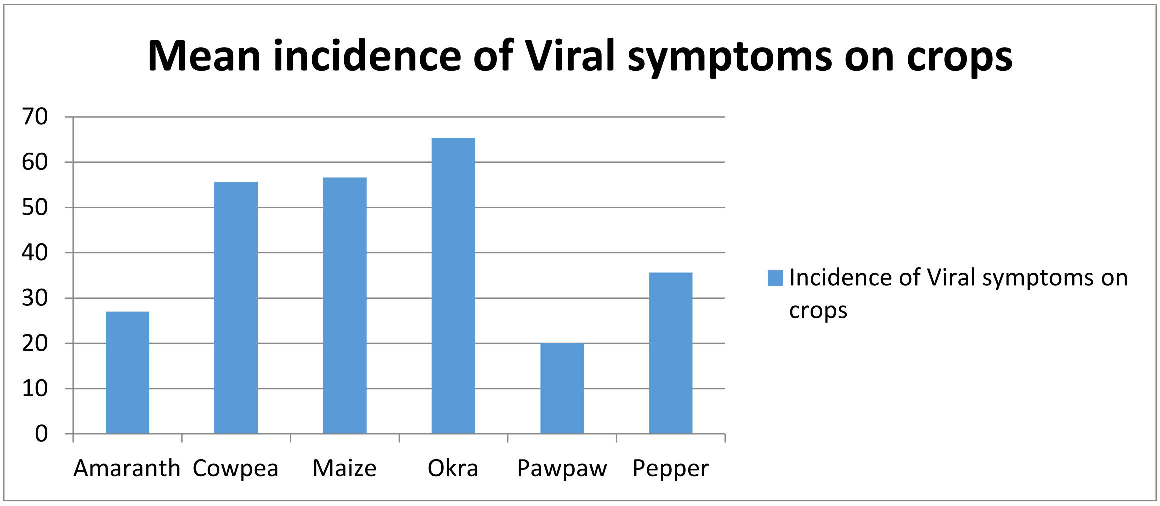

Fig 1: Quantitative comparison of viral infected crops in DLGA.

DISCUSSION

Research results identified *Amaranthu sp. L.*, *Vigna unguiculata(L.)Walp*, *Zea mays L.*, *Abelmoschus esculentus(L.)Monech*, *Carica papaya L.* and *Capsicum spp. L.* as the commonly grown crops in the study area and were determined to possess viral symptoms in all locations surveyed. This is consistent with the reports of [8] who reported that plant viruses confer certain characteristic symptoms on infected plants. This also agrees with the findings of [20] who reported that symptoms caused by plant viruses on infected plants usually serve as the bases on which diseased plant problems are first noticed. Disease symptoms of *Amaranth sp*., obtained in this research are consistent with the reports by [21] who reported mosaic patterning or mottling and malformed leaves of Amaranthus to be symptoms of *Amaranthus* mosaic disease. Viral symptoms observed with Cowpea in this research corroborates with the reports of [22], who attributed chlorotic lesions, green mottle and yellow mosaics formations on leaves of Cowpea plant to *Cowpea* mosaic disease. Symptoms conferred on Maize as revealed in this research agrees favourably with [23], who reported that Maize mosaic disease causes yellow striping along the midrib, chlorotic streaks on leaves, with light yellow patches on upper leaf surface. [24] reported that vein clearing, chlorosis of leaves, yellow mosaic patterning associated with Okra as obtained in this research is attributed to Okra mosaic disease of Okra. [25] in his report on Papaya disease and its control reported severe leaf crinkling and curling with dark green patches and vein clearing as obtained in this research as viral symptoms conferred on papaya plant by leaf curl disease of papaya. [26] identified in the field in Brazil a disease of pepper that caused vein branding and yellow mosaic formations which agrees favourably with results obtained in this research and attributed it to Pepper yellow mosaic disease.

Research reveals the association of vectors with diseased crops suggesting, their role in the transmission of viral diseases. This corroborates with the findings of [10], who reported that, majority of plant viruses that cause disease in agricultural crops rely on biotic vectors for transmission and survival and agrees favourably with [9], who reported that plant viruses are transmitted from host to host by vectors which ensure their maintenance and continuous survival. Evidence from this research shows that, Aphids were found to be associated with diseased Amaranth plants and is supported by the reports of [27]. Thrips and whiteflies were also found to be associated with diseased cowpea plants this is consistent with the reports of [28] that whiteflies are vectors of cowpea mosaic virus and is also supported by the reports of

[29] and [30]. Aphids and leafhoppers were also found in association with diseased maize plants agreeing favourably with the reports of [31,32] who both reported that Aphids and Leafhoppers are vectors of maize mosaic disease. [33] reported that the main vectors of the okra mosaic virus were Aphids and whiteflies, these two arthropods were also found to be associated with the diseased okra plants sampled in this research. Aphids and whiteflies were found to be associated with diseased Pawpaw plants this is consistent with reports by [25] who reported that whiteflies are responsible for the transmission of Leaf curl disease of papaya. Aphids were found on diseased pepper plants in both locations where high incidence was recorded, these results are in correlation with the findings of [26], who reported that Pepper yellow mottle mosaic disease is transmitted by aphids.

Results of this study reveal variations in the rate of infection in the different locations surveyed. Crops with viral symptoms in some locations showed high incidence, while their incidence was relatively low in other locations. For instance, the cowpea was higher in Sokoto Rima farms with 84% and relatively low in Wakaji village with 34%. Such variations were also observed with Okra with an incidence rate of 100% in Garhi village and 45% in FUDMA botanical garden, this according to [34] can be as a result of many factors such as variations in the age of plant as at the time of infection, environmental factors, climatic factors of temperature, rain, wind, cultural practices employed and the presence or absence of disease vectors. It was observed that plants with close spacing showed significantly higher incidence rate than wider spaced plants, this corroborates with the report by [35] that close spacing of rice encouraged the spread of bacterial leaf blight. According to [36] close spacing also favours the optomotor landing response of Aphids by providing enough groundcover for the landing of winged aphids.

Research results also revealed that areas like Garhi village, Sokoto Rima Farms and FUDMA livestock farms which had shade plants and dense vegetation cover such as weeds had a higher population of aphids and other vectors, this is consistent with the reports of [34] who reported that Aphid survival and population growth are strongly influenced by local environmental factors and survive on alternate plants such as weeds, roadside vegetation and verges from where they move to crop edges before moving into other parts of the crops.

From the results of this research Pawpaw and Pepper plants with viral symptoms shows the highest incidence rate with 100% and 89% respectively, followed by Okra with 72%, Maize and Cowpea both showed an incidence of 64% and Amaranth was least with 29%. The high incidence of Pepper plants with viral disease symptoms in Garhi and Wakaji village could be as a result of numerous alternate host species surrounding the pepper field such tomato, okra and a host of other vegetables. This corroborates with the findings of [37] who reported that the proximity of pepper plants to certain important weed host also has contributed greatly to the spread of viral diseases of pepper; these weeds include *Vigna sinensis and Solanum nigrum*. This is also supported by [34]. Research results of higher incidence rate of disease on *Capsicum spp. L.* than other crop plants is consistent with finding of [38] who reported that pepper is highly susceptible to virus diseases in Nigeria and the infection of mosaic viruses is more on pepper than all other vegetable crops.

Incidences of crop plants with viral symptoms show highly significant difference at ($P \leq 0.01$). This informs a significantly high incidence of viral disease in DLGA based on symptoms.

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.

REFERENCES

1. Savary S., Mille B., Rolland B., and Lucas P. (2006). Patterns and management of crop multiple pathosystems. **35**: 231-263.
2. Bem, A.A., Terna, P. and Bem, L.S. (2012). Foundations of plant pathology. Lambert academic publishing, Germany. Pp. 186-200.
3. Evans, L. T. (1998). *Feeding the Ten billion. Plants and population growth*. Cambridge: Cambridge University Press.Gergerich R.C. and Dolja, V. V. (2006). Introduction to Plant Viruses, the Invisible Foe. *The Plant Health Instructor*. DOI: 10.1094/PHI-I-2006-0414-01
4. Smil, V. (2000). *Feeding the world: a challenge for the twenty-first century*. Cambridge: The Massachusetts Institute of Technology Press. **11**: 12-14.
5. Nellemann, C., MacDevette, M., Manders, T., Eickhout, B., Svihus, B., Prins, A. and Kaltenborn, B. (eds) (2009) The Environmental Food Crisis. The environment's role in averting future food crises. A UNEP rapid response assessment. Arendal, UNDP.
6. Strange R.N., and Scott P.R., (2005). Plant disease: a threat to global food security. *Annual Review.Phytopathol.* **43**:83–116.
7. Walkey, D. (1991). *Applied Plant Virology*. (2nd Eds). Chapman and Hall, London. Pp. 121- 132.
8. Ford, R. and Evans, T. (2003). Tobacco mosaic virus. *The Plant Health Instructor*. DOI: 10.1094/PHI-K-2003-0528-01.
9. Andret-Link and Fuchs. (2005). Transmission specificity of plant viruses by vectors. *Journal of plant pathology*. **87** (3): 153-165.
10. Ralf G.D., Krin S.M. and Karyn N.J., (2016). Plant Virus–Insect Vector Interactions: Current and Potential Future Research Directions. *Virology* **8:**303
11. Gergerich R.C. and Dolja, V. V. (2006). Introduction to Plant Viruses, the Invisible Foe. *The Plant Health Instructor*. DOI: 10.1094/PHI-I-2006-0414-01
12. Hull, R. (2002). *Matthews' Plant Virology*. (4th Ed.). Academic Press, New York. Pp. 56-65.
13. Cembali, T., (2003). Economic implications of a virus prevention program in deciduous tree fruits in the US. *Crop Protection* **22**: 1149-1156.
14. Astier, S., Albouy J., Maury, Y., and Lecoq H, (2001). *Principes de Virologie Végétale*. (2nd Ed.), INRA publishers, Paris, France. **67**:34-45
15. Macfarlane, S.A and Inga, Z. (2016). Nematode-borne plant viruses. The James Hutton Institute Invergowrie, Dundee, U.K. Pp 365-378
16. Sohrab, S.S., Kamal.M.A., llah, A., Husen, A., Bhattacharya, P.S., Rana, D. (2016). Development of Cotton leaf curl virus resistant transgenic cotton using antisense ßC1 gene. *Saudi Journal of Biological Sciences*. **23** (3): 358-362.
17. MacLean M.A., Campbell R.N., Hamilton R.I., Rochon D.M. (1994). Involvement of the *necrosis virus* coat protein in the specificity of fungus transmission by *Olpidium bornovanus*. *Virology* **204**: 840-842.
18. Eric, M. R. (1998) Microscopy of arthropods: Collection and identification of arthropods. *Entomology*. **37**:67-69
19. Kleynhan K.P. SA, N., (1999). Collecting and preserving nematodes. A manual for

nematology. Ultra vitro, Heriotdale, Johannesberg.

20. Sarah D. E., Michael J. B., and Landon H. R., (2008). Nematode Diseases of Plants. *Plant Pathology*. **8**: 41-52.
21. Ehinmore, I and Kareem, K.T. (2010). Effect of *Amaranthus mosaic virus* on the growth characters of *Amaranthus hybridus*. *Agric. Biol. J.N*. **1**(2):75-79
22. Bliss, F.A. and Robertson, D.G. (1971). Genetics and host reaction in *Cowpea mosaic virus* and *Cowpea mottle virus*. *Crop science*. **11**:258.
23. James, T. and Bryce W.F. (1990). Insect vectors and their pathogens of maize in the tropics. *Plant Pathology.* **16:**89-93.
24. Pradeep, K. (2016). Identification of yellow mosaic in Okra. *Agronomic sciences,* Dehradun U.K
25. Vinod, K. (2012). Papaya diseases and its control. *Plant pathology*. **15:**67-68
26. Inoue, N., Fonseca, E.N., and Resende R.O. (2002). Pepper yellow mosaic virus. *Archives of Virology*.**147:**849-855.
27. Masanobu, O. and Hiroshi, K. (1994). Mosaic disease of grain amaranth. *Phytopathology*. **60**:119.
28. Whitney, W.K, and Gilmer R.M. (1974). Insect vectors of cowpea mosaic virus in Nigeria. *Annuals of applied biology*. **77**:17-21.
29. Chant S.R. (1959). Viruses of Cowpea, *Vigna unguiculata* in Nigeria. *Annuals of Applied Biology*. 47**(3):**565-573.
30. Bock, K. R. (1971). East African plant virus Diseases *Cowpea Mosaic Virus*. *East Africans agriculture and forestry Journal.* **37**:60.
31. Bryce, W.F and James, H.T. (1990). Insect vectors and their pathogens of Maize in the tropics. *Phytopathology.*
32. Mohammed, B., Alegbejo, M.D., Kashina, B.D. and Banwo, O.O. (2017). Prevalence of viruses infecting sorghum in Nigeria. *International Journal of plant and soil science*. 17**(2):**1-11.
33. Givord, L., Pfeiffer and Hirth V. (1972). Yellow mosaic virus of Okra. *Virology.* **275**:1563
34. Kym, P., and Ken, H. (2010). Aphids natural enemy and smarter management. *Agronomic sciences.* **86**:22-25.
35. Have, T., and Kauffman, H.E. (1972). Effect of nitrogen and spacing on bacterial leaf blight of rice. *Indian farming*. **21:**7-10
36. John, B. (1964). Effect of planting date and spacing on the incidence of groundnut rosette disease and of the aphid vector. *Annuals of applied biology*. Doi:10.1111/j.1744-7348.
37. Alegbejo, M.D. and Uvah, I.I. (1987). Effect of intercropping pepper with tall companion plants on the incidence of pepper mottle virus on pepper. *Nigerian Journal of Entomology*. **7:** 82-87.
38. Olawole, A., Olusegun, S.B. and Kehinde, T.K. (2012). Ocurrence and distribution of pepper veinal mottle virus and cumcumber mosaic virus in pepper in Ibadan, Nigeria. *Virology Journal*. **9:**79.

APPENDIX: FIELD DATA

Crops sampled from FUDMA botanical garden

Crop Sample	Number Infected	Number unaffected	Total No. Sampled
Amaranth	7	8	15
Cowpea	11	19	30
Maize	69	81	150
Pawpaw	40	0	40
Okra	68	82	150

Crops sampled from Garhi Village

Crop Sample	Total No. Infected	Number unaffected	Total No. Sampled
Amaranth	0	20	20
Cowpea	27	23	50
Maize	97	53	150
Okra	100	0	100
Pepper	280	0	280

Crops sampled from FUDMA livestock farm

Crop Sample	Total No. Infected	Number unaffected	Total No. Sampled
Amaranth	63	37	100
Cowpea	69	31	100
Maize	72	28	100
Okra	100	0	100

Crops sampled from Sokoto Rima Farm

Crop Sample	Number Infected	Number unaffected	Total No. Sampled
Amaranth	12	38	50
Cowpea	168	32	200
Maize	67	33	100
Okra	82	18	100

Crops sampled from Wakaji Village

Crop Sample	Number Infected	Number unaffected	Total No. Sampled
Amaranth	0	100	100
Cowpea	34	66	100
Maize	110	40	150
Okra	46	56	100
Pepper	235	65	300