

Full Length Research Paper

## Characteristic symptoms of melon diseases caused by fungi in south western Nigeria

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In a survey of farmers' fields across four states of south western Nigeria, major diseases of egusi melon were evaluated and symptoms described. Pathogenicity tests of foliage and fruits were conducted in the laboratory and causal pathogens identified. Powdery mildew (*Erysiphe cucurbitarum*) appeared as round whitish spots on the lower surface which increased in size and later appeared as whitish talcum on the upper surface. Downy mildew (*Peronospora cucurbitarum*) appeared on the upper surface as small and pale green to yellow angular spot which became chlorotic and shriveled. Alternaria leaf spot (*Alternaria cucumerina*) appeared as small circular water soaked areas which turned dark brown to black; and Cercospora leaf spot (*Cercospora citrullina*) appeared as circular spot with white to tan centers having dark margins. Foliar spots which began as small yellowish water-soaked areas on the veins that later turned circular, dried up, broke and became shattered were symptoms observed for the Anthracnose disease (*Colletotrichum lagenarium*). Fruit anthracnose started as small, circular, black, sunken canker with raised margin. Leaf blight, stem blight and fruit rot (*Didymella bryoniae*) disease symptoms were observed on leaves, stems and fruits respectively. Leaf symptoms began as light brown, irregular spots surrounded by yellow borders that developed from the tip of the leaves and gradually progressed backwards. Brown lesions were observed on the stem which split open and turned dark. Lesions observed on fruits appeared as small, almost circular water-soaked areas which enlarged, resulting in dark, firm and leathery depressed areas. Symptoms of vine wilt were observed as elongated brown lesions which developed on stems near the crown and extended as long, narrow, brown streaks causing stem to completely wilt. Wet rot of flower and fruit (*Choanephora cucurbitarum*) appeared as characteristic fungus growth resembling numerous pins stuck in a pin-cushion on the infected surface. The study will help to bridge the gap of information on the characteristic symptoms and causal pathogens of melon diseases in south western Nigeria

**Key words:** "Egusi" melon, south western, field diseases, symptoms.

### INTRODUCTION

Melon (*Citrullus lanatus*) is an important crop plant and vegetable in Nigeria, cultivated for its edible nutrient rich seeds popularly called "egusi" (Denton and Olufolaji, 2000). It belongs to the family Cucurbitaceae (Oyolu 1977). The 'egusi' melon plant is a creeping, hairy, herbaceous annual crop (Cobley, 1979; Tindal, 1983; Burkill, 1985). Melon seeds are nutrient-rich, thus they

have been found to have value in various uses, including condiment in enriching the taste and appearance of local stew (Denton and Olufolaji, 2000). The oil extracted from the seed varies in quality and quantity depending on the cultivars (Adewusi et al., 2000), and it is widely used for cooking, frying and in the food industries for manufacturing margarine, salad oil and canned fish (Ajibola

et al., 1990); soap making, medicine and illuminant (Burkill, 1985). It contributes to food production, land erosion control and products with economic value in domestic markets. Egusi melon contains 34-38% protein when undefatted and 69-78% when defatted. It also contains 11% starch, 2.50% soluble sugars and 12% crude fibre and ash (Burkill, 1985; Nwokolo and Sim, 1987; Fayemi, 1999). 'Egusi' melon is often cultivated as cash crop with other arable crops in the rainy and dry seasons (Adewusi et al., 2000). Its production varies among the states. It is usually planted before the food crops in traditional mixed cropping system. It is sown with starch staples such as yam (*Dioscorea rotundata* Poir), maize (*Zea mays* L.), and sorghum (*Sorghum bicolor* L.) Moench) and cassava (*Manihot esculenta* Crantz), in the rainy and dry seasons in the Southern and Eastern parts of Nigeria (Asoegwu, 1987; Adewusi et al., 2000). Development of appropriate crop protection measures depend on the knowledge of the diseases and causal pathogens. The traditional method of intercropping melon with other crops has helped peasant farmers to evolve crop protection techniques that are readily adaptable. However, a major constraint to the adoption of these methodologies beyond the peasant farmers' condition is the difficulty in appropriate identification of crop diseases. Similarly, causal agents of diseases and their peculiar characteristics are major points of reference when control strategies are being developed. For egusi melon, there is paucity of information on the characteristic symptoms, its development and causal pathogens in South-western, Nigeria. This requires to be elucidated in order to give the farmer added advantage in respect of resource utilization and specificity of efforts and results in the bid to manage challenges posed by melon diseases on the farm.

## MATERIALS AND METHODS

### Field surveys

During late (August - November) and early (April and July) planting seasons, a survey for diseases was carried out in 4 local government areas (LGA) of four states viz Oyo, Ogun, Ondo and Oshun. Three villages were selected per LGA, and the choice of the villages in each state was the high melon production areas. One farm per village was evaluated in this study. At onset of the visits, 50 plants were tagged per farm and subsequent observations were made from the tagged plants. Farmers' fields were monitored once a week till crop maturity. Development of the symptoms was closely observed from initiation to full expression. Furthermore, from each diseased leaf, stem, fruits and flower, samples were collected for identification of casual organisms. They were stored separately in polythene bags, labeled and kept for further use.

### Isolation of pathogens

Symptomatic leaves were rinsed in tap water and small pieces (2 mm) were cut from the junction between the healthy and infected portions (4 pieces per plant). These were surfaced sterilized in 0.5% NaOCl for 5 m, rinsed twice in sterile distilled water and placed onto Potato dextrose Agar (PDA Oxoid Ltd, Basingstoke,

Hampshire, UK, 3.9%) amended with Streptomycin sulfate (0.39% Sigma, St Louis, MO). The cultures were incubated at room temperature ( $28\pm 2^{\circ}\text{C}$ ) for up to 8 days. Fungal colonies which emerged were subcultured until pure. Macroscopic and microscopic cultural characteristics were used to identify the fungi with reference to Barnett and Hunter (1998), Lucas et al. (1992) and Kenaga et al. (1971).

### Pathogenicity tests

Surfaced sterilised (10% NaOCl for 5 m) egusi melon seeds were sown in plastic pots (21 cm diameter) half filled with steam sterilized ( $160^{\circ}\text{C}$  for 2 h) soil in a screen house with natural lighting. Pots were watered daily and seedlings which emerged were thinned to 5 plants per pot. Pots were arranged in the screen house in a randomized complete block design with four replicates per treatment and control. Three to four day old melon seedlings were used to assess pathogenicity of the following fungi: *Cercospora citrullina*, *Aspergillus niger*, *A. flavus*, *Fusarium oxysporium*, *Rhizopus stolonifer*, *Colletotrichum lagenarium* and *Didymella bryoniae*.

### Effect of inoculum on the leaves of egusi melon

Test fungi were investigated for pathogenicity on leaves by spraying the leaf surface to run off with the spore suspension  $6 \times 10^4 - 3 \times 10^6$  spores/ml (0.1% (vol/vol) to which tween 20 was added. Spore suspension of *Didymella bryoniae* were obtained by flooding 8 to 10-day old cultures with 5 to 10 ml of sterile distilled water with lactic acid (pH 4.0) was used to increase spore discharge from pycnidia to reduce clumping of spore. Spore suspension was filtered through 4 layers of cheese cloth to remove pycnidia (Williams, 2003) and adjusted to  $10^4 - 10^6$  spore/ml. Four uninoculated plants served as controls. Plants were kept in the screen house and disease assessment was a visual observation of presence or absence of symptoms for 20 days after inoculation.

### Effect of inoculum on the stem of egusi melon

The fungal isolates associated with the stem diseases were inoculated via stem inoculum and dipping method. Two stem surfaces of one week-old plants were punctured with sterile needle. The punctured surfaces were then sprayed with the inoculum. Uninoculated stem served as control.

### Effect of inoculum on the fruits of egusi melon

Inoculation of fruits with pathogens isolated from diseased fruits was carried out on 60-day-old intact fruits. The fruits were wounded by means of a scalpel and spray-inoculated to run off with the spore suspension of the pathogens. Control fruits were sprayed with sterile distilled water. Disease assessment was a visual observation of presence or absence of symptoms after inoculation. Fungi were reisolated from the diseased tissue and compared with original isolates.

## RESULTS

### Pathogenicity tests

All plants inoculated with corresponding organisms showed disease symptoms similar to those observed at



**Figure 1.** Anthracnose on melon leaves (arrowed): (a) early stage of infection (b) late stage of infection.

sampling times in the fields. Based on cultural characteristics and fungal morphology, the isolates were identified as *Colletotrichum lagenarium* for anthracnose disease and *Didymella bryoniae* for blight disease. For powdery mildew symptom, *Erysiphe cucurbitarum* was consistently isolated from diseased leaf tissues and was found to be the causal agent. *Peronospora cubensis* caused the downy mildew symptom of egusi melon. The pathogen frequently found associated with Alternaria leaf spot symptom was *Alternaria cucumerina* and was confirmed the causal agent of the Alternaria symptom. *Fusarium solani* caused the vine wilt disease of the plant while *Cercospora* leaf spot disease was caused by *Cercospora citrullina*.

### Isolation of fungal species

A total of 11 fungal species namely: *Colletotrichum lagenarium*, *Didymella bryoniae*, *Peronospora cubensis*, *Erysiphe cucurbitarum*, *Cercospora citrullina*, *Alternaria cucumerina*, *Aspergillus niger*, *A. flavus*, *Fusarium oxysporum*, *F. solani* and *Rhizopus stolonifer* were isolated from the different diseased samples collected from the melon fields. The organisms were observed in all fields surveyed.

### Symptomatology

#### **Anthracnose disease (*Colletotrichum lagenarium*)**

Foliar spots began as small yellowish and water-soaked areas on the veins that later turned more or less

circular (Figure 1a). Diseased tissues dried up and became dark brown, while necrotic areas broke and shattered at the centre of the lesion (Figure 1b). Plants were infected at any stage of growth. On the stem, the disease started as elongated, narrow and water soaked lesions. Lesions sometimes became slightly sunken and yellowish in colour (Figure 2a). Lesions also penetrated the stem to cause lip canker in humans in most cases (Figure 2b). Symptoms observed on the fruits consisted of small, circular, black, sunken canker with raised margin. Spots were about 2.5-3 cm in diameter and 0.8 cm deep but later coalesced to form larger spots. Fruit rot was observed at parts where lesion was in contact with the soil (Figure 3a). Fruit pedicels were also affected, leading to the darkening, shriveling and death of very young fruits (Figure 3b). White mycelia were sometimes found on the pedicel and fruits.

#### **Leaf blight, stem blight and fruit rot (*Didymella bryoniae*)**

Symptoms were observed on leaves, stems and fruits. On plants, small green spots were observed on the underside of cotyledons at the start of infection. Spots later became greyish green and round to irregular in shapes. Spots expanded rapidly and killed the entire cotyledon. Blighting of the cotyledon, extended to the hypocotyls which resulted in the death of the plant. Symptoms were also observed on older leaves close to the soil line. Leaf symptoms began as light brown, irregular spots surrounded by yellow borders that developed from the tip of the leaves and gradually progressed backwards (Figure 4a). At advanced stage,



**Figure 2.** Stem Anthracnose showing a) slightly sunken brownish lesion on stem (arrowed) and b) lip canker on stem of melon (arrowed).

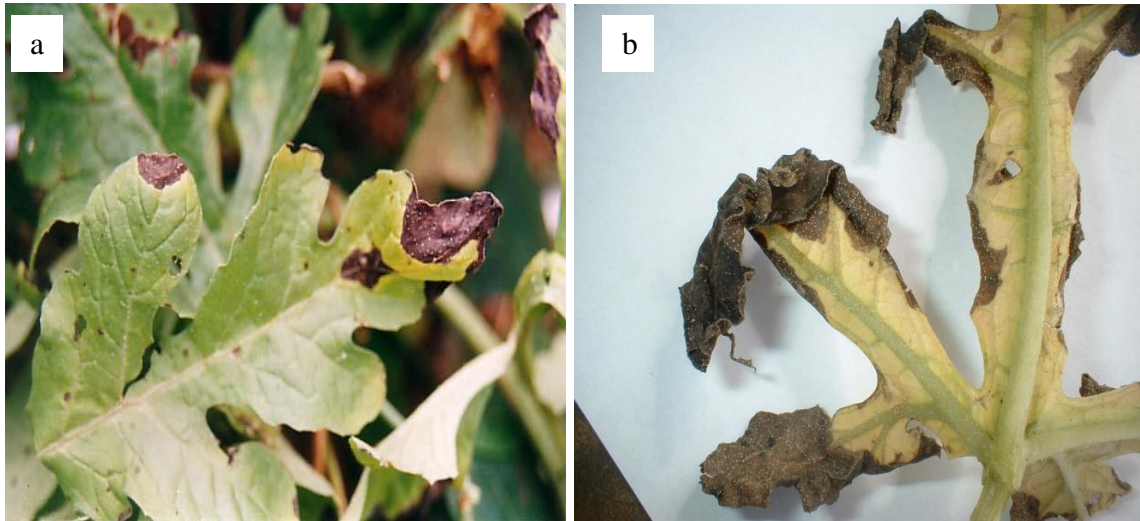


**Figure 3.** Anthracnose disease on egusi melon fruits. (a) Mature fruit showing fruit rot at point in contact with the soil (b) Darkened and shriveled infected young fruits.

lesions became larger. Black fruiting bodies (pycnidia) covered the lesions on leaves. Leaves turned yellow, then black and eventually died (Figure 4b).

Symptom observed on stem appeared around the stem node of plants during the fruiting period (6<sup>th</sup> - 7<sup>th</sup> week) after seedling emergence. The areas appeared oily-green with elongated light brown clearing. Affected areas later cracked and exuded sap that dried to form coloured gum deposit. Brown lesions were also observed on the stem (Figure 5). This split opened and turned brown with age. The vine cankers which produced brown exudates were

also found near the soil lines. Tiny brown to black speck-like fruiting structures (pycnidia) were often seen on the infected stem or nodes. As infection progressed, lesions enlarged and vines beyond the infected nodes turned yellow, wilted and died. Lesions observed on fruits appeared as small, almost circular water-soaked areas, which enlarged, resulting in dark, firm and leathery depressed areas. As the season progressed, cracked areas were noticed from the depressed points on the affected areas. From the cracked areas, gummy exudates emanated. The spots later became sunken



**Figure 4.** (a) Early stage and (b) advanced stage of leaf blight caused by *Didymella bryoniae*.



**Figure 5.** Brown stem blight (arrowed) caused by *D. bryoniae*.

and brownish black in colour (Figure 6)

#### ***Powdery mildew (Erysiphe cucurbitarum)***

The disease appeared as round whitish spots on the lower surfaces of the oldest leaves. The spots increased in number and size, coalesced and appeared on the

upper surface as whitish, talcum-like powdery growth (Figure 7). Small, black, globose, speck-sized cleistothecia eventually covered most of the lesion surfaces. At advanced stage of infection, severely affected leaves lost their normal dark green colour, turned brown and shrivelled. No symptom was not observed on fruits, but fruits growing on infected vines ripened prematurely and appeared sunburned.



**Figure 6.** Dark brown fruit rot with brownish gummy exudate (arrowed) caused by *D. bryoniae*.



**Figure 7.** Egusi melon leaf showing whitish talcum-like symptom of powdery mildew (arrowed).



**Figure 8.** Leaf of egusi melon showing chlorotic lesions (arrowed) caused by downy mildew fungus.

#### ***Downy mildew (Peronospora cucurbitarum)***

At the early stage of infection, symptoms appeared on the upper surface of the oldest leaves near the crown. Symptoms appeared as 2-4, small and pale-green to yellow angular spots (Figure 8). The underside of the leaves opposite the yellow spots became covered with layers of greyish mycelial growth. The leaf veins confined the spots and at advanced stage, severely infected leaves became chlorotic, turned light brown and shrivelled.

#### ***Alternaria leaf spot (Alternaria cucumerina)***

Spots appeared first on older leaves near the crown of the plant. Symptoms initially appeared as small, circular and water soaked areas. The spots increased in number, enlarged to 0.8 cm in diameter and turned dark brown to black. Spots were distinct, with definite margins and concentric rings within the lesions (Figure 9a and b). On the lower surface of leaves, rings rarely occurred and the margins were indistinct. At advanced stage, severely affected leaves were entirely covered with the lesions (on which black conidia appeared). Eventually, leaves

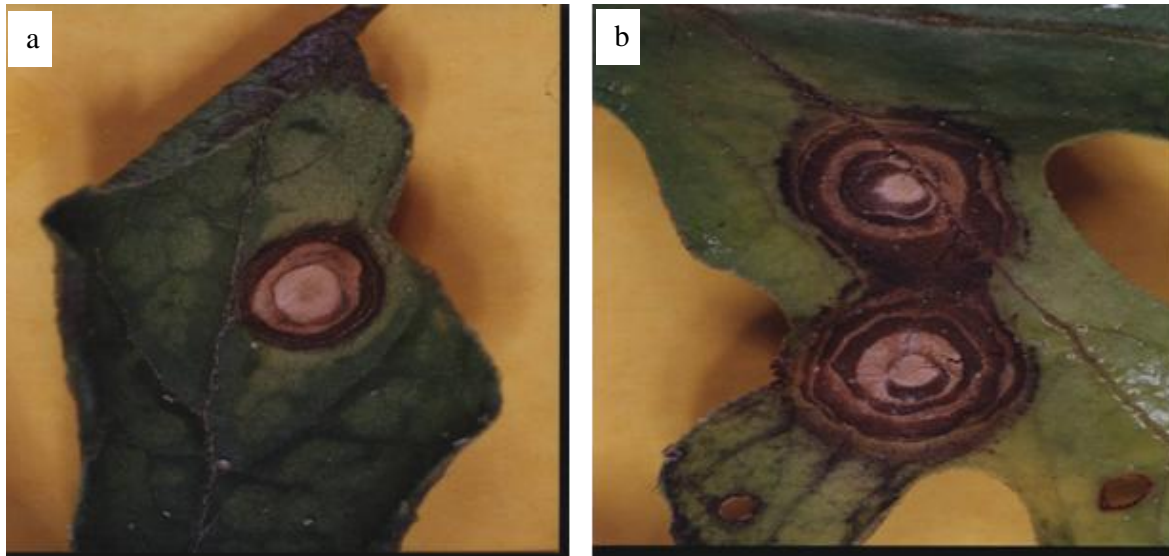
shrivelled, died and dropped off.

#### ***Vine wilts (Fusarium oxysporum)***

Both young and mature plants were susceptible to the pathogen. Infection of older plants resulted in yellowing and loss of lustre on one or more branches near the crown at the early stage. Elongated brown lesions developed on stems near the crown and extended as long, narrow, brown streaks. Salmon pink, spore masses, which appeared as pink mould, were also observed on the lesions. The affected vines and entire plants eventually wilted and died (Figure 10a and b). Roots of severely affected plants were often decayed and appeared shredded. Sometimes the lesions form on hypocotyls thereby causing the tissue to rot.

#### ***Cercospora leaf spot (Cercospora citrullina)***

Few small spots (0.32 to 0.64 cm in diameter) appeared first on older leaves as oily green spots. The spots later became numerous and necrotic. Spots were small, circular to irregularly circular, with white to tan centres



**Figure 9.** *Alternaria* leaf spot of egusi melon showing: (a) Dark brown concentric rings of early stage of leaf spot development; (b) Coalesced spots at advanced stage of disease development.



**Figure 10.** Wilting of runners of egusi-melon: (a) early stage and (b) advanced stage on mature plants.

and dark margins (Figure 11).

***Wet rot of flower and fruit (Choanephora cucurbitarum)***

The disease affected the blossoms and fruit. The fruiting

bodies consisted of white stalks (sporangiophores) with white to brown heads (sporangia), having characteristic metallic lustre that later changed to purplish black. Flowers were infected soon after they opened (Figure 12a). A characteristic fungal growth resembling numerous pins stuck in a pin-cushion developed on the infected surface (Figure 12b). The affected tissue beneath





**Figure 11.** Symptom of *Cercospora* leaf spot (arrowed).



**Figure 12.** Flower rot of egusi melon caused by *Choanephora cucurbitarum* showing: (a) Dead flowers on a vine (b) fungal growth on infected (dead) flowers.

the mass of fungus became translucent, water-soaked and rotten.

The fungus was usually confined to the end of the fruit,

but during wetness, the entire fruit decayed (Figure 13a and b). The fruiting bodies did not appear on the rotted parts of fruits. Fruits also rotted backwards from the



**Figure 13.** Fruit rot of egusi melon caused by *Choanephora cucurbitarum* showing: (a) Rotted immature fruits; (b) Rotted mature fruits.

blossom end. Affected fruits dropped off prematurely.

## DISCUSSION

*Colletotrichum lagenarium* is the causal pathogen of leaf, stem and fruit anthracnose of egusi melon. The fungus was reported by Prakash et al. (1974), Timchenko (1977); Pegerine et al. (1984) and Wei et al. (1991) as the causal agent of anthracnose diseases on infected leaves of melon. Lesions were observed as dark brown which were more or less circular. Ferrin (2008) reported that lesions were brown to black with irregular margins often restricted by leaf veins. The differences in disease symptom presentation may be due to the differences in cultivars assessed.

*Didymella bryoniae* is the causal pathogen of leaf blight, stem blight and fruit rot of egusi melon. It is a disease found on all parts of plants except the root. It has been found to cause extensive damage to all above ground parts of green house grown cucumbers (Miller et al., 2009). It is reported to be the most destructive disease of cucurbits (Choi et al., 2010). Robert and Kucharek (2004) also confirmed *D. Bryoniae* to be the causal organism of blight disease on squash but was found to be a minor disease on water melon in Dar-es-salam (Peregrine et al., 1984).

*Erysiphe cucurbitarum* was confirmed the causal organism of powdery mildew in this study. This pathogen was among the pathogens listed by Hill and Waller (1999), as causal agents of watermelon diseases in the United States of America. It is reported to be a common disease of cucurbits in the field and green houses in most areas of the world and can be a major production problem. *Sphaerotheca* spp. and *Erysiphe* spp. are the

two most commonly reported fungal pathogens of powdery mildew (McGrath, 1997).

Pathogenicity test confirmed *Peronospora cucurbitarum* as the causal organism of downy mildew which affects only the leaves of the crop. Colucci and Holmes (2010) reported that although the disease infects only the foliage, a reduction in photosynthetic activity early in plant development results in stunted plant, yield reduction and premature defoliation which eventually results in fruit sunscald. Downy mildew has a wide host (Colucci and Holmes, 2010) and this could have facilitated the wide distribution of diseases. Other infected plants could readily provide alternative host status for the pathogen until periods congenial for melon production.

*Alternaria cucumerina* caused the Alternaria leaf spot disease, however, the disease was limited to the foliage of egusi melon. Wei et al. (1991) and Buzi et al. (2002) stated that leaf spot disease caused by *A. cucumerina* is one of the major diseases observed on water melon in China and Italy respectively. It causes damage by defoliating the vines and reducing fruit yield, size and quality with only partial defoliation. The fruit may sunscald and ripen prematurely on cucumber, squashes, watermelon and pumpkin (Babadoost, 1989).

*Fusarium oxysporum* was found associated with vine wilt of egusi melon. This result confirms the reports of Wei et al. (1991) and Park et al. (1996) who reported *Fusarium oxysporum* as the causal organism of wilt of water melon. Fusarium disease has been reported on several crops such as cotton, tomato, lettuce, sweet potatoes and beans. Musoni et al. (2010) reported that Fusarium wilt caused by *Fusarium oxysporum* f. sp. *phaseoli* caused growers to abandon the most popular climbing bean cultivar in Rwanda. Thus, the wide host range of fusarium spp. makes the pathogen a major threat

to melon production in South-western Nigeria where climatic conditions favourable to disease development subsist.

Results of this study agree with the reports of Peregrine et al. (1984) and Rego (1994) that *Cercospora citrullina* causes leaf spot diseases on various cucurbitaceae. In West Africa, cercospora leaf spot has been reported to be one of the most widely occurring leaf spot diseases of cassava found occurring in several zones (Wydra and Msikita, 1998). The disease causes severe defoliation in the most susceptible cultivars but with slight yield losses.

*Choanephora cucurbitarum* is the causal organism of wet rot of flower and fruit in egusi melon. Symptoms of the disease observed in this study were similar to that on common garden petunia. Flowers with water soaked lesions wilted and rotted on these whitish mycelia and monosporous sporangia were produced (Jun and Hiromichi, 2000). *C. cucurbitarum* has been reported to cause devastating inflorescence disease of *Amaranthus* sp. During severe infection and favourable conditions, the inflorescence head may be completely cut off such that the plant does not produce any seed or the yield may be reduced to half or less (Adebanjo, 1990).

*C. cucurbitareum* was reported to cause the wet rot of okra (Siddiqui et al., 2009). The understanding of the unique symptoms and causal pathogens of egusi melon diseases in South-western Nigeria will facilitate easy adoption of management techniques by farmers in a bid to reduce the adverse effect of diseases on melon production.

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