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RESEARCH ARTICLE **(Open Access)**

# Cowpea virus disease occurrence: implication for food security and sustainable development in Kwara State – Nigeria

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**Abstract**

A virus disease survey was carried out between the months of October and November 2011, in thirty locations of the guinea savanna and rain forest agroecologies of Kwara State – Nigeria with the objective of evaluating the incidence and severity of cowpea viruses. The virus incidence (VI), on cowpea were estimated based on fifty plant observations per field and virus severity (VS), was scored on a scale of 1-5 based on the percentage number of leaves per plant showing virus symptoms. The results indicated that virus incidence were higher in the rain forest agroecology (79% - 90%) compared with the guinea savannah agroecology (43% - 73%). The severity index value were however similar irrespective of the agroecology. The findings indicate the need for the sustainable management of virus diseases which in this study has been found to be rampant and therefore could cause crop yield reductions. It is important to curb the menace of these viruses since cowpea is an important food source for the rural poor. It is therefore expedient to imbibe eco-friendly, cost effective and sustainable management practices to control the viral pathogens. This would enhance food security and cause the reduction in poverty levels among rural dwellers in a developing country like Nigeria.

**Keywords:** Cowpea, Survey, Food security, Rural farmers, Sustainable management, Plant pathogen.

## 1. Introduction

Cowpea (*Vigna unguiculata* L. Walp) a dicotyledonous plant belonging to the family fabaceae, genus *Vigna* (4) is of major importance to the livelihood of millions of people in the tropics and provides a cheap and nutritious food for relatively poor urban communities **(**19). Cowpea has been touted as a crop that may have a wide role in contributing to food security, income generation, and the maintenance of the environment for millions of small-scale farmers who grow it.

Cowpea is widely cultivated in the humid tropics of South-western Nigeria, however, its cultivation is faced with several setbacks, such as pests and diseases (1). It is susceptible to a variety of disease caused by fungi, bacteria, viruses and nematodes. Of these, viruses constitute the major group of pathogens infecting cowpea (17).

Virus cause significant yield losses to arable crops and its effects can be devastating and constitutes a major constraint to cowpea production. Up to 120 viruses have been reported to occur on cowpea worldwide, but only eight are known to infect cowpea in Africa ((27).

Aphids are the most common vectors implicated in the epidemiology of plant viruses and aphid-borne non persistently transmitted viral diseases are of greatest economic importance in several annual cropping systems (23). It has also been shown that about 50% of the approximately 600 viruses with invertebrate vectors are transmitted by aphids and most of the roughly 290 known aphid borne viruses are non-persistent (10). Seed transmission of viruses is also of particular importance since the extent of spread of viruses in fields grown to cowpea is faster when infected cowpea seeds are used as the seed lot (28).

In spite of several reports on the availability of sources of resistance to viruses, natural multiple viral infections of cultivated cowpeas have been reported in Nigeria (25). In a three year survey for the incidence and distribution of cowpea viruses in all the agroecological zones in Nigeria, 390 out of 649 cowpea collected were detected for the presence of viruses (22). This confirms the susceptibility of Nigeria's commercial cowpea cultivars to viral infections and therefore the need to intensify efforts at continuously monitoring the predominant field virus strains **(**26).

Food security exists when all people, at all times, have access to sufficient, safe and nutritious food to meet their dietary needs for an active and healthy life (6). Currently there are over 800 million people without sufficient access to food, while over 40% of Africans cannot secure adequate food on a day-to-day basis (8). The prospects for reducing hunger, malnutrition and food insecurity through increase in

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cowpea productivity is therefore considered a priority (3), especially in the third world where cowpea is regarded as the "poor man's meat".

Critical information in the assessment of disease is the amount of disease that is present. This can be measured as the proportion of a plant community that is diseased (disease incidence) or as the proportion of plant area that is affected (disease severity). Nigerian farmers in their quest to boost food production and ward off the effects of plant diseases, resulted to the use of expensive imported toxic pesticides which have over the years accumulated in the soil causing environmental hazards((21).

To curb food security challenges therefore, sustainability initiatives in the control of plant pathogens, particularly cowpea viruses is warranted. Sustainable agriculture has been described as the act of farming using principles of ecology, the study of relationships between organisms and their environment. Sustainable agriculture also aims to initiate effective and feasible measures integrated into crop protection, which has the potential to contribute to reduction in environmental impact in a way that the environment is not degraded (2).

Kwara state of Nigeria, lies between $8^0$ and $10^0$ North latitudes and $3^0$ and $6^0$ East longitudes and covers a land area of about 32,500km$^2$ with a population of about 2.37 million people. The guinea savannah grasslands dominate the northern parts of the state while some parts of the south fall within the rain forest agroecological zone. Cowpea is an integral component of the traditional cropping systems and a source of nutritious food and fodder across the state (13).

The objective of the study was to evaluate the incidence and severity of cowpea viral diseases in the cowpea growing locations in the guinea savanna and rain forest agroecology of Kwara State. The study aims to contribute to the baseline information data base on cowpea virus occurrence in Kwara State. This information could help planners in designing alternative control initiatives which are environmentally sustainable and affordable by poor resource farmers.

## 2. Materials And Methods

### *Location and Sampling Technique*

A survey for the incidence and severity of cowpea virus disease in thirty different locations within the guinea savanna and rain forest agroecology of Kwara State was carried out in October – November, 2011 cropping season. The survey was done at the time when the crops were at the vegetative growth stage. The locations surveyed for the viruses are noted for cowpea production in the State. The locations chosen, were based on agroecological positioning. 15 locations are in the guinea savanna agroecology and the other 15 locations are in the rain forest agroecology (Table 1). For each location, the farm size was not less than 0.5acre (2000m$^2$ ) and a hand- held geographical positioning system(GPS), was used to record the elevation, longitude and latitude of each of the 30 farm locations.

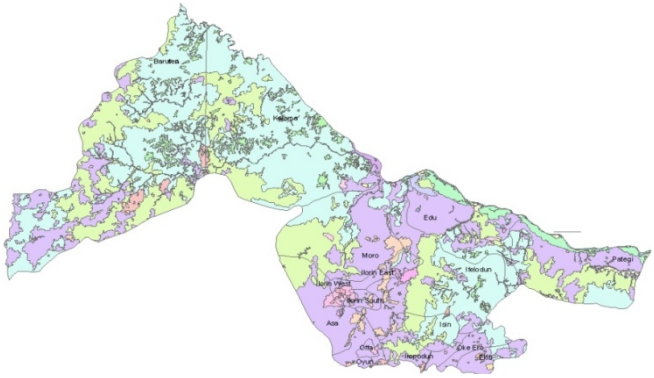


**Figure 1**: Map of Kwara State (**Source: Kwara State Agricultural Development Project 2007)**

### *Estimation of virus incidence*

Virus disease incidence on cowpea was estimated based on fifty (50) plant observations per field. Observations on the 50 plants was taken by walking across a "W" shaped path in a field, with 10 plants per side spaced at an equal distance of 0.75m X 0.25m from each other. Percentage virus incidence was calculated based on an adapted formula of (2):

### *Symptom severity rating*

Viral infection severity was scored on a scale of 1-5, based on extent of leaf damage and percentage number of leaves showing symptoms of the fifty plants counted for disease incidence. A modified version of (5) scale was adopted for the study whereby:

1 = 1 - 20% (very mild);

2 = 21 - 40% (mild);

3 = 41 - 60% (severe);

4 = 61- 80% (very severe); and

5 = 81-100% (almost dead)

$$Percentage\ incidence = \frac{Number\ of\ infected\ plants\ (symptomatic\ plants)}{Total\ plants\ Sampled\ (50)}\ x\ 100$$

**Table 1**: Location and elevation of survey Sites

| *S/No* | *Town* | *Longitude/Latitude* | *Elevation (m)* | *Agroecology* |
|---|---|---|---|---|
| 1 | Iloffa | $8^0\ 05^I 32.12^{II}$ N $5^0\ 09^I\ 55.44^{II}$ E | 551.4 | Rain forest |
| 2 | Ekanmeje | $8^0\ 25^I 46.87^{II}$ N $4^0\ 50^I\ 29.68^{II}$ E | 443.2 | Rain forest |
| 3 | Osi | $8^0\ 04^I 18.25^{II}$ N $5^0\ 15^I\ 08.47^{II}$ E | 488.6 | Rain forest |
| 4 | Odo-Owa | $8^0\ 36^I 56.19^{II}$ N $4^0\ 66^I\ 45.55^{II}$ E | 373.9 | Rain forest |
| 5 | Idera | $8^0\ 04^I 18.25^{II}$ N $5^0\ 15^I\ 08.47^{II}$ E | 451.4 | Rain forest |
| 6 | Idofian | $8^0\ 16^I 24.60^{II}$ N $4^0\ 48^I\ 17.76^{II}$ E | 378.9 | Rain forest |
| 7 | Igbaja | $8^0\ 23^I 22.55^{II}$ N $4^0\ 53^I\ 11.21^{II}$ E | 429.2 | Rain forest |
| 8 | Ilala | $8^0\ 17^I 14.68^{II}$ N $4^0\ 44^I\ 48.26^{II}$ E | 396.9 | Rain forest |
| 9 | Omu-Aran | $8^0\ 08^I 24.89^{II}$ N $5^0\ 07^I\ 25.98^{II}$ E | 545.9 | Rain forest |
| 10 | Ajasse-Ipo | $8^0\ 14^I 45.15^{II}$ N $4^0\ 48^I\ 42.80^{II}$ E | 382.8 | Rain forest |
| 11 | Oke-Ode | $8^0\ 23^I 32.14^{II}$ N $4^0\ 58^I\ 09.76^{II}$ E | 444.4 | Rain forest |
| 12 | Erin-Ile | $8^0\ 05^I 22.63^{II}$ N $4^0\ 43^I\ 22.65^{II}$ E | 398.1 | Rain forest |
| 13 | Ilemona | $8^0\ 06^I 59.55^{II}$ N $4^0\ 39^I\ 57.50^{II}$ E | 411.2 | Rain forest |
| 14 | Jimba-Oja | $8^0\ 22^I 41.67^{II}$ N $4^0\ 42^I\ 30.06^{II}$ E | 406.6 | Rain forest |
| 15 | Elerinjare | $8^0\ 15^I 33.43^{II}$ N $4^0\ 44^I\ 67.72^{II}$ E | 386.2 | Rain forest |
| 16 | Pategi | $8^0\ 44^I 22.56^{II}$ N $5^0\ 45^I\ 12.43^{II}$ E | 118.3 | Guinea savannah |
| 17 | Shonga | $9^0\ 08^I 23.16^{II}$ N $5^0\ 04^I\ 56.10^{II}$ E | 76.8 | Guinea savannah |
| 18 | Molete | $8^0\ 39^I 00.03^{II}$ N $4^0\ 34^I\ 43.01^{II}$ E | 258.8 | Guinea savannah |
| 19 | Alapa | $8^0\ 36^I 52.25^{II}$ N $4^0\ 45^I\ 16.22^{II}$ E | 325.8 | Guinea savannah |
| 20 | Shao | $8^0\ 35^I 31.21^{II}$ N $4^0\ 33^I\ 35.58^{II}$ E | 305.1 | Guinea savannah |
| 21 | Share | $8^0\ 59^I 44.61^{II}$ N $4^0\ 97^I\ 33.11^{II}$ E | 504.1 | Guinea savannah |
| 22 | Bubu | $8^0\ 47^I 07.75^{II}$ N $5^0\ 17^I\ 50.02^{II}$ E | 240.5 | Guinea savannah |
| 23 | Afon | $8^0\ 33^I 76.41^{II}$ N $4^0\ 42^I\ 62.22^{II}$ E | 341.4 | Guinea savannah |
| 24 | Awonga | $8^0\ 45^I 57.88^{II}$ N $5^0\ 37^I\ 07.86^{II}$ E | 121.9 | Guinea savannah |
| 25 | Kanbi | $8^0\ 39^I 18.64^{II}$ N $4^0\ 33^I\ 44.52^{II}$ E | 304.9 | Guinea savannah |
| 26 | Olooru | $8^0\ 39^I 41.17^{II}$ N $4^0\ 35^I\ 40.89^{II}$ E | 315.2 | Guinea savannah |
| 27 | Badi | $8^0\ 58^I 32.25^{II}$ N $4^0\ 86^I\ 11.65^{II}$ E | 368.2 | Guinea savannah |
| 28 | Alade | $8^0\ 35^I 18.25^{II}$ N $4^0\ 55^I\ 54.88^{II}$ E | 439.5 | Guinea savannah |
| 29 | Gwanara | $8^0\ 53^I 30.30^{II}$ N $3^0\ 08^I\ 02.82^{II}$ E | 359.4 | Guinea savannah |
| 30 | Kosubosu | $8^0\ 54^I 38.58^{II}$ N $3^0\ 27^I\ 02.28^{II}$ E | 401.1 | Guinea savannah |

**Source: Field survey 2011**

## 3. Results

*Virus disease incidence*

Figures 1 and 2 show the percentage incidence of virus infection on cowpea in the locations of the rain forest and guinea savanna agroecologies of Kwara State. The results showed that percentage incidence of cowpea viruses in the locations varied between 79 and 90% in the rain forest agroecology and 43 to 73% in the guinea savanna agroecology.

Figure 1 shows the results of the intra-ecology considerations of the values for the rain forest agroecology locations. The results show that virus incidence was highest (90%) in Osi, 84% in Oke-Ode, 81% in Igbaja and 80% in both Erin-Ile and Jimba. The other locations within the rain forest agroecology had the following virus incidence values: Ekanmeje (78%), Odo-Owa (77%), Ajasse and Idofian (74%), Idera (76%), Ilala (72%), Omu-Aran and Illoffa (73%), Ilemona (71%), and Elerinjare (70%).

Figure 2 shows the percentage incidence of virus infection on cowpea in each of the 15 locations of the

savanna agroecology. The highest incidence was recorded at Alade (73%), followed by Shao (70%), and Kosubosu (63%). The locations at Badi and Share had 62% virus incidence, Alapa and Pategi both had 60% incidence. Low virus incidences were recorded at Olooru, Molete and Gwanara (58%), Shonga (54), Kanbi (55), Bubu (51), Awonga (47) and the lowest virus incidence was at Afon (43%).

The comparative average percentage virus disease incidence for the guinea savanna and rain forest agroecology (figure 3), shows that virus incidence was higher in locations within the forest agroecology. The average virus incidence in the locations of the rain forest agroecology was 76.9%, while the locations of the guinea savanna agroecology had 58.3% incidence.

*Virus disease severity*

Table 2 shows the severity index of virus infection on cowpea plants in the 30 selected locations in Kwara State. The results indicated that, the severity index values for all the locations surveyed ranged from very mild in 11 locations, mild in 11 locations, severe in 7 locations and to very severe in 1 location. The highest severity index of 4 (very severe), was recorded at Osi. The locations of Ekanmeje, Odo-Owa, Igbaja, Idera, Oke-Ode, Erin-Ile and Jimba, situated within the forest agroecology have the severity index of 3(severe).

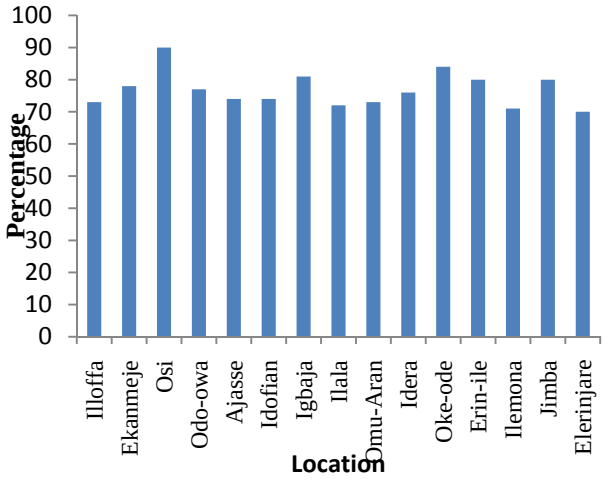


**Figure 1**: Percentage incidence of virus in rain forest agroecology

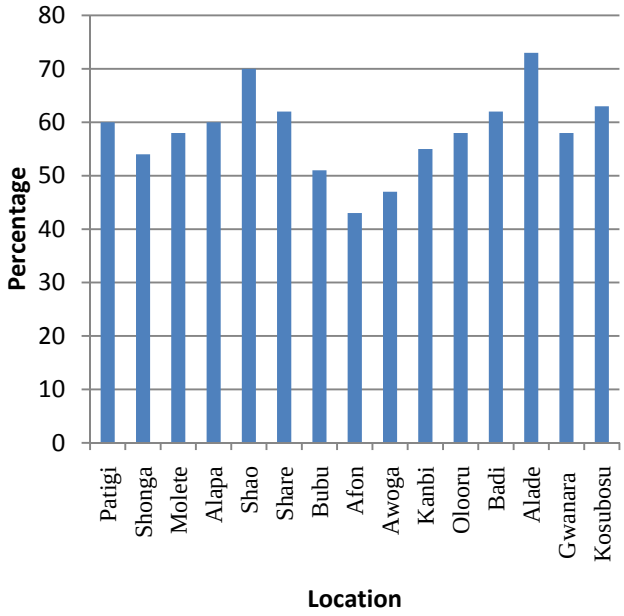


**Figure 2**: Percentage incidence of virus infection in Guinea savanna agroecology

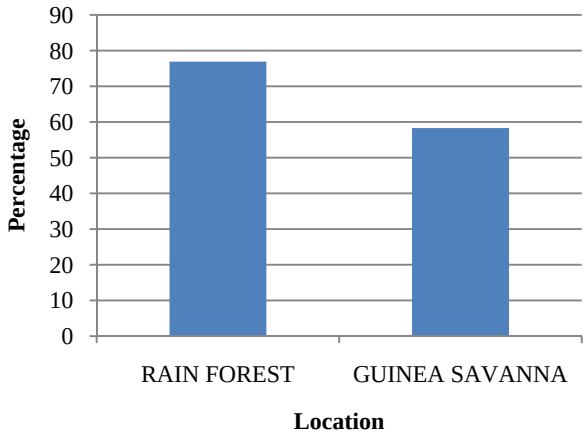


**Figure 3**: Comparative average percentage virus incidence in Rain forest and Guinea savanna agroecology

The severity index of 2 ( mild ), were recorded for the locations at Ajasse-Ipo, Idofian, Illala, Omu-Aran, Ilemona, Elerinjare, Shao, Share, Badi and Alade. The severity index 1 (very mild), was recorded in the guinea savanna agroecology locations in Patigi, Shonga, Molete, Alapa, Bubu, Afon, Awoga, Kanbi, Olooru, Gwanara and Kosubosu .

These results obtained indicated that the severity index for cowpea virus symptoms were very mild or mild in 36.7% of the locations, severe in 23.3% of the locations and very severe in 3.3% of the locations surveyed for cowpea viruses.

**Table 2**:Severity index of virus infection on cowpea in some selected locations in Kwara State

| *S / no* | *Location* | *Agroecology* | *Severity index* |
|---|---|---|---|
| 1 | Illoffa | Forest | 2 |
| 2 | Ekanmeje | Forest | 3 |
| 3 | Osi | Forest | 4 |
| 4 | Odo-owa | Forest | 3 |
| 5 | Ajasse | Forest | 2 |
| 6 | Idofian | Forest | 2 |
| 7 | Igbaja | Forest | 3 |
| 8 | Ilala | Forest | 2 |
| 9 | Omu-Aran | Forest | 2 |
| 10 | Idera | Forest | 3 |
| 11 | Oke-ode | Forest | 3 |
| 12 | Erin-ile | Forest | 3 |
| 13 | Ilemona | Forest | 2 |
| 14 | Jimba-oja | Forest | 3 |
| 15 | Elerinjare | Forest | 2 |
| 16 | Pategi | Savanna | 1 |
| 17 | Shonga | Savanna | 1 |
| 18 | Molete | Savanna | 1 |
| 19 | Alapa | Savanna | 1 |
| 20 | Shao | Savanna | 2 |
| 21 | Share | Savanna | 5 |
| 22 | Bubu | Savanna | 1 |
| 23 | Afon | Savanna | 1 |
| 24 | Awonga | Savanna | 1 |
| 25 | Kanbi | Savanna | 1 |
| 26 | Olooru | Savanna | 1 |
| 27 | Badi | Savanna | 2 |
| 28 | Alade | Savanna | 2 |
| 29 | Gwanara | Savanna | 1 |
| 30 | Kosubosu | Savanna | 1 |

**Source: field survey 2011**

## 4. Discussion

The results from this study indicated a substantial incidence of viruses in the cowpea growing areas within the guinea savanna and rain forest agroecologies of Kwara State. This shows the susceptibility of the cowpea varieties grown and the extensive spread of the virus pathogens across the State.

The study indicated considerable variations of incidence among the locations surveyed. It was observed that viral incidence was higher in the rain forest agroecology compared to the guinea savannah agroecology.

Relative humidity is a key factor that determines the development of many diseases. High relative humidity in particular help pathogens reach the infection site and enhances disease occurrence (16). (29) observed that the prevalence of ergot infection was as the result of high humidity provided by rain in the morning and afternoon drizzle.

The rain forest agroecology is characterized by high humidity levels, preponderance of large trees and thick vegetation cover. A combination of these factors would create a reservoir of virulent viral pathogens and cause higher infection rates. It therefore seems logical to conclude that the higher viral disease incidence observed in the rain forest agroecology as compared to the guinea savannah agroecology was as a result of increased humidity and the thick vegetation in the rain forest agroecology. This finding is in agreement with (12), who reported that humidity levels had a positive relationship with virus disease development and (9), who observed the occurrence of *cowpea aphid borne mosaic virus* on *Mucuna pruriens*, which is a major vegetation cover of cowpeas on the field. The result is also a confirmation of the assertion by (20).

The severity index considerations showed that the values obtained in the 30 locations were similar irrespective of the agroecology. The results indicated that 97% of the locations had severity index classified as severe, while only one location recorded a moderate severity index.

Similarities in the severity indexes could be due to the time of planting of the cowpea varieties and the similar planting population that were adopted in the locations surveyed. Earlier studies by (14) had shown that the critical factors that affect virus severity were the planting dates and inter row spacing between plants. The slight differences in severity index could be as a result of mixed virus infections in the cowpea plants. Mixed viral occurrence were found by (7) and (18) to elicit more severe symptoms through synergistic interactions. (15) also reported that differences in symptom severity between years and regions in virus diseases were attributable to synergistic effect of mixed viral infection.

## 5. Conclusion

The study provides relevant information on the occurrence of cowpea viruses in Kwara State. while incidence of the viruses varied with location, the severity was apparently the same. This fact is indicative of the potentials of viruses in causing yield reductions in cowpea productivity in the State. Cowpea as an important crop in most parts of the savannah zones of sub-Saharan Africa, fills a significant gap in the farming systems of most poor farmers where it solves their food problems (24). There are great prospects in its ability to solve poverty and malnutrition problems and contribute to the sustainability of African agricultural systems (11).

The key to attaining food sufficiency in Nigeria is ensuring that crops stay healthy and protected from damages by pathogens. There is the need therefore to determine the incidence and severity levels of pathogenic organisms like viruses on major food crops to be able to establish effective and sustainable control measures to curb the spread. Farmers should be encouraged to imbibe eco-friendly initiatives such as the use of certified virus – free seeds, control of insect vectors with regulated biopesticides, promote safe-handling techniques of chemicals, promote the use of botanical pesticides and deploy extension services for up-scaling best practices. These would help in conditioning the rate of adoption and hence an increased contribution of cowpea to improved livelihoods and a sustainable development of the rural farmers.

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