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Incidence and Severity of Okra Mosaic Virus on Field-grown Three Cultivars of Okra (Abelmoschus Esculentus L.)

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ABSTRACT

Okra is an economically important vegetable crop grown on a wide range of soil types in tropical Africa as well as in other parts of the world. Okra cultivation has been widely practiced in Nigeria owing to its importance as a food crop. Okra yield is mostly limited by soil fertility, cultural management, pests, and diseases. A field experiment was conducted to investigate the incidence and severity of okra mosaic virus (okmv) on three field-grown cultivars of okra which are NHe-4, LDu-88, and V35. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The disease was investigated among the three cultivars under natural field conditions in two planting seasons. The incidence of infection was taken by visual observation of symptoms and the severity of the virus using a scale of 1-5. The result showed that the cultivars were susceptible to okra mosaic virus (Okmv). The highest viral incidence and higher disease severity were on cultivar V35, which resulted in the lowest yield among other cultivars observed. The prevailing vector of okmv in the study area was Podagrica spp., which indicated that okmv had significant effects on okra growth and yield.

Keywords: Incidence, Severity, Field-experiment, Okra mosaic virus, Cultivars.

INTRODUCTION

Okra *(Abelmoschus esculentus)* is found all over the world, from the Mediterranean to equatorial areas. Okra *Abelmoschus esculentus* (L.) is an economically important vegetable crop grown in tropical Africa (Alegbejo *et al*., 2008) as well as in other parts of the world, tropics, and subtropics. Okra cultivation has been widely practiced in Nigeria owing to its importance as a food crop and in the economic development of the country (Katung, 2007). Okra can be grown on a wide range of soil types. Its yield is mostly limited by soil fertility, cultural management, pests, and diseases (Nyande *et al.*, 2021). Nigeria is the largest producer of Okra in Africa, total annual yield is estimated at 1, 837, 904 tonnes in 2020 and yield 11, 459kg/ha (FAO, 2019). There are two distinct seasons for okra production, the peak and the lean seasons. During the lean season, okra fruits are produced in low quantities, scarce and expensive (Bamire and Oke, 2003). In the peak season, it is produced in large quantities beyond what the local populace can consume and this results in a glut with a reduction in market price.

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Problems of okra production are insect pest infestation, disease incidence, and poor soil nutrient levels (Nyande *et al.*, 2021). Youdeowei (2002) documented insects of primary importance in the cultivation of okra crops such as *Podagrica* spp, thrips, aphids, flower beetles, cotton stainers, and stick bugs as major vectors of okra. Okra mosaic virus (okmv) is widely reported in West Africa, most especially in Nigeria with important yield loss on affected crops (Alegbejo *et al*., 2008; Thottappilly, 1996).

Okra mosaic virus contains a single-stranded positive–sense RNA and it consists of isometric particles of 28nm in diameter (Gisword and Koenig 1974). Okra Mosaic virus has always been a serious problem in okra and symptoms are characterized by a homogenous interwoven network of yellow mosaic patterns enclosing islands of green tissues in leaf blades. In extreme cases, infected leaves become yellowish or creamy in color (Fajinmi and Fajinmi, 2010). The virus is not seed transmitted (Givord and Koeing, 1974), but it is transmitted principally by *Aphis spiraecola*, *Toxopteracitricidus* and *Podagrica spp* (Atiri, 1984, Alegbejo, 2001a). The Virus was initially reported in Coted Ivoire and Nigeria only. It is likely to be widespread in many West African countries (Katung, 2007).

Low productivity of okra production in Nigeria, particularly in Osun state has been attributed to diseases. Prominent among these diseases is the okra mosaic virus (okmv). However, limited report is available on the prevalence of okmv in the State and farmers rarely identify the incidence and severity of this disease in the study area. In this research, the presence of okmv was established by particle morphology, symptoms on okra plants, and available literature data (Alegbejo *et al*., 2008; Owolabi *et al*., 1998; Thottappilly, 1996).

Materials and Methods

Experimental site

The study was carried out at the Teaching and Research Farm, Joseph Ayo Babalola University, Ikeji-Arakeji in the 2020/2021 cropping seasons. The experimental field lies between Latitude $07^0 16^1$ and $07^0 18^1$ and longitude $05^0\ 09^1$ and $05^0\ 11^1$ E. The place is characterized by a tropical climate with 1500mm average rainfall per annum, 27^0c average temperature with high relative humidity in the rainy season that lasts for about eight months in a year. The land has long been subjected to the cultivation of arable crops such as maize, cassava, and cowpea. Total manual clearing of the experimental field was done followed by minimum soil tillage of the plots.

Source of planting materials

Seeds from three okra cultivars (NHe47-4, LDu-88, and V35) were obtained from agricultural research institutes in Nigeria. Two of the cultivars of okra used were obtained from NIHORT, (NHe47-4 and LDu-88) while the V35 was obtained from the Institute of Agricultural Research and Training (IAR&T).

Experimental design and layout

The three treatments were replicated three times in a Randomized Complete Block Design (RCBD). The experimental site was marked into three (3) blocks while each block was also marked into three (3) plots, giving a total number of nine (9) plots. Each plot was 4m × 1.5m. Control was also set up for the trial in a screen house of 4m × 1.5m in dimension. Three seeds per hole were planted with intra and inter-row spacing of 30cm × 60cm. Seedlings were thinned to two stands at two weeks after germination.

Weed Management

Manual weeding was done to maintain a weed-free trial.

Data collection

Five plants were randomly selected for the purpose of data collection. Data collection started one week after planting (1WAP) and this continued to the end of the growing period. The data collected were centered on the following parameters; Plant height (cm), yield (kg/ha), disease incidence, and disease severity. Plant height was taken in centimeters from the base of the plant to the tip of the last leaf at week intervals. The weight of fresh fruits (kg) harvested from each plot was taken and averaged. Figure 1 shows available vectors collected from the experimental field at two-week intervals, using the hand netting method with specific targets on *Aphis spiraecola*, *Toxopteracitricidus*, and *Podagrica spp*. Insect populations were recorded and averaged for 10 weeks. Disease incidence (DI) was calculated based on the number of plants showing symptoms of okmv in the total population of plants per plot expressed in percentage.

Mathematically,

$$\frac{number\ of\ symptomatic\ plants\ in\ a\ plot}{Total\ number\ of\ plants\ per\ plot}\ X\ 100$$

Disease severity was observed from 2 weeks to 10 weeks after planting, using a visual scale of 1 - 5 developed by (Alegbejo, 1997). Where: 1 = no visible symptoms, 2 = slight mosaic of leaves in the apex, 3 = mild mosaic and curling of leaves, 4 = mild mosaic with no leaf distortion, 5 =severe mosaic and curling of leaves.

Data analysis

Data collected were subjected to analysis of variance (ANOVA) using PROC ANOVA (SAS 9.2) and means were separated using least significant difference (LSD) at 0.05.

Results and Discussion

Effects of the disease (okmv) on plant height (cm)

The effects of okmv on the plant height of the okra cultivars used are shown in Table 1. Results obtained showed that there was a significant difference in the plant height of the cultivars. Control had the highest plant height at 4 and 8 weeks (68.45cm and 87.11cm). LDu–88 had the lowest plant height (29.02cm) at four weeks. There was no significant difference in plant height of NHe47-4 and V35 (42.71cm and 40.69cm) at 4 weeks after planting. However, there was a significant difference in plant height of LDu-88 (82.50cm) observed at 8 weeks. At 4 and 8 weeks, the control showed a significant difference in plant height among the three cultivars of okra, this implies that okra mosaic virus had a significant effect on the growth of Okra cultivars used in this experiment. This agrees with Alegbejo, 1997 that incidence may affect the agronomic performance of okra and may reach 100% before harvest in experimental and commercial planting. Symptoms exhibited by diseased plants confirmed earlier reports by Swanson and Harrison, 1993; Brunt *et al*., 1990.

Table 1: Effect of okra mosaic virus on plant height (cm) on three okra cultivars

Cultivar	Plant Height at 4 weeks	Plant Height at 8 weeks
V1NHe47 - 4	42.71b	45.20b
V2 LDu – 88	29.02c	82.50a
V3 V35	40.69b	40.71b
Control	68.45a	68.45a

Mean followed by the same letter within each column is not significantly different (P<0.05)

Incidence of okra mosaic virus on three okra cultivars

The incidence of okra mosaic virus on three okra cultivars is represented in Table 2. The disease incidence varied among the selected cultivars used at 4 and 8 weeks after planting respectively. Cultivar V35 had a significantly higher disease incidence at 4 weeks (55.93) than cultivar LDu-88 and cultivar NHe47 – 4, both of which did not statistically differ. Similarly, at 8 weeks after planting cultivar V35 was significantly different (63.16) than cultivar NHe47– 4 and cultivar LDu-88 which had 58.46 and 47.85 respectively. This however implies that there is a significant difference in disease incidence observed on the selected cultivars. Control results at 4 weeks and 8 weeks respectively showed no incidence of okmv on the three cultivars of okra. The level of incidence and severity varies in the three okra cultivars and may be due to the area concentration of the vectors or the genetic makeup of the cultivars (Bisht *et al.,* 2006). Furthermore, this investigation revealed that there are okra cultivars that will produce yield at high level of severity to okmv. Alegbejo (2001b) also reported some okra cultivars that were moderately resistant to okmv in northern Nigeria. Disease incidence above 50% showed that the cultivars are susceptible. This agrees with Nyande *et al.*, 2021 who reported cultivars of okra susceptible to okmv in West Africa.

Table 2: Incidence of okra mosaic virus on three okra cultivars

Cultivar	Disease incidence at 4weeks %	Disease incidence at 8weeks %
NHe47 - 4	40.37b	58.46b
LDu - 88	42.22b	47.85c
V35	55.93a	63.16a
Control	0.00c	0.00d

Mean followed by the same letter within each column are not significantly different (P<0.05)

Severity of okra mosaic virus on three cultivars of okra

The severity of okra mosaic virus on three cultivars of okra is represented in Table 3. Disease severity varied significantly among the three cultivars and through the weeks of assessment. At two weeks cultivar V35 gave a significantly higher disease severity (2.96) (slight mosaic of leaves in the apex) than cultivar NHe47-4 and cultivar LDu-88 which are not significantly different. Similarly, at 4 weeks, cultivar V35 was also significantly different in severity (3.81) (mild mosaic and curling of leaves), this result at 4 weeks indicated no significant difference between the level of severity on NHe47-4 and cultivar LDu-88. At 6 weeks of disease severity assessment, the same cultivar V35 indicated a significant difference in severity (4.25) (mild mosaic with no leaf distortion) while there is no significant difference between cultivar one (NHe47-4) and cultivar two (LDu-88). However at 8 weeks, V35 and NHe47 – 4 were not significantly different in severity to okmv (4.37 and 4.30) (mild mosaic with no leaf distortion), but it must be noted that 'control' was not significantly different in the weeks of observation. Assessment at week 10 showed two cultivars two (LDu-88 and V35) had the highest disease severity and were not significantly different. In this result, cultivars V35 and LDu – 88 indicated the highest disease severity. The high level of severity to okmv also conforms to the incidence level on cultivar V35. For the control, the highest level of severity was (1.15) (no visible symptoms) throughout the weeks of assessment. The observation that the cultivars used vary in their severity to okmv may be influenced by the presence of alternative hosts of the disease and viruliferous insect vector population dynamics in the environment (Igwegbe 1983; Atiri, 1984).

Table 3: Disease severity of okra mosaic virus on three cultivars of okra

Cultivar	**2weeks**	**4weeks**	**6weeks**	**8weeks**	**10weeks**
NHe47 – 4	1.11b	2.78b	3.52b	4.30a	3.44b
LDu – 88	1.11b	2.59b	3.72b	3.30b	4.41a
V35	2.96a	3.81a	4.25a	4.37a	4.48a
Control	1.01c	1.01c	1.11c	1.11b	1.15c

Mean followed by the same letter within each column are not significantly different (P<0.05)

Effects of okra mosaic virus on yield of three okra cultivars

Table 4 shows the effect of okra mosaic virus on the yield of three okra cultivars. There were variations among the yield recorded per cultivars. There was no significant difference in the yield obtained from cultivar LDu-88 (1,444kg/ha) and NHe47-4 (1,389kg/ha). Cultivar V35 had the lowest yield 889.8kg/ha which is significantly lower. Control had the highest and significantly different yield in the experiment. The stunted growth and low yield observed on the cultivars in relation to control reiterated the report of Alegbejo, 2008 that a high level of incidence and severity of okmv may lead to 100% yield loss.

Table 4: Effects of okra mosaic virus on the yield of three selected cultivars of okra

Cultivar	Yield (kg/hectare)
NHe47 - 4	1,389b
LDu - 88	1,444b
V35	889.8c
Control	1,850a

Mean followed by the same letter within each column are not significantly different (P<0.05)

Presence of *Aphis spiraecola*, *Toxopteracitricidus* and *Podagrica spp*. as causative agents of okmv

Figure 1 showed that *Aphis spiraecola*, *Toxopteracitricidus*, and *Podagrica spp*. were all present on the experimental field but it was observed that *Podagrica spp*. had the highest population on the field, followed by *Aphis spiraecola*. The increasing population of causative vectors resulted in increasing incidence and high levels of severity; this confirmed the findings of Echezona *et al*., 2011 that increasing population density of flea beetles reduces the yield of okra. Vector population also revealed that *Podagrica spp*. is the leading causative agent of okmv, this reiterated the findings of Fajinmi and Fajinmi, 2010.

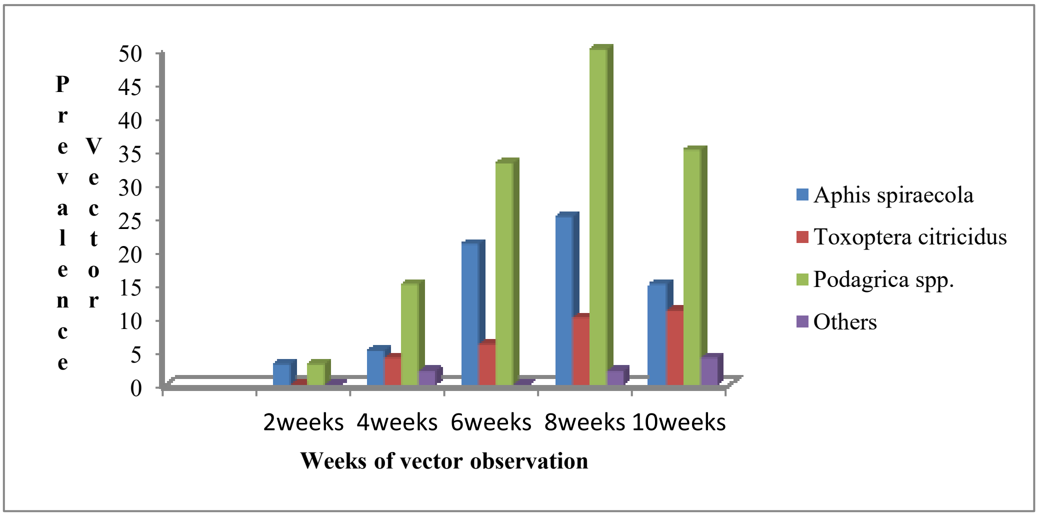

Figure 1. Prevalence of vectors as causative agent for okra mosaic virus on the experimental field

Conclusion

The incidence and severity of okmv played a key role in the stunted growth and low yield of the selected okra cultivars in this experiment. The prevailing vector of okmv in the study area is *Podagrica* spp. and resistant okra cultivars should be introduced to farmers, to increase yield and reduce the prevalence of the disease vector.

Conflict of Interest

The authors declare that we have no conflict of interest.

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معدل حدوث وشدة فيروس فسيفساء البامية في ثلاثة أصناف من البامية المزروعة حقلياً (Abelmoschus esculentus L.)

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ملخص

البامية هي محصول نباتي ذو أهمية اقتصادية يزرع في مجموعة واسعة من أنواع التربة في أفريقيا الاستوائية وكذلك في أجزاء أخرى من العالم. تُمارس زراعة البامية على نطاق واسع في نيجيريا نظرًا لأهميتها كمحصول غذائي. يعتمد إنتاج البامية في الغالب على خصوبة التربة والإدارة الثقافية والآفات والأمراض. أجريت تجربة حقلية لمعرفة مدى حدوث وشدة فيروس موزاييك البامية (okmv) على ثلاثة أصناف من البامية المزروعة حقلياً وهي NHe-4، LDu-88، وV35. نفذت التجربة وفق تصميم القطاعات العشوائية الكاملة (RCBD) بثلاثة مكررات. تمت دراسة المرض بين الأصناف الثلاثة تحت الظروف الحقلية الطبيعية خلال موسمين زراعيين. وتم قياس حدوث الإصابة من خلال الملاحظة البصرية للأعراض وشدة الفيروس باستخدام مقياس من 1 إلى 5. أظهرت النتائج أن الأصناف كانت حساسة لفيروس موزاييك البامية (Okmv) حيث كانت أعلى نسبة حدوث فيروسي واعلى شدة مرض في الصنف V35، مما أدى إلى أقل إنتاجية ملحوظة بين الأصناف الأخرى. إن الناقل السائد لمرض okmv في منطقة الدراسة هو Podagrica spp .، مما يشير إلى أن okmv كان له تأثيرات معنوية على نمو وإنتاجية البامية..

الكلمات الدالة: الإصابة، الشدة، التجربة الحقلية، فيروس موزاييك البامية، الأصناف.

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