

FARMERS' AWARENESS OF VIRUS SYMPTOMS AND ASSOCIATED DAMAGE ON THREE FRUIT VEGETABLE CROPS GROWN IN TWO STATES OF SOUTHWEST NIGERIA

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SUMMARY

*The study assessed farmers' awareness of viral disease symptoms and associated levels of severity on Pepper (*Capsicum* spp.), Tomato (*Solanum lycopersicum* L.) and Okra (*Abelmoschus esculentus* L. Moench). Structured questionnaire was used to collect data from 94 farmers in Oyo and Ogun states in southwestern Nigeria. Responses were analyzed using descriptive statistics. Of the respondents, the average age of married male farmers was 46 years (46.48 ± 11.43) and 43.6% had secondary education. Pepper (cv. Rodo) was cultivated by 42.5% of respondents followed by okra (landrace) (37.2%), and tomato (cv. Beske) (29.4%). For pepper and tomato, most farmers observed leaf curl symptoms (73.4 and 72.3%, respectively) while leaf deformation symptom (36.2%) was observed in okra. Farmers observed damage such as reduction in yield (74.5%); reduction in number of leaves and fruit size (70.2%) and reduction in fruit size and yield (41.5%) for pepper, tomato and okra, respectively. Damage caused on these vegetables due to viral infection has led to reduction in family income (94.8%). The farmers made attempts to control the symptoms observed by spraying with chemicals; only 1% dispose the infected plants by burying. This study concludes that the farmers recognized virus disease symptoms on the selected vegetables, admitted that infection leads to yield losses and attempted some control measures, though inappropriate. Thus, farmers should be sensitized on the proper measures for controlling viral infections on the selected vegetable crops.*

Keywords: Virus damage, Vegetable farmers, leaf curl, leaf deformation, questionnaire, virus symptoms

Plant pathogens alter plant diversity, ecological stability, and ecosystem productivity by reducing growth and ability of infected plants to compete (Burdon *et al.*, 2006; Bradley *et al.*, 2008; Maron *et al.*, 2011; Latz *et al.*, 2012). Rapid spread of crop viral pests has been attributed to globalization, climate change, trade, and reduced resilience in production systems over time due to agricultural intensification. There has been economic loss on a yearly basis due to plant virus diseases in the tropics and sub-tropics (Varma and Malathi, 2003; Anderson *et al.*, 2004; Islam *et al.*, 2017a, b).

Vegetables provide humans with vitamins and minerals (Abang *et al.*, 2014). Tomato (*Solanum lycopersicum* (Linnaeus), pepper (*Capsicum* spp.) and okra [*Abelmoschus esculentus* (L) Moench] are some of the most important vegetables grown in Nigeria. They also serve as a means of economic opportunity for reducing rural poverty in developing countries. Tomato has been reported to be a good source of vitamins A, C, E and minerals (Olaniyi *et al.*, 2010) and contributes to the income of producers (Ayoola, 2014). Pepper is produced by smallholder farmers (Arogundade *et al.*, 2012) and has been reported to have high economic, nutritional and medicinal importance and as an excellent source of antioxidants (Howard *et al.*, 2000). Okra is widely cultivated in sub-Saharan Africa (Mbah *et al.*, 2009; Edet and Etim, 2010; Ayoola, 2014; Ngbede *et al.*, 2014) and reported to contain some essential amino acids and has medical applications

(Farinde *et al.*, 2007). These vegetables are part of the most important vegetables as production figures according to the Food and Agriculture Organization Statistics (FAOSTAT) revealed that in year 2017, 4,100,000 tonnes of tomato, 748,559 tonnes of pepper and 2,060,280 tonnes of okra were produced in Nigeria (Plaisier *et al.*, 2019).

In the rainy season, the production of tomato is associated with high incidence of pathogen induced diseases (Ayoola, 2014), just like pepper and okra. Since symptoms of virus induced are similar in appearance to diseases caused by abiotic causes, farmers often find it difficult to differentiate them (Van de Bosch *et al.*, 2007; Jones, 2014). It is important to find a way of making growers aware of viral diseases of vegetable crops. Knowledge about transmission of viruses and their infection cycle is important for proper management as there are no commercial antiviral products available (Schreinemachers *et al.*, 2015). If left unmanaged, viral diseases can lead to total loss of crops.

Okra is susceptible to a range of insect pests and diseases at various stages of its growth (Fasunwon and Banjo, 2010). One of the most important diseases of okra is caused by *Okra mosaic virus* (Alegbejo, 2003). Pepper has been reported to be susceptible to about 40 viruses with prevalent types being *Cucumber mosaic virus* genus *Cucumovirus* and *Pepper vein mottle virus* genus *Potyvirus* (Arogundade *et al.*, 2012; Arogundade *et al.*, 2015; Ayo-John and Odedara, 2017). Viral disease symptoms seen on pepper plants in southwest Nigeria include mottle, vein chlorosis, leaf distortion and stunting (Arogundade *et al.*, 2012).

Studies in Nigeria have examined viral infection on vegetable crops including tomato, pepper and okra. Ayo-John and Odedara (2017) reported the distribution of viruses on tomato and pepper in southwest Nigeria. Abraham *et al.* (2019) documented research on important virus infecting tomato in Nigeria. The incidence of viruses in the farmers' field have been reported to be relatively high with the occurrence of multiple virus diseases a common phenomenon Arogundade *et al.*, 2015). The occurrence of *Okra mosaic virus* is an important virus disease of okra which have contributed to losses (Alegbejo *et al.*, 2008; Abdulraheem and Moshood 2019).

However, many farmers do not have knowledge of viral diseases in tomato and pepper and as such; they do not incorporate management practices for disease protection (Ayo-John and Odedara, 2017). The study assessed farmers' awareness of viral diseases of tomato, pepper and okra, their susceptibility to viral infection, damage caused and extent of damage by the viral diseases. It also assessed constraints faced by farmers due to viral diseases, and farmer's socio-economic attributes.

MATERIALS AND METHODS

The study was conducted in the year 2018 in southwestern Nigeria, specifically Ogun and Oyo States in Nigeria. In both states, 7 local government areas where vegetable crops are grown were selected proportionate to the number of Local Government Areas (LGAs) in each state. The local government areas visited in Ogun state were Odeda, Yewa North and Ada-Odo Ota while in Oyo state, Ibarapa Central, Ibarapa East, Ido and Akinyele local government areas were selected. Ninety-four farmers producing vegetables were randomly sampled within the local government areas with 54 farmers selected from 4 LGAs in Oyo state and 40 farmers selected from 3 LGAs in Ogun state.

Structured questionnaires were used to obtain information from farmers on (i) awareness of viral diseases on pepper, tomato and okra (ii) damage caused, and extent of damage caused, by viral diseases and (iii) control measures employed by farmers and constraints faced due to viral diseases on vegetables. To assess the farmers' awareness of viral diseases, a description of symptoms was presented to them, and their identification of the symptoms was used to determine their level of awareness of virus symptoms. Data collected was analyzed using descriptive statistics specifically frequencies and percentages.

RESULTS AND DISCUSSION

For Pepper, most farmers were aware of leaf curling up or down (73.4%), yellowing of leaves (69.1%), mottling of leaves (66.0%), while they were least aware of puckering (54.3%) (Table 1). Most farmers were aware of leaf folding up or down (72.3%), leaf deformation (66.0%) and puckering (53.2%) in tomato. Some of the farmers were aware of leaf deformation (36.2%), mottling of leaves (35.1%) and intra-veinal yellowing (26.6%) in Okra (Table 1). This is similar to the report of Asare-Bediako *et al.* (2014) where most farmers in Central Region of Ghana were aware of the *Tomato yellow leaf curl virus disease*.

Types of vegetable crops planted and their susceptibility to viral infection

In the study area, it was observed that vegetable farmers were growing more than one type of each of the vegetable crops under study. It was noted that most farmers were involved in the production of pepper (48.31%) and tomato (36.70%) while a few also grew okra (14.98%) (Table 2). Okra cv. NHAe 47-4 was the mostly grown type by 37.2% of the respondents. The area under each of the vegetable production differed probably because of the preference of the people of the region and market demand.

Pepper cultivar "Rodo" was the most grown pepper type in the study area (43.41%). This is in agreement with an agreement earlier made by Arogundade (2012) (unpublished) which revealed that the area under hot pepper production in Southwest Nigeria was more compared to "long cayenne", "sweet pepper" and "bird eye pepper". Other cultivars grown were "Bawa", "Sonbo" and "Tatase" cultivated by 20.93%, 18.60% and 16.28% of the farmers producing pepper in the study area respectively. Over half (58.93%) of the farmers opined that this cultivar "rodo" is more common with viral infection. However, 25.93% stated that this cultivar is "very susceptible" to viral infections.

For tomato, 29.59% of the farmers grow tomato cv. "Beske", cv. "Kerewa" 27.55%, cv "Alausa" 19.33%, among others. Most of the farmers (75.86%, 70.37% and 63.16%) observed that cultivars "Beske", "Kerewa" and "Alausa" are susceptible to viral infections. More than half (57.14%) of the farmers stated that tomato cv. "Local" is less susceptible to viral infection.

Most of the farmers were observed to grow Okra cv. "NHAe 47-4" (87.50%) with 54.29% of them adjudged the cultivar type to be susceptible. The farmer who grows okra cv. "Agric" submitted that it is very susceptible to viral infections (Table 2).

Table 1: Awareness of virus symptoms on vegetable crops by farmers in Ogun and Oyo states in Southwest Nigeria

Symptom	Occurrence (%)		
	Pepper	Tomato	Okra
Leaf folding up or down	73.4	72.3	33.0
Plant stunting	60.6	62.8	29.8
Appearance of mosaic pattern on leaves	62.8	57.4	31.9
Intraveinal yellowing	61.7	58.5	26.6
Yellowing of leaves/chlorotic coloration	69.1	61.7	30.9
Mottling of leaves	66.0	61.7	35.1
Leaf deformation	62.1	66.0	36.2
Puckering	54.3	53.2	33.0

Table 2: Farmer's perception of virus symptoms of vegetable crops grown in Ogun and Oyo states in Southwest Nigeria

in Southwestern Nigeria

Vegetable/Type	Percentage of vegetable farmers	Rating		
		Very susceptible	Susceptible	Less susceptible
Pepper (<i>Capsicum</i> spp.)				
Bawa (Cayenne pepper)	27 (20.93) ^a	7 (25.93)	15 (55.56)	5 (18.52)
Rodo (Chili pepper)	56 (43.41)	13 (25.93)	33 (58.93)	9 (16.07)
Sombo (Cayenne pepper)	24 (18.60)	4 (23.21)	15 (62.50)	5 (20.83)
Tatase (Bell pepper)	21 (16.28)	2 (16.67)	13 (61.90)	6 (28.57)
Others	1 (0.78)	-	1 (100.00)	-
Total	129 (48.31)			
Tomato (<i>Solanum lycopersicum</i>)				
Alausa ^b	19 (19.39)	5 (26.32)	12 (63.16)	2 (10.53)
Beske	29 (29.59)	4 (13.79)	22 (75.86)	3 (10.34)
Kerewa	27 (27.55)	5 (18.52)	19 (70.37)	3 (11.11)
Local	7 (7.14)	-	4 (57.14)	3 (42.86)
Onityre	9 (9.18)	4 (44.44)	3 (33.33)	2(22.22)
Others	7 (7.14)	1 (14.29)	6 (85.71)	-
Total	98 (36.70)			
Okra (<i>Abelmoschus esculentus</i>)				
Agric	1 (2.50)	1 (100.00)	-	-
NHAe 47-4	35 (87.50)	3 (8.57)	19 (54.29)	13 (37.14)
Others	4 (10.00)	1 (25.00)	1 (25.00)	2 (50.00)
Total	40 (14.98)			
Grand total	267 (100.00)			

^a Values outside of parentheses are frequency; values in parentheses are percent.

Damage caused by viral diseases and extent of damage on pepper

Most farmers were aware of reduction in harvest/yield (74.5%), leaf dropping (70.2%), as the damage caused by viral diseases of pepper (Table 2). Most of the farmers that noticed reduction in harvest on pepper opined that it leads to very severe damage (36.2%). For leaf dropping, 38.3% of the farmers submitted that it caused severe damage. Reduction in the number of fruits produced, on pepper by 67.0% of the farmers was considered as severe damage by 42.6% (Table 3).

Also, 69.1% of the farmers noticed that reduction in number of leaves and fruit dropping were the damage caused by viral diseases in pepper. Fifty percent of them agreed that this damage was severe on the pepper plants. The knowledge of the farmers about the various damages caused by plant viruses in pepper fields in the study states confirmed the report of Arogundade et al. (2015) that in Nigeria, most pepper farms exhibited complex symptoms of mosaic, mottle, leaf distortion, vein chlorosis and stunting that cause considerable losses in yield and plant vigour.

Damage caused by viral disease and extent of damage on tomato

Among the farmers that cultivated tomato, 70.2% were aware of the damage caused to tomato varieties as a result of reduction in leaf number, 70.2% of them reckoned that damage done was as a result of reduction in fruit size while 69.1% attributed the damage to fruit dropping. However, the farmers were least aware of the damage caused by ring-like patches on the tomato fruit (54.3%) (Table 4). Fifty two percent (52.1%) of farmers adjudged the damage caused by reduction in leaf number as severe while 50%, 46.8%, 46.8% and 36.2% adjudged fruit dropping, reduction in fruit size, reduction in number of fruits and flower dropping as severe respectively (Table 4). Reduced fruit size and chlorotic rings are some of the manifestations of *Tomato bushy stunt virus* in Nigeria (Abranham et al, 2019).

Damage caused by viral disease and extent of damage on okra

Most of the okra farmers (41.5%) observed reduction in fruit size and yield as damage noticed on Okra plants. They opined that the damage was severe (26.6%). Furthermore, damage caused by virus on okra include reduction in the number of fruits (40.4%), leaf dropping (39.4%), reduction in number of leaves (38.3%), flower and fruit dropping (36.2% respectively). Most farmers (24.5%) noted that fruit dropping caused a very severe damage (Table 5).

Table 3: Damage caused by viral disease and extent of damage on Pepper grown in Ogun and Oyo states in Southwest Nigeria

Damage	Yes	Damage (%)		
		Very severe	Severe	Not severe
Reduction in number of leaves	69.1	7.4	48.9	12.8
Leaf drop	70.2	6.4	38.3	25.5
Flower drop	62.8	8.5	26.6	28.7
Fruit drop	69.1	10.6	42.6	16.0
Delay in flowering or fruiting	63.8	11.7	37.2	16.0
Reduction in fruit size	63.8	8.5	38.3	16.0
Reduction in number of fruits	67.0	14.9	42.6	8.5
Deformed fruit	56.4	3.2	20.2	34.0
Ring-like patches on fruit different from its original color	50.0	1.1	25.5	26.6
Reduction in harvest/yield	74.5	36.2	26.6	10.6

Table 4: Damage and severity of virus symptoms associated with Tomato in Ogun and Oyo states in Southwest Nigeria

Damage	Yes	Damage (%)		
		Very severe	Severe	Not severe
Reduction in number of leaves	70.2	5.3	52.1	12.8
Leaf dropping	66.0	4.3	43.6	18.1
Flower dropping	68.1	4.3	36.2	27.7
Fruit dropping	69.1	6.4	50.0	12.8
Delay in flowering or fruiting	56.4	9.6	31.9	16.0
Reduction in fruit size	70.2	8.5	46.8	14.9
Reduction in number of fruits	68.1	13.8	46.8	7.4
Deformed fruit	58.5	3.2	24.5	31.9
Ring-like patches on fruit different from its original color	54.3	1.1	31.9	21.3
Reduction in harvest/yield	68.1	28.7	36.2	3.2

Table 5: Damage and severity of virus symptoms associated with Okra in Ogun and Oyo states in Southwest Nigeria

Damage	Yes	Damage (%)		
		Very severe	Severe	Not severe
Reduction in number of leaves	38.3	1.1	18.1	19.1
Leaf dropping	39.4	-	26.6	12.8
Flower dropping	36.2	1.1	11.7	23.4
Fruit dropping	36.2	-	24.5	11.7
Delay in flowering or fruiting	34.0	3.2	19.1	11.7
Reduction in fruit size	41.5	4.3	26.6	10.6
Reduction in number of fruits	40.4	7.4	24.5	8.5
Deformed fruit	33.0	-	11.7	21.3
Ring-like patches on fruit different from its original color	30.9	-	19.1	11.7
Reduction in harvest/yield	41.5	11.7	26.6	3.2

– Means no response.

Measures taken by farmers to control viral diseases of vegetable crops

Table 6 documents the actions taken by farmers to control the viral diseases. Most of the respondents (86.2%) attempted some form of control measures while 13.8 % were indifferent. Among those that applied any control measure, 85.1% sprayed either insecticides, fungicides or both while 1.1% abandoned their farms. Schreinemachers *et al*, (2015) in their study also noted that farmers normally use synthetic pesticides to control pests and diseases of vegetable crops in developing countries. Only 1.1% of the farmers disposed the diseased plants by burying, while majority (89.4%) took no action. The farmers seem to apply any kind of pesticides such as fungicides to control symptoms of viruses because of the lack of knowledge of the causal agents of the symptoms and specifications for their control.

Constraints faced by vegetable farmers

The major impact of viral infections on the three vegetable crops reported by 94.7% of the farmers was the reduction in family income because of reduced yields. About half (53.2%) of the respondents agreed that the spread of infection to other crops was a constraint to vegetable production in the study area.

Table 6: Actions taken by farmers to manage viral diseases of vegetable crops grown in Ogun and Oyo states in Southwest Nigeria.

Action	Number of farmers (%)
Control of virus	
Yes	86.2 ^a
No	13.8
Method of control	
Use of chemicals	85.1
Abandon farm and clear	1.1
Unanswered	13.8
Disposal of diseased plants	
Burning	-
Burying	1.0
Others (no action)	89.4
Unanswered	9.6

– Means no response.

Farmers' socio-economic attributes

The results showed that most of the respondents were male (96.8%), married (91.4%) with 91.5% having one form of education or the other ranging from primary to tertiary (Table 7). Aliyu (2014) had reported similar findings that most of the Okra farmers were males and married in a study on perception of farmers on Okra diseases.

Farmers involved in the study are moving out of the active working age as observed in their average age of 46.48 ± 11.43 (47 years). Also, average farm size for vegetable farmers was 3.84 ± 3.30 hectares. The farmers had average farming experience of 21.74 ± 11.56 (22 years). This implies that most of them have been long in farming business and are expected to know the intricacies of the production processes involved for each of the vegetable crops being cultivated. A high percentage of the farmers (76.60%) are involved in farming as their primary occupation earning an average monthly income of ₦36, 549.45 $\pm$ 23,215.18 from this occupation. Majority of them (88.30%) are involved in mixed cropping; 11.70% involved in sole cropping of the sampled vegetables (pepper, tomato and okra). Other crops planted by the farmers were cassava (36.89%); maize (34.47%) and other horticultural crops (5.83%) such as cucumber, watermelon, plantain and pawpaw.

Table 7: Socio-economic attributes of selected farmers in Ogun and Oyo States in 2018

Attribute	Percent (%)	Mean (standard deviation)
Age		46.48 (11.43)
Sex		
Male	96.80	
Female	3.20	
Marital status		
Single	8.60	
Married	91.40	
Educational status		
No formal education	8.60	
Primary education	34.40	
Secondary education	44.10	
NCE/OND	9.70	
HND/BSc/BA	2.20	
MSc/PhD	1.10	
Average farm size (ha)		3.84 (3.30)
Years of farming experience		21.74 (11.56)
Average income from primary occupation		₦36,549.45 ^c (23,215.18)
Primary occupation		
Farming	76.60	
Artisan	13.83	
Civil service	7.45	
Others	2.13	
Cropping system		
Mixed cropping	88.30	
Monocropping (sampled vegetables only)	11.70	
Other crops grown		
Cassava	36.89	
Maize	34.47	
Yam	16.02	
Cocoyam	4.85	
Cucumber, watermelon	3.40	
Peanut	1.94	
Pawpaw, plantain	2.43	

NCE = National Certificate of Education; OND = Ordinary National Diploma; HND = Higher National Diploma; BSc = Bachelor of Science degree; BA = Bachelor of Arts degree; MSc = Master of Science degree; PhD = Doctor of Philosophy; ₦ = Naira (Nigerian currency); \$1US=₦360.00 as of 3 August 2018.

CONCLUSION

The study concluded that the vegetable farmers were familiar with the various symptoms of viral diseases on their fields even though they did not know that the symptoms were caused by viruses and so did not attribute some of the symptoms as disease. They however agreed that the symptoms led to reduced yield and family income. For pepper, tomato and okra, most farmers opined that cv.

‘rodo’, cv. ‘Beske’, and cv. ‘NHAe 47-4’ show more symptoms of viral infections. They could also describe the degree of the severity of the viral diseases on the selected vegetables- tomato, pepper and okra. However, the method of control and disposal of infected plants being used by most farmers were inadequate and ineffective because they do not know or understand the causal agent. Moreover, farmers experienced huge reduction in income because of virus infection on their vegetable plants. To minimize this, it is imperative to make available to the farmers virus-resistant vegetable seeds for planting. This will enhance increased yield and subsequent improvement in the well-being of the vegetable growers.

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