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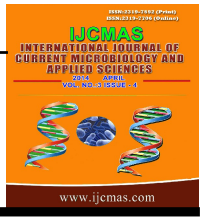

Original Research Article

Survey of the incidence and severity of okra (*Abelmoschus esculentus* L. Moench) Fruit rot in Awka South lga, Anambra state, Nigeria

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A B S T R A C T

A survey of the incidence and severity of okra (*Abelmoschus esculentus* L.) fruit rot was carried out in four towns in Awka South LGA of Anambra State in the cropping season of 2013 (June - August). The towns are Amawbia, Awka, Nise and Okpuno. Results of the survey show that farmers in the areas cultivated both local and improved cultivars of okra. It was observed that okra fruit rot was quite rampant in the surveyed locations during the period reviewed. Isolation of associated organisms resulted in six fungi namely: *Rhizopus stolonifer, Fusarium oxysporum, Rhizoctonia solani, Penicillium oxalicum, Botryodiplodia theobromae* and *Aspergillus flavus.* Pathogenicity test showed that four of the isolates namely: *R. stolonifer, F. oxysporum, R. solani* and *A. flavus* reproduced fruit rot in artificially inoculated okra fruits. The other two isolates, *P. oxalicum,* and *B. theobromae* did not prove pathogenic under the conditions of this study.

Keywords

Abelmoschus esculentus, fruit rot, pathogenic, incidence and severity.

Introduction

Okra (*Abelmoschus esculentus* (L.) Moench) is an economically important, tall growing, warm season, vegetable crop grown in tropical parts of the world. It is cultivated throughout the tropical and warm temperate regions of the world for its green edible fibrous fruits and pods containing round, white seeds as well as for its ornamental value. This crop is suitable for cultivation as a garden crop as well as large commercial farm (Oyenuga and Fetuga, 1975). Okra is known by different names and has a number of varieties which vary in plant size, shape, pod type, colour and number of spines. It is called Lady's finger in England and Gumbo in USA. In Nigeria, it is known as 'Ila" in Yoruba, "Kubewa" in Hausa and

"Okworo" in Igbo (Chauchan, 1972). The dwarf varieties do not have spines and are well suited for home gardens. According to Oyenuga and Fetuga (1975), there are about eight (8) species of *Abelmoschus* namely: *A. moschatus* Medikus, *A. manihot* (L). Medikus, *A. esculentus* (L.) Moench, *A. tuberculatus*, *A. ficulneus* (L.) Wight & Arn., *A. crinitus*, *A. angulosus* Wall ex Wight & Arn. and *A.caillei* (A. Chev.) Stevels. *A. esculentus* is the most important of all these species.

Okra plant grows to a height of 3-6 feet or more with some local varieties reaching 12 feet with a stem base of up to 4 inches in diameter. Propagation is through seeds and seeds can be soaked overnight in warm water before sowing to improve germination. Seed quality has been reported to affect yield in various okra varieties (Thapa *et al*., 2012). The stems are woody and bear hairy and usually lobed leaves. Plants branch out only when they reach a height of 30-40cm. Branch thinning or cutting off branches may be necessary to control dense growth of the plant. The flowers are large and up to 2 inches in diameter, mostly yellow in colour and last only for a day in most varieties. Okra grows well in warm weather and should be planted in full sun. The soil for growing okra should be fertile, well drained and high in organic matter with a pH ranging from 6.0 to 6.5.
Okra plays an important role in the human diet by supplying fats, proteins, carbohydrates, minerals and vitamins. Moreover, its mucilage is suitable for certain medical and industrial applications (Benchasri, 2012). The fruits are green to dark green sometimes yellow to red (Tripathi *et al.,* 2011) and contain moderate levels of vitamins A and C. Okra starts yielding about 60 days after planting and if the pods/fruits are not picked on time and allowed to mature on the plant, flowering and further production will be reduced. The importance of okra lies in the "draw" or mucilaginous properties of the fruits, which makes for easy consumption of bulk staple foods (IBPGR, 1991; Kumar *et al.,* 2010). Henz *et al.* (2007) have reported that Okra (*Abelmoschus esculentus* L.) is a popular vegetable crop in Southeastern and Northeastearn Brazil, where its immature pods are used in many regional dishes.

Okra is susceptible to several diseases, both in the field and in storage. Some varieties are highly susceptible to root decaying/root rot organisms while some are associated with both field and storage deterioration of the fruits. Reported causal agents of okra fruit rot in Nigeria include *Choanephora cucurbitarum* and *Fusarium solani* (Esuruoso *et al*., 1975), *Rhizopus stolonifer* in Romania, *Phoma exigua* in India, *Geotrichum candidum* in Egypt and *Rhizoctonia solani* in Malaysia (Snowdon, 1991). Micro-organisms that cause rots do so at a high relative humidity RH) and temperature of 25-30^{o}C (Adeniyi,1970) with some being more aggressive at higher temperature of 35^{o}C. Other common diseases of the okra plant are the *Verticillium* wilt, powdery mildew, *Ascochyta* and *Cercospora* leaf spots and root knot caused by root nematodes.

Different control measures including chemicals, plant extracts and biocontrol have been used to reduce diseases in different crops and increase yield. Generally, the use of plant extracts for control of diseases is favoured (Akueshi *et al*., 2002; Olusanmi and Amadi, 2009; Amadi *et al*., 2010) because they are non toxic and are easily biodegradable. Some

recommended cultural control measures for okra diseases are crop rotation and the destruction of diseased plants.

The objectives of this study are to investigate the okra varieties cultivated in Awka South LGA, survey the incidence and severity of okra fruit rot and to isolate and identify the organism(s) responsible for the disease.

Materials and Methods

Source of Plant Materials

The plant materials used for this study were obtained from four farmers randomly selected from each of the following four communities: Amawbia, Awka, Nise and Okpuno all in Awka South Local Government Area (LGA) of Anambra State. From each community, diseased okra fruit samples were collected randomly from selected farmers. The farmers were also interviewed in order to obtain information on the okra cropping patterns and the different okra cultivars grown in the area. Efforts were made to identify the different cultivars including the land races using their morphological and agronomic characteristics. Major attributes responsible for choice of okra cultivars to cultivate among the people were noted.

Medium and Isolation

Sabouraud dextrose agar (SDA) was the medium used in this study. It is *an acidic medium composed of mycological peptone – 10g/l; glucose (dextrose) - 40g/l and agar - 15g/l. The medium was prepared routinely by a*dding 65g to 1 litre of distilled water. Bring to the boil to dissolve completely, sterilize by autoclaving at 121°C for 15 minutes and then pour into sterile Petri dishes. This medium is suitable for the cultivation and differentiation of fungi and is often used with antibiotics for the isolation of pathogenic fungi from material containing large numbers of other fungi or bacteria.

Okra fruit samples showing rot symptoms were cut into small disks about 3-4mm diameter with a sterile razor blade. The disks were rinsed in sterile distilled water and sterilized in 70% ethanol for 1minute (Fawole and Oso, 1988). The disks were later rinsed in two changes of sterile distilled water (SDW), blotted dry and then plated. The inoculated plates were incubated at 27±2^{o}C and observed daily for mycelial growth. Emerging colonies were sub-cultured several times to obtain pure cultures for subsequent studies. Identification of isolates was based mainly on colony morphological characteristics and microscopic observations with reference to laboratory manual (Fawole and Oso, 1988).

Occurrence of Isolates and Pathogenicity Test

The frequency of occurrence of the different fungal isolates was determined for each isolate at each location. Isolation was made from different okra fruits showing rot symptoms. The frequency of occurrence of each isolate in each location was calculated thus:

$$\text{Isolate \% occurrence/location} = \frac{x \times 100}{n}$$

where x = total number of each organism in a location

n = total number of all the organisms in a location

Total frequency of occurrence for all the organisms in all the locations was also calculated thus:

$$\text{Total \% occurrence} = \frac{X \times 100}{N}$$

where X = total number of all organisms in a location

N = total number of all the organisms in all the locations

Pathogenicity test was conducted by following the steps outlined in Koch's postulates. This involved artificial inoculation of sterile, healthy okra fruits separately with the spore suspension of each of the isolates. Inoculated fruits were incubated for 7days at 25^{o}C with frequent observation for symptom development. Re-isolation was made from artificially infected fruits and the isolate(s) compared with the artificially introduced inoculum.

Results and Discussion

Okra Cultivars Grown in the Locality

Results of this study show clearly that there are distinct variations between the okra cultivars cultivated in Awka South LGA. Ten okra cultivars were grown by farmers in the area surveyed in this study. Among these ten cultivars while some were the early maturing (improved) types some others were the late (local) maturing cultivars. The farmers distinguish them by their names: Red burgundy, Silver queen, Star of David, Cow horn, Louisiana short, Heirloom red, Burmese, Jade, Emerald and Alabama red. Many of the farmers interviewed indicated their preference for the early maturing cultivars but a breakdown of the field observations showed that twenty four percent (24%) cultivate only improved cultivars, sixteen percent (16%) cultivate only local okra cultivars while majority (60%) of the farmers grow both improved and local cultivars either in mixture with other crops or solely in their farms. Other attributes responsible for farmers' choice include pest and disease resistance, ability to compete with weeds, high yield, drought resistance, ease of harvest, storability/keeping qaulity, colour of fruits, palatability, branching habit and ecological adaptation (Table 1). The cow horn is the most favoured cultivar among majority of the farmers because the improved cultivars were specifically bred against pests and diseases.

Isolation of Associated Fungi and Pathogenicity Test

Results indicate that six different fungi were isolated from diseased okra samples collected from the different towns surveyed in Awka South LGA of Anambra State. The fungi were identified as *Rhizopus stolonifer* Link, *Fusarium oxysporum, Rhizoctonia solani*, *Penicillium oxalicum* Currie and Thom, *Botryodiplodia theobromae* Pat. and *Aspergillius flavus* Van. The most frequently occurring fungus under the conditions of this study was *R. stolonifer* (100%) followed by *F. oxysporum* (75%) and *A. flavus* (75%). Nise had the highest incidence of occurrence of microorganisms followed by Amawbia (Table 2). Each of the isolated organisms occurred in Nise with the exception of *P. oxalicum.*

Result of the pathogenicity test carried out revealed that four of the isolates namely *R. stolonifer*, *R. solani, F. oxysporum,* and *A. flavus* reproduced rot in artificially inoculated okra fruits (Plate 1). These organisms are, therefore, pathogens of okra (*A. esculentus* L.) and are considered to be responsible for okra fruit rot in the field. Laboratory observation showed that

Table.1 Attributes of Ten Okra Cultivars Cultivated in Awka South LGA, of Anambra State

Variety	**Attributes**			
	Branching Habit	**Maturity**	**Ecol. Adaptations**	**Pest/Dis. Resistance**
Cow horn	Moderate	Early	Wide	High
Silver queen	Moderate	Early	Wide	High
Star of David	Moderate	Early	Wide	High
Red burgundy	Moderate	Early	Wide	High
Lousianashort	Moderate	Early	Wide	Low
Heirloom red	Moderate	Late	Wide	Low
Burmese	Moderate	Late	Wide	Low
Jade	Moderate	Early	Wide	Low
Emerald	Moderate	Late	Wide	Low
Alabama red	Moderate	Late	Wide	Low

Table.2 Frequency of Occurrence of Fungi Isolated From Different Locations in Awka South LGA, Anambra State

Samples	Fungi							
	R.stolonifer	*F.oxysporum*	*R. solani*	*P.oxalicum*	*B.theobromae*	*A.flavus*	Total	%
Amawbia	+	+	-	+	-	+	4	67
Awka	+	-	-	+	-	+	3	50
Nise	+	+	+	-	+	+	5	83
Okpuno	+	+	+	-	-	-	3	50
Total	4	3	2	2	1	3	**15**	63
%	100	75	50	50	25	75	63	-

Plate.1A Slices of Healthy Okra (*Abelmoschus esculentus* L.) fruit showing clean white seeds

Plate.1B Slices of inoculated fruit showing rot symptoms and discoloured seeds

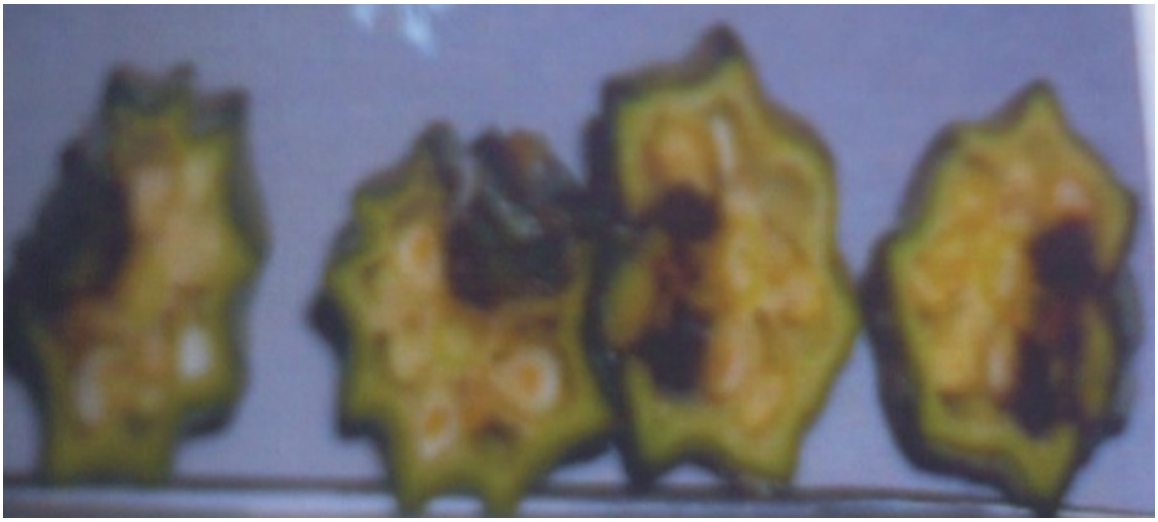
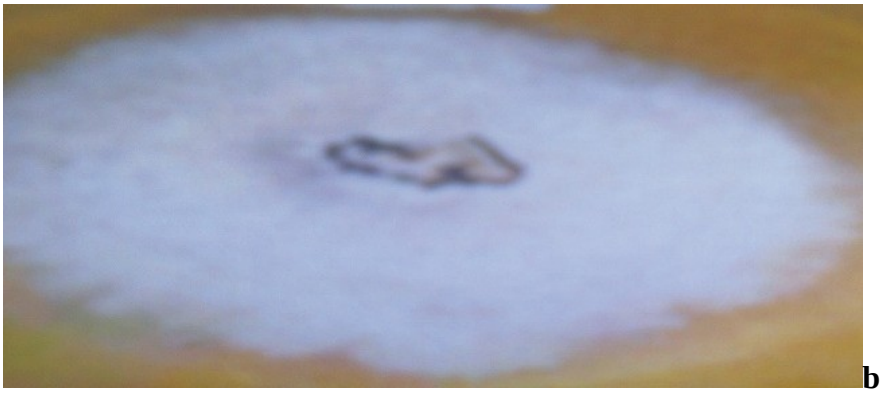


Plate 1:

Pure Culture Plates of Okra Fruit Rot Isolates Identified as (A) *Fusarium oxysporum* and (B) *Rhizoctonia solani*

a



b

R. stolonifer caused more severe rot in inoculated okra fruit than any of the other pathogens. Under the conditions of the present study *P. oxalicum* and *B. theobromae* did not bring about okra fruit rot in inoculated healthy fruits. Severity survey carried out in the study areas showed that okra fruit rot was particularly rampant in the year 2013. The cropping season (June - August) was marked with increased wetness, humid temperature with relative warmth that favoured rot development in susceptible cultivars. Both the incidence and severity of fruit rot was most severe in Awka in 2013 out of the four towns surveyed in Awka South LGA, Anambra State. Observation of the cultural characteristics of the isolated organisms in the laboratory showed that they grew luxuriantly in the Sabouraud dextrose agar (SDA) medium used (Plate 2).

Several reports and reviews have been written on the diseases associated with okra (*A. esculentus* L.) both in the fields and in storage. The most common diseases affecting the okra plant include fruit rot, *Verticillium* wilt, powdery mildew and viral diseases such as yellowing. This study was undertaken to study okra fruit rot in Awka South LGA, Anambra State. Six different fungi were subsequently isolated from infected okra fruits namely *R. stolonifer, F. oxysporum, R. solani, P. oxalicum, B. theobromae* and *A. flavus.* These organisms are commonly implicated in the postharvest deterioration of many crop produce and have been reported severally (Booth, 1976, Amadi and Oso, 1996, Amadi, 2005 and Oyetunji *et al*., 2012). Henz *et al*. (2007) have reported *R. solani* in okra fruits in Brazil. These organisms generally gain access into the crops by several means. While some of them utilize wounds created in different ways on the surface of the plant materials others may access the crops through natural openings on the surface of the produce (Akinyele and Ikotun, 1989).

Result of the pathogenicity test showed that *R. stolonifer*, *F. oxysporum*, and *A. flavus* were the causal agents of okra fruit rot under the conditions of this study. This is in accordance with previous reports regarding postharvest losses of fruits and vegetables generally (Amadi, 2009; Amadi *et al*., 2009). In this study disease incidence was highest in Nise but disease severity was highest in Awka. This may be due to other factors of disease such as weather, host resistance, inoculum load and so on. The conditions that favour disease development differ slightly with the conditions that bring about the disease occurrence. A disease may occur but if the conditions are not right, its development could be halted due to some of those factors earlier mentioned. Fungi are spread primarily by spores which are produced in abundance. The spores can be carried and disseminated by wind current, water (splashing or rain), soil (dust), insects, birds and the remains of plants that once were infected. The extent of dissemination of the disease inoculums will determine the development and severity of the disease.

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