AEXTJ AGRICULTURAL EXTENSION JOURNAL

ISSN 2582- 564X

Available Online at www.aextj.com
Agricultural Extension Journal 2026; 10(1):1-6

RESEARCH ARTICLE

Assessment of Pepper Leaf Curl Virus Disease Incidence, Severity (PepYLCV) and Vector (*Bemisia tabaci*) Population Dynamics in Kebbi State, Nigeria

I. J. Yusuf[1], A. Musa[1], I. Bello[2], I.U. Mohammed[1], I. D. Yusuf[3], A. Muhammad[1], U.Z. Khadija[4], A. Afiu[4]

[1]Department of Crop Science, Faculty of Agriculture, Abdullahi Fodio University of Science and Technology, Aliero, Nigeria, [2]Department of Crop Science, Faculty of Agriculture, Usman Danfodiyo University, Sokoto, Nigeria, [3]Department of Crop Protection, Bayero University Kano, Kano State, [4]Department of Crop Science, Faculty of Agriculture, Federal University of Agriculture, Zuru, Kebbi State

Received: 05-03-2026; Revised: 06-03-2026; Accepted: 18-03-2026

ABSTRACT

Pepper (*Capsicum* spp.) is widely produced and consumed in Sub-Saharan Africa. Nigeria is the largest producer of pepper in Africa. A field study was conducted in two Local Government Areas of Kebbi State, Nigeria. A field assessment was carried out in Jega (Birnin Malan and Gindi) and Aliero (Kashin Zama and Marmaro) to assess the incidence and symptom severity (SS) of pepper leaf curl virus (PLCV) and the population density of its whitefly vector on pepper plants. Thirty symptomatic and asymptomatic pepper plants were randomly selected per location and evaluated for visual disease symptoms and severity. Whiteflies were counted on the terminal leaflets of each assessed plant. Results revealed notable PLCV incidence, SS, and high whitefly populations across both locations. Among the surveyed areas, Kashin Zama recorded the highest disease incidence (60.0%), followed by Aliero and Birnin Malan (53.33%), Marmaro and Gindi (50.0%), and Jega (40.0%). The highest SS was observed in Aliero (2.2%), followed by Kashin Zama (2.0%), Marmaro (1.9%), and Birnin Malan and Gindi (1.8%), with Jega recording the lowest severity (1.5%). Whitefly populations were highest in Kashin Zama (23.0 per plant), followed by Aliero (21.0), Birnin Malan (20.0), Marmaro (19.0), Jega (18.0), and Gindi (17.0). These findings confirm the presence and variability of PLCV and its vector in Kebbi State, highlighting the need for region-specific management strategies, as this will mitigate vector population and disease pressure in the study area.

Key words: Peppers, severity, symptoms, whitefly

INTRODUCTION

Peppers (*Capsicum* spp.) are an important Solanaceae crop cultivated for culinary use as a vegetable and spice and as a source of food colorants and secondary metabolites.[1] As a high-value crop, pepper is a significant source of income for farmers, particularly smallholder farmers in Asia and Africa.[2]

Pepper is one of the oldest crops domesticated by humans.[3] In Sub-Saharan Africa, it plays a key role in maintaining the annual vegetable supply. In Nigeria, peppers are the most widely produced vegetable fruit and the most widely consumed spice also.[4] Africa contributes 1,008,574 tons (approximately 21% of global production) from a harvested area of 375,989 ha to global dry pepper production and 3,472,485 tons (approximately 10% of global production) from 331,064 ha to global green pepper production.[5] The genus *Capsicum* comprises 43 species, five of which are domesticated and cultivated.[6] The widely cultivated domesticated species are *Capsicum annuum* (L.), *Capsicum frutescens* (L.), *Capsicum chinense* (Jacq.), *Capsicum baccatum* (L.), and *Capsicum pubescens*

Address for correspondence:
I. J. Yusuf
E-mail: ibrahimyusuf090@gmail.com

(Ruiz and Pav.).[7] Globally, *C. annuum* is the most widely produced and consumed species; however, in Africa, significant production of *C. chinense* and, to a lesser extent, *C. frutescens* also occurs.[8]

In Africa, chilli production is generally limited to small plots ranging from 0.5 to 1.2 ha.[9] The crop can be an important source of income for smallholder and family farmers in rural areas. However, pepper production is frequently threatened by many biotic factors, such as pests and diseases. Among these, viral diseases are reported to be the most significant constraint to pepper production in Africa.[9] Increasing outbreaks of viruses infecting pepper have become a major problem for producers across the continent.[9] Most viruses infecting pepper are transmitted by arthropod vectors, namely aphids, whiteflies, mealybugs, and thrips. Consequently, farmers rely heavily on insecticides for their management.[8] Numerous viruses cause symptoms in pepper in Africa, including Chilli veinal mottle virus (*Potyvirus*), Pepper veinal mottle virus (*Potyvirus*), and Pepper leaf curl virus (PLCV). PLCV is one of the most serious viral diseases infecting pepper in Nigeria, particularly in the northern region. It causes considerable yield loss; in severe cases, at the flowering stage, many flowers may abort due to the infection.

PLCV is transmitted by the whitefly through sap feeding; however, the symptoms include flower abortion, leaf curling, plant stunting, the presence of honeydew on infected leaves, leaf yellowing and drop, wilting, and plant death in severe cases.

Extensive cultural management strategies and insecticide applications have been employed to manage virus infections in cultivated peppers, especially for viruses transmitted by whiteflies in a non-persistent manner, with varying degrees of success. However, the vector has often developed resistance due to the frequent use of synthetic chemicals.[10,11]

Therefore, assessing the incidence, symptom severity (SS), and vector dynamics of PLCV in the study areas is of great importance to develop strategies for reducing the spread of the disease and its vector. This study may be highly relevant to farmers, entomologists, plant pathologists, and plant breeders.

The use of synthetic insecticides has often been ineffective against numerous hemipteran insect pests, as they generally feed on the underside of foliage or within the plant canopy. Their small size, short life cycle, high fecundity, and resistance to synthetic chemicals contribute to high reproductive rates. In this context, plants with insecticidal properties could serve as beneficial antifeedants against such pests. These, coupled with farming practices such as farm sanitation, removal of infested plants, and regular weeding would greatly benefit efforts to minimize the spread of PLCV and its vector.

Consequently, this research aims to provide a sound and better alternative control strategy for farmers in the study area.

MATERIALS AND METHODS

Materials

Materials used for this study were mainly survey materials such as field survey data sheet for collecting relevant information for the research, global positioning system receptor for taking coordinates of the locations (longitude and latitude); pencil and eraser were also used as writing materials.

Methods

Fields survey

A field survey was conducted in December 2021, during the dry season across pepper-producing villages of two selected LGAs of Kebbi State: Aliero, Marmaro, Kashin Zama, in Aliero, while Jega, Gindi, and Birnin Malan in Jega local government area. In each field, 30 pepper plants were randomly sampled along two diagonals in the form of an “X” and examined for symptoms of PLCV on disease incidence (DI), SS, and whiteflies preference.[12] Five symptomatic and asymptomatic leaf samples were sampled from each field and recorded in a data sheet. The coordinates of each location were taken and map was produced Figure 1.

DI

DI of each field was calculated as the percentage (%) of visually diseased plants over the total plants assessed in the two diagonal methods using the following formula, as suggested by Sseruwagi *et al*.[13] and the percentage of DI of each field was used to calculate the percentage DIs.

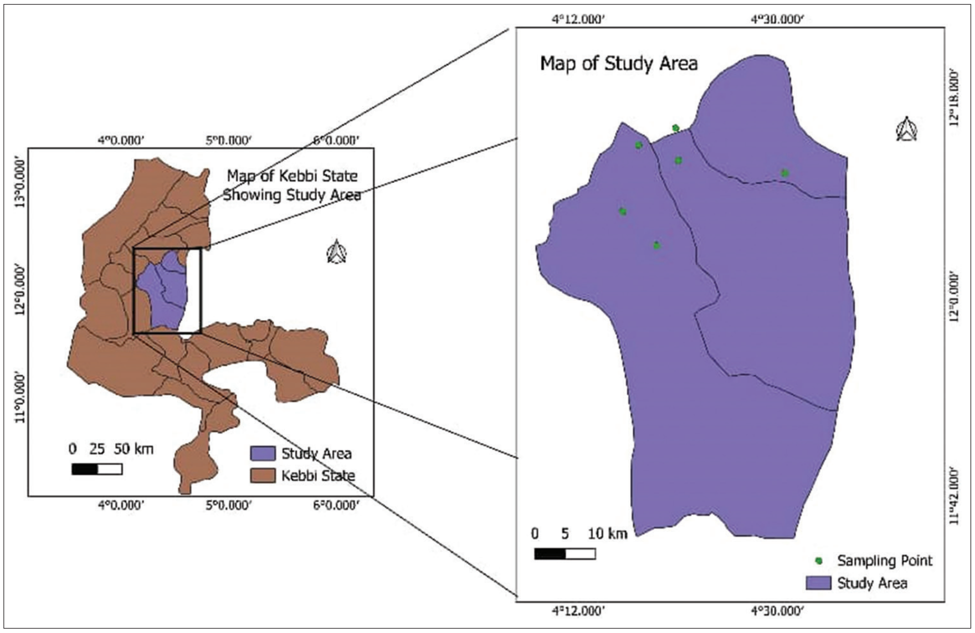

Figure 1: Map, showing the study area

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

SS

SS of each field was scored by the arbitrary score: 1–5, indicating the degree of symptom development of each sampled plant in the field. Mean SS of each field was calculated according to the method of Mueangkhong *et al*.[14]

Where:

1. Healthy/symptomless (no symptom development)
2. Mild (symptoms but no pronounced development)
3. Moderate (pronounced symptom on about one-third of the leaves)
4. Severe (symptoms on about two-thirds of the leaves)
5. Very severe (symptoms on almost all the leaves).

Estimation of whiteflies preference

Adult whiteflies were directly counted on the five (5) youngest apical leaves of pepper from each 30 plants sampled according to the method developed by Ndunguru *et al*.[12]

Data analysis

Data collected on incidence, SS of PLCV, whiteflies count in Aliero LGA, and Jega of Kebbi State, Nigeria, were analyzed using GenStat software (17th Edition).

RESULTS

The results showed that there is a higher DI of pepper leaf curl disease and SS than whitefly count in Figure 2.

The epidemiological survey of PLCV across six locations in Kebbi State revealed a clear and consistent pattern regarding disease pressure and its vector, *Bemisia tabaci*. As summarized in Figure 1 and the accompanying data, the mean values for both DI and SS were significantly higher than the corresponding whitefly count (WC) in all surveyed Local Government Areas. This indicates a non-linear relationship between vector population density at the time of sampling and the resulting disease expression in the field.

Kashin Zama recorded the highest DI (60.0%) and the highest whitefly population (23.0%), suggesting a strong correlation between vector pressure and infection rate in that location. Similarly, Aliero, with the second-highest whitefly count (21.0%), exhibited the highest SS (2.2%) and a high incidence (53.33%). This pattern aligns with the expected role of *B. tabaci* as the primary vector for PLCV. However, a more nuanced relationship is evident when comparing other sites. For instance, Birnin Mallam and Gindi reported identical DI (53.33%

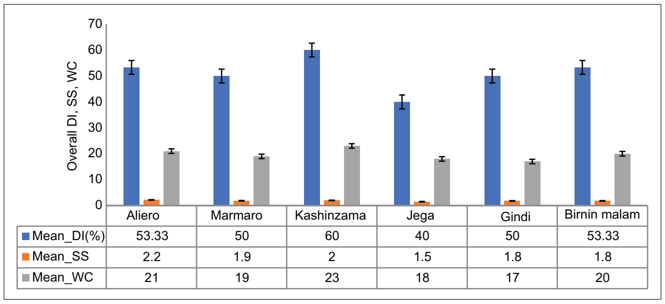

Figure 2: DI: Disease incidence, SS: Symptom severity, WC: Whitefly count based on locations surveyed. Bars indicate standard error of means at 5% probability level

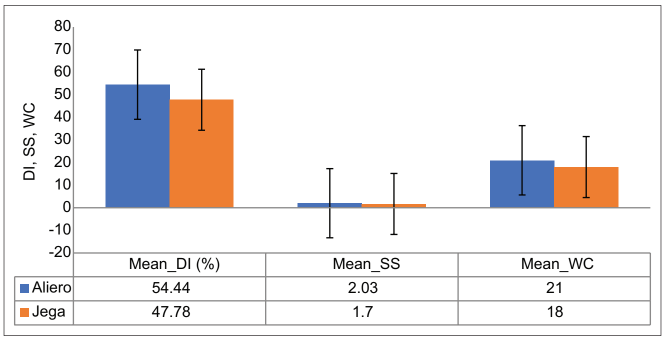

Figure 3: DI: Disease incidence, SS: Symptom severity, and WC: Whitefly Count in Jega and Government. Bars indicate standard error of means at 5% probability level

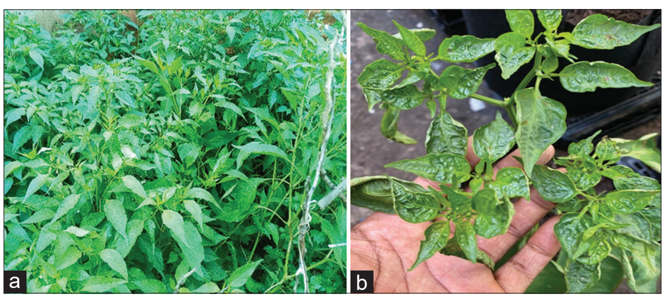

Plate 1: (a) Healthy Pepper plant from the surveyed area, (b) Diseased pepper plant in the surveyed area

and 50.0%, respectively) and similar SS (1.8% for both), despite a noticeable difference in their whitefly counts (20.0% and 17.0%). Most notably, Jega presented the lowest metrics across all three parameters (DI: 40.0%, SS: 1.5%, WC: 18.0%), yet its disease levels were still proportionally high relative to its vector count Figure 2.

The comparative analysis of PLCV epidemiology between Aliero and Jega reveals a clear gradient in disease pressure, with Aliero exhibiting significantly higher agronomic and entomological metrics. Specifically, Aliero recorded a higher DI (54.44%) and SS (2.03) compared to Jega (47.78% and 1.7, respectively). This pattern was mirrored in the whitefly (B. tabaci) vector population, which was also greater in Aliero (21 counts) than in Jega (18 counts).

Specifically, Figure 3 in Aliero recorded a higher DI (54.44%) and SS (2.03) compared to Jega (47.78% and 1.7, respectively).

Plate 1 shows SS of each field was scored by the arbitrary score: 1–5, indicating the degree of symptom development of each sampled plant in the field.

DISCUSSION

The survey carried out in the 2021 dry season in Aliero and Jega LGAs showed high PLCV incidence and relatively high whitefly populations but only low to moderate SS. This pattern is consistent with studies on begomoviruses (including *Pepper yellow leaf curl virus*, PepYLCV/PepYLCIV) in Africa and Asia, where widespread infection and abundant vectors are often recorded, while symptom expression varies with host plant, environment, and management practices.[14]

However, Kashin Zama had the highest incidence, followed by Aliero and Birnin Mallam, with the lowest in Jega. Such spatial variation is typical of whitefly-transmitted begomoviruses, where incidence can differ significantly between locations and crops within the same region.[15] In northwest Nigeria, whitefly infestations and begomovirus incidence varied markedly among states and host crops, and pepper generally carried lower whitefly populations than some other hosts but could still show substantial virus incidence.[15]

The higher incidence in Kashin Zama, Marmaro, and Birnin Mallam is plausibly linked to the use of susceptible pepper varieties. Experimental work with PepYLCIV shows that susceptible cultivars consistently develop higher incidence and severity than resistant ones under similar whitefly pressure.[16] Genetic studies on PepYLCV resistance in pepper further demonstrate that specific resistance greatly reduces symptom expressions and disease scores when plants are challenged with viruliferous whitefly vectors.[17] Thus, the adoption of susceptible landraces by farmers in these villages likely facilitated rapid virus spread and higher incidence compared with areas where more tolerant varieties or better management practices were used.

At the LGA level, the higher mean incidence in Aliero compared to Jega can be associated with poorer farm sanitation and vectorfavorable conditions since irrigation is constantly applied during the production. In northwest Nigeria, higher whitefly numbers have been linked to irrigated conditions, continuous host availability, and poor field hygiene.[15] Similar observations are reported in Benin, where limited sanitation, monoculture, and lack of awareness about viral diseases contribute to high virus prevalence in pepper.[8] Moreover, whitefly populations were relatively high among the LGAs, with Kashin Zama having the highest than Gindi and Jega with the lowest. Numerous studies on PepYLCV and related viruses show a positive correlation between whitefly density and DI and severity, although the relationship is not always linear.[18] In Indonesian chilli fields, each additional whitefly per leaf increased begomovirus incidence by about 26% and severity by about 15%, illustrating the strong epidemiological role of the vector.[19]

However, surveys in northwest Nigeria documented cases where begomovirus incidence did not strictly follow whitefly population size, indicating that factors such as prior infection foci, alternative hosts, and cropping history can decouple vector population from current incidence. Likewise, Amaliah *et al.*[20] reported low *B. tabaci* populations but relatively high PepYLCIV incidence, suggesting additional routes (e.g., seed-borne virus) or early infection events.

The slightly higher whitefly population observed in Kashin Zama may also relate to insecticide use patterns and resistance. Repeated insecticide applications are widely used by African and Asian farmers against *B. tabaci* and can select for resistant biotypes and disrupt natural enemies, resulting over time in persistent or even increased whitefly pressure.[8,16] This aligns with the suggestion that excessive insecticide use in Kashin Zama could favor vector survival and persistence in the fields.

In contrast, the lower whitefly densities recorded in Jega and Gindi are consistent with improved management practices such as timely planting, regular weeding, and better field sanitation. In northwest Nigeria, good sanitation and removal of alternative hosts are recommended to suppress whitefly populations and reduce virus spread.[15] Studies in chilli also show that protected seedlings, barrier crops, and field hygiene can significantly reduce whitefly abundance and PepYLCV incidence, improving yields.[18]

CONCLUSION

It has been concluded that there is an incidence, SS of PLCV and whitefly population in Aliero and Jega LGA during the research work.

Therefore, the rapid spread of PLCV and whitefly population coupled with their polyphagous feeding behavior can lead to the emergence of damage to crops. This occurrence of such disease and whitefly population may quickly explain the rate at which the disease can be spread, which may eventually lead to reasonable yield loss or even total crop failure.

RECOMMENDATIONS

The research work recommended that the farmers should adopt appropriate planting methods, resistant cultivars, and good farm sanitation to make the farm unsuitable for whiteflies which transmit disease to the pepper plants. However, the indiscriminate use of chemical insecticides to control insects should be avoided so as to prevent insects from being resistant to chemicals. The research work recommends that the farmers should adopt appropriate agronomic practices such as field sanitation, regular weeding, and crop rotation that may reduce the population of vector transmitting PLCV in the study areas.

REFERENCES

1. Islam MS, Hossain MM, Rahman MS. Pepper production and marketing in Asia: A review. J Agric Econ Dev 2020;9:1-12.
2. Waweru BW, Gitonga ZM, Muthoni J. Pepper production and marketing in Africa: A review. Afr J Hortic Sci 2020;15:1-15.
3. Perry L, Sandweiss DH, Piperno DR, Dickau R, Zarrillo S, Holst I, *et al*. Starch fossils and the domestication and dispersal of chili peppers (*Capsicum* spp. L.) in the Americas. Science 2007;316:986-8.
4. Gniffke PA, Lin SW, Wang YW. AVRDC's vegetable breeding program: Improving nutrition and food security. Acta Hortic 2013;1004:27-34.
5. FOASTAT. Land Cover Statistics 2000-20019 (Global, Reginal and Country Trends). Italy: FOASTAT; 2022.
6. Barboza GE, Hunziker AT, Giacchino A. *Capsicum*. In the Plant Family Solanaceae. New York: Springer; 2022. p. 129-45.

7. Ibiza VP, Blanca JM, Cañizares J. Genetic diversity of *Capsicum*: A review. Sci Hortic 2012;143:15-24.
8. Zohoungbogbo FJ, Dansi A, Loko LY. Pepper leaf curl virus in Africa: A review. Crop Prot 2024;179:106551.
9. Zohoungbogbo FJ, Dansi A, Loko LY. Viral diseases of pepper in West Africa: A review. J Plant Prot Environ 2022;19:1-12.
10. Sasikala M, Ravikumar R. Management f whiteflies and whitefly-transmitted viruses in chili. J Plant Prot Environ 2013;10:1-8.
11. Pahla I, Shanower TG, Tadesse A. Insecticide resistance in whiteflies (*Bemisia tabaci*): A review. J Insect Sci 2014;14:751-64.
12. Ndunguru J, Kapinga R, Sseruwagi P, Sayi B, Mwanga RO, Tumwegamire S, *et al*. Assessing the sweetpotato virus disease and its associated vectors in Northwestern Tanzania and central Uganda. Afr J Agric Res 2009;4:334-43.
13. Sseruwagi P, Sserubombwe WS, Legg JP, Ndunguru J, Thresh JM. Methods of surveying the incidence and severity of cassava mosaic disease and whitefly vector populations on cassava in Africa: A review. Virus Res 2004;100:129-42.
14. Mueangkhong M, Suwor P, Techawongstien S, Teerarak M, Tsai WS, Tarinta T, *et al*. Differential biochemical responses of resistant and susceptible genotypes of chili to pepper yellow leaf curl Thailand virus. Horticulturae 2025;11:1124.
15. Yusuf IJ, Mohammed IU, Musa A, Na'allah MS, Kwaifa NM, Busari YA, *et al*. Detection and distribution of Begomovirus in whiteflies *(Bemisia tabaci* Genn.) found infesting selected crops and their population in northwest Nigeria. Niger J Sci Environ 2025;24:1-12.
16. Arfiani N, Nasruddin A. Control of Pepper yellow leaf curl Indonesia virus and its vector (*Bemisia tabaci* Genn.) on chili plants using resistant variety and insecticide application. IOP Conf Series Earth Environ Sci 2023;1260:012018.
17. Barchenger DW, Yule S, Jeeatid N, Lin SW, Wang YW, Lin TH, *et al*. A novel source of resistance to Pepper yellow leaf curl Thailand virus (PepYLCThV) (*Begomovirus*) in chile pepper. HortScience 2019;54:2200-7.
18. Udiarto BK, Setiawati W, Muharam AD. Seedling protection and barrier crops in chili pepper to reduce whitefly denseness and prevalence of pepper yellow leaf curl virus. IOP Conf Series Earth Environ Sci 2023;1172:012029.
19. Taufik M, Hasan A, Mallarangeng R, Gusnawaty HS, Khaeruni A, Botek M, *et al*. Relationship between whitefly (*Bemisia tabaci*) population and pepper yellow leaf curl disease on chili plant yield in the field. Cropsaver J Plant Prot 2023;6:19.
20. Amaliah I, Daud ID, Nasruddin A. Effect of several reduced-risk insecticides on the population of *Bemisia tabaci* Genn. and incidence of pepper yellow leaf curl Indonesia virus (PepYLCIV) on chili plants. IOP Conf Series Earth Environ Sci 2023;1192:012025.