Journal of Agriculture, Environmental Resources and Management

Journal of Agriculture, Environmental Resources and Management
ISSN2245-1800(paper) ISSN 2245-2943(online)
7(12)1-800;**December**.2025; pp21- 25

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Review on the Challenges and Prospects of the Bacterial Diseases of the *CURCUBITACEAE* Family

Robert, U. A. and Opara, E. U.

*[1, 2]Department of Plant Health Management, Michael Okpara University of Agriculture, Umudike.

*[1] corresponding Author's Email: uduakrobert59@gmail.com,

Abstract: *The major challenges of the family Cucurbitaceae posed by bacteria and the prospects was evaluated. This was done with the view to knowing the disease types, damage and prospects in practice for the identified challenges and hence, aims to improve yield of this family. The method adopted was research approach. Literatures were consulted form reliable sources and documented. From the study, a host of bacterial agents pose threat to the cultivation and production of members of the cucurbit family. Among the challenges posed by bacterial pathogens to the curcubitaceae includes fruit deterioration leading to yield loss, collapse and death of infected plant in severe cases, affected fruits have spoilt taste, damage to succulent part such as fruit, tubers, stems and bulbs of plants in nearly every plant family etc. The prospect in recent times include exploitation of biocontrol method like useof Endophytic bacteria (EB) for angular leaf disease, exploitation integrated biocontrol for the management of bacterial wilt, deployment of bacteriophage for bacterial leaf spot, use of bacterial predators Bdellovibro and like organisms (BALOs) for bacterial soft rot disease. The result gotten from this study is useful to advice farmers and educate researchers in the various disease management practices for optimum yield of members of the cucurbitaceae family.*

Keywords: *Bacterial agents, biocontrol methods, cucurbitaceae, Management, Symptoalogy.*

Introduction: The *Cucurbitaceae* family is the second largest plant family among fruits and vegetables next to the family *Solaneceae* (Kumud, J. Rajender, S. J., Priyanka, B., Arpana, S. and Somya, H. (2023). This family consists of genetically diverse group of plants. Several commodity crops known in the world including cucumber, pumpkin, and melon belong to this family (Van Laethem, S., Frans, M., Aerts, R. 2021). Commonly called cucurbits, this family is a source of dietary fibre such as vitamin C, β-carotene, pro-vitamin A, and potassium (Shaffana,M. A. A. and Rosli, W. W., 2018). The family is a rich source of phytochemicals like the saponins, phytosterols, cucurbitacins, carotenoids, polyphenols and antioxidants (Salehi, B., Quispe, C., Sharifi-Rad, J., Giri, L., Suyai, R. and Jugran, A. K., 2021). Cucurbits include watermelons, cantaloupes, cucumbers, pumpkins, squash, bitter melons, gourds, and hairy melons. Cucurbits are warm weather crops which are sown, grown and harvested over spring, summer and autumn. The number, severity and complexity of diseases attacking these vital crops have increased in the past decade.

Cucurbits cultivation faces a lot of challenges including attacks by a number of insects and pathogens. Among these, *Xantomonas cucurbitae* (Bryan) Dowson or *Xanthomonas campestris* pv. *cucurbitae* causing bacterial leaf spot (BLS), *Pseudomonas syringae* pv. *lachrymans* causing Angular Leaf spot (ALS), *Erwinia tracheiphila*, causing bacterial wilt, *Erwinia carotovora* causing bacterial soft rot and *Acidovorax citrulli* causing bacterial fruit blotch are emerging as important bacterial pathogens and constitutes a menace to cucurbits cultivation and causes huge losses in the crops up to 90% (Kumud *et al*., 2023). There are few reports on the management methods as well as the prospects of bacterial diseases on cucurbits in Nigeria, hence the purpose of this review is to aid in the identification of important bacterial diseases of the cucurbit family as well help researchers and farmers in the management of such diseases. Correct disease identification is key to effective management. Economic importance of the cucurbits includes; It contains several important commodity and food crops in many parts of the world such as cucumber (*Cucumis sativa*), water melon (*citrulus lanatus*) fluted pumpkin (*Telfairia occidentalis*), *Cucurbita pepo and* melon (*cucumis melo*).; Members of the family creates and eradicate poverty.; This family generates high profit, especially when the land is relatively small and labour is abundant when

compared to other families.; Some taxa have medicinal or horticultural uses.

Challenges f Bacterial Diseases To The *Cucurbitaceae* Family: Challenges of bacterial disease implies the demanding or stimulating situations faced by plant when attacked by bacterial pathogens. It is the defiance from normal growth and production process in crops when such crops are exposed to pathogenic organisms while in the field, or while in storage or both. The challenges posed to plants differ with the different causal agents. While some effects will lead to loss of plant part or reduced yield, other serious ones leads to complete death of the plant or plant parts.

Prospects for Plant Diseases: Prospect for plant diseases are the scientific research or contributions to the possibility of future success in averting or conquering abnormally in plants as a result of pathogenic organisms. Prospect also entails the search for something desirable especially such that will enhance our food production by devising new means. Scientific researches, as well as students project works often aim at proffering new and affordable ways of combating the daily challenges in the plant environments including the wild and cultivated fields, the storage methods and the general human environment.

Major Bacterial Diseases of Cucurbitaceae Family: Bacterial Leaf Spot (BLS): This is one of the most important diseases of the cucurbits which affects the family in cultivated fields and leads to huge losses. This disease is induced by the pathogen *Xanthomonas cucurbitae* (syn=*X. campestris* pv. *cucurbitae*) (Bassey, I. N. and Opara, E. U. 2016; Opara, E. U. and Robert, U. A. 2019). BLS of water melon is reported to be caused by *Pseudomonas syringae* pv. *syringae*, with symptoms consisting of circular necrotic legions, sometimes with a white to tan center surrounded by chlorotic halo (Dutta, B., Gitaitis, R. D., Driver, J. E. and Smith, S. 2016; Newberry, E. A., Ritchie, L., Babu, B., Sanchez, T. Beckhan, K. A., Jones, J. B., Freeman, J. H., Default, N.S. and Paret, M. L. 2017). . Lesions appear first underneath the leaves as small, water soaked dots that look yellow from the upper side of the The symptoms of this disease appear in all plant parts including the fruits. The disease is favoured by moderate-to-high temperatures and high humidity. The pathogen perpetuates in the seed and infected crop debris.

The common symptoms include; Small water-soaked areas in the under surface of affected leaf, which pierce the upper surface of leaf as ill-defined yellow spots (fig. 1)**.;** The spots grow in size to form a definite round spot, about 6-7mm in width, and are restricted by veins. The upper surface of leaf has prominent yellow halo; As infection spreads, large dead areas are produced by the coalescence, but these dead tissues do not drop out; On fruits, the symptom include fruit surface having circular water-soaked spots 3-6mm in width. The spots are somewhat sunken with the presence of sticky exudates.**;** Transverse section of the spot shows bacteria oozing out of the cut surface (kumud *et. al*., 2023); On watermelon leaves, the bacterium gives rise to small angular and water-soaked spots with a chlorotic halo, which often becomes necrotic, as well as scab-like lesions on fruits (Dutta *et al*.,2016; Newberry *et al.,* 2017).

The Challenges of Bacterial Leaf Spot (BLS) include; It leads to huge losses to the cucurbits as the symptoms of the disease appear on all parts including fruits. Yield losses of up to 20% have been reported in highly susceptible cultivars (Larazev, 2018)**;** It can reduce yield of the crop by up to 90 per cent by causing severe infection of foliage as well as fruit (Kumud *et al.,* 2023); The disease is an emerging disease at international and national level (Sulley, *et al*., 2021).

Prospects for BLS includes; Deployment of bacteriophage: Bacteriophage are viruses which infect and replicate within bacteria (Moineau, 2013). They are studied and seen as natural antimicrobial agents for BLS. According to Flaherty, J. E., Jones, J. B., Harbaugh, B. K., Sonomodi, G. C. and Jackson, L. E. (2014), a folial application of bacteriophage decreased the BLS incidence from 40.5% (control) to 0.9% on green house-grown tomato. In the deployment of bacteriophage, invitro methods has shown that lactobacillus MK_3, *Pseudomonas aeroginosa* 1128 acts as potential anthogonist of *Xanthomonas euvesicotoria* pv. *euvesicatoria*. *Paenibacilus elgii* was also evaluated by (Le, K. D., Kim, J., Yu, N. H., Kim, B., Lee, C. W. and Kim, J. 2020) and it effectively suppressed the chilli bacteria leaf spot in pot trials with control values of 67%.

Incorporating stable host resistant is a critical component in ongoing management for bacteria leaf spot

BACTERIAL WILT: this is a bacterial challenge caused by the bacterial pathogen known as *Erwinia tracheiphila* (Jose Pablo Sota-Arias, 2019). The bacterium is dispersed from one plant to another via the help of the striped cucumber beetle (*Acalymma vittatum*) and the spotted cucumber beetle (*Diabrotica undecinipuncta*). *E. tracheiphila* overwinters in the gut of these beetles. Beetles that feed on infected plants pick up the bacteria and then moves to new plants, creating wounds through feeding. The bacteria on the mouthparts or in the fecal matter of the beetle enter the plant through the feeding wound.

Symptoms of bacterial wilt (on fig.2) are; -Leaves first appear dull green, wilt during the day and recover during the night. Affected leaves eventually turns yellow or brown at the margins, completely wither and die.; Wilt progresses down the vine until the entire vine dies.

Major challenges of bacterial wilt include;* Bacterial wilt cannot be controlled once a plant is infected, since chemical sprays are not effective for control immediately plants show symptoms. Bacteria clog the vascular tissues, stopping the flow of water to leaves; Yield loss of leaves and vines; Loss of income to farmers and government revenue; Leads to serious world-wide economic losses particularly in the tropics

The prospects for bacterial wilt include; Exploitation of integrated biocontrol for the management of bacterial wilt. *Bacillus amyoliquefaciens* ZM9, calcium cyanamide and rice bran were applied to tobacco fields in different ways by Yun *et al.,* (2021) to control *Ralstonia solanacearum*, a causal agent of tobacco bacterial wilt (TBW). This integrated biocontrol method had the highest control efficiency of TBW and bacteria community diversity. Additionally, it could improve the colonization ability of *B. amyoliquefaciens* ZM9 as well as effectively suppressing

TBW by regulating soil physicochemical properties, promoting beneficial bacteria and antagonistic bacteria of rhizopshere soil.

ANGULAR LEAF SPOT: This is caused by *Pseudomonas syringae* pv. *lachrymans.* This disease can originate with infested seed, infected transplants or in the field from infected volunteer plants as well as from infested crop residue. Infection occurs through stomata, hydathodes and wounds. Humid conditions favour disease development. The bacterium can be spread from plant to plant by splashing water, insects, farm equipment and workers.

Symptoms of this disease include; foliar symptoms initially appearing as small, water-soaked areas on the underside of the leaf, which develop an angular appearance due to restriction by the small leaf veins. Also, spots turn brown and may develop yellow haloes. Infection on stems, petioles and fruit first appears as water-soaked spots, which may produce milky exudate under humid conditions and corresponding white crust upon drying (fig.3).

Challenges posed by angular leaf spot disease includes; Affected leaf dries and shrinks Infected leaf may tear away from the healthy portion leaving irregular holes.;Leaves approaching maturity are more susceptible than the older leaves; Fruits may be attacked. Fruit spots are small, nearly circular and superficial; The bacteria survive in association with seed.

The prospects for angular leaf spot are; Exploitation of biocontrol method: Endophytic bacteria (EB) isolate have been demonstrated by Mustafa and Hatice (2018) to be effective biocontrol agent of angular leaf spot disease and colonization of cucumber (*Cucumis sativus* L.). In the study, EB isolated from healthy cucumber plant tissues (root, stem, leaves) were evaluated as possible biological control of *Pseudomonas syringae* pv. *lachrymans*, a causal agent of angular leaf spot in cucumber.

BACTERIAL FRUIT BLOTCH: This disease is caused by a gram negative *Acidovorax citrulli.* This affects cucurbit plant around the world and can be a serious threat to farmers because it spreads through contaminated seed. Most significant losses are observed in melon and water melon (Lynn Brandenberger and John Damicone, 2020). It also affects pumpkin, Zucchini and cucumber but these are not as economically devastated as that of melon. Symptoms of this disease includes water soaked lesions on cotyledons and hypocotyls, fruit symptoms begin as small water soaked spots, it expands rapidly and may cover the upper surface of the fruit. Later, lesions turn red-brown and develop cracks and generally, fruit rot may follow and in some cases white bacterial ooze may form in the legion during wet weather.

Challenges brought by bacterial fruit blotch are; Fruit deterioration leading to yield loss; Collapse and death of infected plant in severe cases**;** Affected plant fruit have spoilt taste

Management practices for bacterial fruit blotch includes; Use of clean seed and disease-free transplants, minimizing handling in transplant greenhouse, keeping temperature and humidity low, Practicing general greenhouse sanitation. In the field; rotation out of cucurbits and control of volunteer watermelon plant. Also, avoiding sprinkler irrigation in the field and ensuring one do not work in fields with wet foliage.

BACTERIAL SOFT ROTS: This disease is caused by species of gram negative bacteria, *Erwinia carotovora* and *Pseudomonas spp.* (Tijjani, A., Adebitans, S. A., Gurama, A. U., Haruna, S. G. and Safiya, T. 2018). The disease is very destructive and affects fruits, vegetables and ornamentals found globally. Disease spread is enhanced by simple physical interaction of healthy plant with infected one during storage as well as by insect (Dutta *et al.*, 2016).

Symptoms include that initially, bacteria soft rot cause water-soaked spots, which enlarge over time and become sunken and soft. A soft, slimy, Foul-smelling rot, Dark internal discoloration while in advocado, the fruit has a darkened metallic sheen externally. internally, the flesh is grey to black and soft with putrid smell.

Challenges posed by bacterial soft rot include; damage of succulent part such as fruit, tubers, stems and bulbs of plants in nearly every plant family.; The bacteria degrade pectate molecules that bind plant cells together, causing plant structure to fall apart.; The disease can occur on crops in the field and harvested crops in storage

Prospect for bacterial soft rot: Use of bacterial predator *Bdellovibro* and like organisms (BALOs) to control potato soft rot has been demonstrated by Daniel, Y., Yael, H., Saul, B., Ofra, M. and Edourd, J. (2020). BALOs are small, motile predatory bacteria found in terrestrial and aquatic environments. They prey on wide range of gram-negative bacteria including animal and plant pathogens. BALOs strains HD 100, 109J etc were shown to efficiently prey on various rot causing strains of *Pectobacterium* and *Dickeya solani*.

Conclusion: Many bacterial agents pose challenges to the production of crops especially members of the *Cucurbitaceae* family, leading to poor quality reduction in yield as well as loss of income to the farmer and the total gross income. Different management strategies and prospectus are available depending on the pest organism. The exploitation of biocontrol methods such as the use of endophytic bacteria, the combination of *Bacillus amyoliquefaciens* ZM9, calcium cyanamide and rice bran, the use of bacterial predator *Bdellovibro* and like organisms (BALOs) as well as the deployment of bacteriophage has been proven effective in curtailing the damage by bacterial diseases and hence recommended for high yield production of the cucurbits.

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Fig. 1: Symptom of Bacterial leaf spot: Water soaked area in the undersurface

Fig. 2: Symptom of Bacterial wilt disease

Fig. 3: Symptom of Angular leaf spot disease

Fig. 4: Angular leaf spot symptoms on cucumber fruits