Chapter

Current and Emerging Pests and Diseases of Cucumber (*Cucumis sativus* L.) in Africa

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Abstract

The place of cucumber (*Cucumis sativus* L.) in Africa was considered insignificant for years due to its previously assumed limited uses. However, it has now gained recognition as one of the important market vegetables in the tropics because of the continued awareness of the numerous health benefits attached to its consumption. This has progressively affected its cultivation and thereby, increased outbreak of diseases and insect pests of the crop. High incidence of insect and disease infestations occur in *Cucumis sativus* L. due to extreme temperatures, heavy rainfall and high humid condition resulting there from, causing huge losses through reduction in yield, lowered quality of harvested produce and increased cost of production. More than 30 pests and diseases are known to contribute to the losses recorded on the crop in Africa, some of which will be discussed in this chapter.

Keywords: infestation, insect, losses, outbreak, tropics, yield

1. Introduction

Cucumber (*Cucumis sativus* L.) is considered the fourth most essential vegetable worldwide, perhaps due to its great nutritional, medicinal and economic potential [1, 2]. In terms of world total production, cucumber is rated an important cucurbit alongside watermelon (*Citrullus lanatus* L.) and melon (*Cucumis melon* L.) [3]. Low yield and insufficient use of the product previously contributed to ranking the crop insignificant in Africa [4]. At present, the demand for cucumber is on the increase daily in Africa because of the continued campaigns about the numerous benefits of the crop [5].

Despite the increasing relevance of cucumber, production is seriously constrained by many factors which include scarcity of suitable planting materials, limited access to capital, climatic conditions, plant pests and diseases, among others [5]. More than 40 diseases caused by viral, bacterial, fungal and nematode pathogens severely affect the cultivation and production of *C. sativus* L. [6]. Insect pests are reported to consume crops sufficient to feed an additional one billion people on a worldwide basis, thereby placing much importance on identifying and managing them prior to infestation [7].

Like other cucurbits, the most common pests of *C. sativus* L. are spotted cucumber beetle (*Diabrotica undecimpunctata*) and striped cucumber beetle

(*Acalymma vitatum*) [8]. Other pests identified on cucumber fields in Africa include Flea beetle (*Phyllotreta cruciferae*), Hadda beetle (*Epilachna vigintioctopunctata*), banded cucumber beetle (*Diabrotica balteata*), squash bug (*Anasa tristis*) and squash vine borer (*Melittia cucurbitae*). Additionally, *C. sativus* L. harbours a number of aphids which include melon aphid (*Aphis gossypii*), cowpea aphid (*Aphis craccivora*), potato aphid (*Macrosiphum euphorbiae*) and green peach aphid (*Myzus persicae*), which serve as common vectors of important viral diseases of *C. sativus* L. [9].

In Africa, cucumber is largely affected by viruses belonging to three genera; namely *Potyvirus*, *Cucumovirus* and *Crinivirus* [10]. *Zucchini yellow mosaic virus* (ZYMV), *Watermelon mosaic virus* (WMV), *Moroccan watermelon mosaic virus* (MWMV), *Papaya ringspot virus* (PRSV), *Cucumber mosaic virus* (CMV) and *Beet pseudo-yellows virus are some of the viruses* that cause severe symptoms to cucumber [11]. Other viruses of minor importance include *cucurbit aphid-borne yellows virus*, *cucurbit yellow stunting disorder virus*, *melon necrotic spot virus*, *squash mosaic virus* and *tomato spotted wilt virus* [12]. Plant virus infections result to reduction in plant growth, lower yields, compromised fruit quality, reproductive difficulty, increased susceptibility of the host plant to other pathogens and economic losses to farmers [13].

Several fungi attack seedlings of cucumber, causing appreciable losses, especially under favourable environmental conditions [14]. In Africa, many pathogenic fungi such as *Alternaria tenuis*, *Alternaria alternata*, *Fusarium equisett*, *Fusarium solani*, *Aspergillus* spp., *Phytophthora capsici*, *Penicillium oxalicum*, *Bipolaris* spp., *Botrytis cinerea*, *Cladosporium tenuissimum*, among others, have been associated with rotting of cucumber fruits [15], causing reasonably high post-harvest losses [16, 17]. Downy mildew, powdery mildew and anthracnose also cause substantial losses. Scab affects aboveground plant parts, including the fruits.

Root-knot nematodes are prevalent destructive pathogens of *C. sativus* L. because even at low levels, high yield losses result [18]. Other nematodes include species of *Rotylenchus*, *Benololaimus*, *Pratylenchus*, *Paratylenchus* and *Trichodorus*. Angular leaf spot is the most common bacterial disease of *C. sativus* L., although it affects all cucurbits. Bacterial wilt disease has also been reported in Africa [19].

The increasing trend of local and international movement of seedlings, cuttings and fruits enhance the risk of introducing new pathogens and vectors, where applicable into new areas. Changing climate conditions can contribute to a more successful spread of pathogens and establishment of such organisms in areas previously unfavourable to their existence. A holistic disease management approach which requires the use of cultural, mechanical, biological and chemical methods is needful to mitigate the negative impact of diseases, insect and weed pests on productivity, hence, the importance of this review on the current and emerging pests and diseases of *C. sativus* L. in Africa.

2. Viruses of cucumber

2.1 Genus: *Potyvirus*

The genus *Potyvirus* is one of the largest genera of plant viruses infecting several economically important cucurbits worldwide [20]. Potyviruses are non-enveloped flexuous filamentous viruses of about 680–900 nm long and 11–15 nm wide, harbouring a monopartite genome consisting of a single positive-sense RNA covalently linked to a viral protein genome at one end and a polyadenyl tail at the other end [11, 21]. Typical symptoms induced by *potyviruses* include mosaics on leaves, leaf distortion, leaf reduction, fruit deformation, yellowing and wilting [22]. The major

potyviruses that affect *C. sativus* L. in Africa include *Zucchini yellow mosaic virus* (ZYMV), *Watermelon mosaic virus* (WMV), *Moroccan watermelon mosaic virus* (MWMV and *Papaya ringspot virus* (PRSV).

2.1.1 Zucchini yellow mosaic virus (ZYMV)

Zucchini yellow mosaic virus (ZYMV) naturally infects cucurbits, mostly cultivated species, a few ornamentals and weeds. There are reports of ZYMV in South Africa, Egypt, Nigeria, Sudan, Tunisia, Mali, Madagascar and Morocco [23, 24]. ZYMV is spread by aphids in a non-persistent manner [22]. Among 26 aphid species capable of transmitting ZYMV, *Aphis gossypii* Glover, *Aphis craccivora* Linnaeus, *Macrosiphum euphorbiae* Thomas and *Myzus persicae* Sulz have been identified as more efficient vectors. Mechanical and seed transmission have also been reported [25]. Symptoms produced on infected plants include vein clearing, yellow mosaic, leaf deformation with blisters, misshaped fruits and stunted growth (**Table 1**).

2.1.1.1 Management of ZYMV

Planting of available resistant/tolerant varieties to ZYMV is advisable. Growing taller non-susceptible companion crop, cross- protection to control severe ZYMV isolate and spraying of insecticides are also good measures against the virus.

2.1.2 Watermelon mosaic virus (WMV)

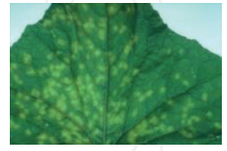
Watermelon mosaic virus (WMV), formerly WMV-2 has a wide host range which include *Cucurbitaceae*, *Apiaceae*, *Chenopodiaceae*, *Fabaceae*, *Malvaceae*, *Orchidaceae* and several weeds [33, 34]. WMV has been reported in such countries as Nigeria, South Africa and Tanzania in Africa [35, 36]. About 35 species of aphids transmit WMV in a non-persistent manner although *A. gossypii*, *A. craccivora* and *Myzus persicae* are regarded as more efficient vectors. Recent studies have also established the possibility of WMV transmission through seed [37]. Symptoms of WMV is dependent on the host and the isolate and these include vein-banding, mosaic, leaf deformation, fruit discolouration and distortion [38].

2.1.2.1 Management of WMV

Eradication of weeds and alternative host helps to reduce the incidence of WMV. Close monitoring of field for timely intervention in the event of WMV disease outbreak is helpful. The use of plastic mulches also reduces insect infestation which, otherwise would transmit the virus.

2.1.3 Moroccan watermelon mosaic virus (MWMV)

Moroccan watermelon mosaic virus was first reported in Morocco in the year 1972 as a strain of WMV, causing severe diseases in various cucurbits [39]. Subsequently, MWMV was discovered as a distinct potyvirus species distantly related to Papaya ringspot virus (PRSV) based on biological and serological properties [40]. The host range of MWMV is limited to members of *Cucurbitaceae* family and papaya. The geographic distribution of the virus in Africa spread through Niger, Cameroon, Nigeria, South Africa, Tunisia, Tanzania, Congo and Zimbabwe [41–43]. *A. gossypii* and *Myzus persicae* transmit the virus in a non-persistent manner. Symptoms associated with MWMV infection include mosaic, severe leaf and fruit deformation, wilting and dark-green blistering [41].

Causal	Disease	Picture	Reference	Causal	Disease	Picture	Reference
Virus	ZYMV		[26]	Bacteria	Angular leaf spot		[27]
Virus	WMV		[26]	Bacteria	Root Knot		[26]
Virus	MWMV		[28]	Nematode	Downy mildew		[29]
Virus	PRSV		[30]	Fungi	Powdery mildew		[26]
Virus	CMV		[26]	Fungi	Alternaria leaf blight		[26]

Causal	Disease	Picture	Reference	Causal	Disease	Picture	Reference
Virus	BPYV		[31]	Fungi	Fusarium wilt		[26]
Bacteria	Bacterial wilt		[26]	Fungi	Damping-off		[32]

***Abbreviations**: ZYMV: Zucchini yellow mosaic virus; WMV: Watermelon mosaic virus; MWMV: Moroccan watermelon mosaic virus; PRSV: Papaya ringspot virus; CMV: Cucumber mosaic virus; BPYV: Beet pseudo-yellows virus.*

Table 1.
Symptom expression of some cucumber diseases.

2.1.3.1 Management of MWMV

Use resistant varieties for planting and avoid planting close to old cucurbit fields. Phyto-sanitation, use of virus-free planting materials and pesticide for control of the vectors have also been employed in the management of MWMV.

2.1.4 Papaya ringspot virus (PRSV)

Papaya ringspot virus (PRSV) has great economic importance for cucurbit and papaya cultivation worldwide. The designated biotype for cucurbits is PRSV-W. The virus has been reported on cucurbits in Tunisia [44], Egypt [45], Morocco [46] and South Africa [47]. Early season infection may lead to poor fruit set while late season infection may result to blotchy fruit. The virus can be transmitted through movement of farm workers and machinery from one place to another and by aphids. At initial stage, symptoms can appear as vein clearing of leaves followed by the development of dark-green mosaics. In cucumber, leaves are distorted along the margins.

2.1.4.1 Management of PRSV

Management of infection on cucurbits can be achieved by using resistant varieties for planting. Insecticide applications may also reduce aphid numbers in the field. Other practices may include the use of mulches and elimination of volunteer weed hosts.

2.2 Genus: *Cucumovirus*

Viruses in this genus have wide host range, infecting over 1200 plant species worldwide [48]. Virions are icosahedral particles of approximately 29 nm in diameter, made of subunits of single capsid protein numbered 180 [49, 50]. The genus consists of three linear positive-sense single stranded RNA molecules. The major *Cucumovirus* infecting *C. sativus* L. in Africa is *Cucumber mosaic virus* (CMV).

2.2.1 Cucumber mosaic virus (CMV)

The first report of cucurbits-infecting virus was obtained on *Cucumber mosaic virus* in 1916. CMV is of great importance in temperate and tropical regions of the world [51]. Report of CMV infection on cucurbits in Africa were established in Tanzania and South Africa [36]. Over 80 species of aphids in more than 30 genera transmit CMV in a non-persistent manner but *Aphis gossypii* and *Myzus persicae* are the most efficient [52, 53]. Rapid spread of the virus has been attributed to the attraction of CMV-infected plants to aphids [54]. Transmission through seed, parasitic weeds such as dodder *Cuscuta* spp. and mechanically have also been established [50, 55, 56]. CMV causes typical mosaic symptoms in cucumber which include mosaic on leaves or fruit, stunted growth, deformed fruit, yellow spot and wilting (**Table 1**).

2.2.1.1 Management of CMV

The use of certified seed for planting, regular weeding and disinfection of hands and farm tools are effective ways to manage CMV. Aphid population should also be kept under control through regular spraying with insecticide.

2.3 Genus: *Crinivirus*

The genus *Crinivirus* comprises of members with cross-banded flexuous particle, five gene nodule and infection that is restricted to the vascular tissues [57]. A typical member of this genus infecting cucurbits in Africa is *Beet pseudo-yellows virus*.

2.3.1 Beet pseudo-yellows virus (BPYV)

Beet pseudo-yellows virus has a broad host range including cucurbits, ornamentals and weeds. BPYV particles are approximately 12 nm wide and 1500–1800 nm long [58]. BPVY has been reported in South Africa [11]. The genome is made up of two linear positive sense, single stranded RNA of about 7.6 to 8 kb, both required for infectivity [57]. Typical BPVY symptoms may be confused with physiological disorders. Symptoms appear first on older leaves as yellow spots which develop into yellow blotchy raised areas between veins, which remain green. Subsequently, younger leaves become affected but the fruit remain intact.

2.3.1.1 Management of BPYV

Prevention of incidence of whitefly infestation, practising crop rotation and regular weeding are recommended ways of managing BPVY. Elimination of inter-cropping of old and young plants and good sanitation are also effective.

3. Bacterial diseases of cucumber

3.1 Genus: *Erwinia*

The genus *Erwinia* comprises rod-shaped bacteria that are plant-pathogenic and plant-associated [59]. Bacteria in this group are related to *Escherichia coli*, *Shigella*, *Salmonella* and *Yersinia*. A typical member of this genus which affects *C. sativus* L. is *E. tracheiphila* which causes bacterial wilt of cucurbits in general.

3.1.1 Bacterial wilt of Cucurbits

Bacterial wilt, caused by *Erwinia tracheiphila* and vectored by striped cucumber beetle (*Acalymma vittatum* F.), is one of the serious diseases threatening natural and wild cucurbit crops. Cucumber is one of the most susceptible to the disease [60]. Bacterial wilt remains a major disease of cucurbits in South Africa [61]. Transmission occurs when an infected beetle creates wound during the course of feeding on a plant and defecates therein. The bacterium moves by free water into the xylem, which spreads and multiplies it. Disease symptom appears first on younger plants and these include discolouration of stem tissues and wilting of some or all the parts of the affected plant [62].

3.1.1.1 Management of Bacterial wilt disease of cucurbits

Disease management relies on controlling cucumber beetles, mainly through insecticide applications. Practicing crop rotation and planting cultivars that are less attractive or susceptible to striped cucumber beetles are also helpful.

3.2 Genus: *Pseudomonas*

Members of the genus *Pseudomonas* are pathogenic aerobic bacteria that are naturally widespread in the environment [63]. Their wide occurrence has been attributed to their great deal of metabolic diversity and as a result, ability to colonise a wide range of niches. One of the most studied members of the group is *Pseudomonas syringae*. Angular leaf spot caused by *Pseudomonas syringae* pv. *lachrymans*, is common to almost every cucumber growing area of the world [64].

3.2.1 Angular leaf spot

Angular leaf spot is one of the serious diseases which primarily affects cucumber. The infection can affect the quality of fruit produced by inflicting up to 37 and 40 per cent reduction in fruit number and fruit weight, respectively in addition to rendering some fruits totally unmarketable [65]. At the initial stage, the symptoms appear on leaves in form of small, water-soaked lesions which later enlarge. Older lesions become angular as they enlarge and encounter veins. The infected tissues often dry and fall. The leaves are left with torn-irregular-shaped holes. In Africa, angular leaf spot disease was identified on cucumber seedlings raised from infected seeds in Egypt, with disease incidence of 98 per cent [66]. Different isolates of *P. syringae* pv. *lachrymans* from Egypt are also reported to induce wilting, besides the typical angular leaf spots, within 3 to 6 days of inoculation [67].

3.2.1.1 Management of Angular leaf spot

Angular leaf spot disease can be effectively managed by planting disease-free seeds. Additionally, planting field should have good drainage system to avoid any form of contact from neighbouring cucurbitaceous fields. Crop rotation with non-cucurbits and complete removal of crop remains after harvest are helpful.

4. Nematode diseases of cucumber

4.1 Genus: *Meloidogyne*

Members of the genus *Meloidogyne* have gained worldwide recognition as one of the major plant parasites constraining crops of primary economic importance [68]. *Meloidogyne* spp. are considered among the top five major plant pathogens and the first among the ten most important genera of plant parasitic nematodes in the world [18]. *M. arenaria*, *M. incognita* and *M. javanica* are reportedly dominant in Africa [69]. *Meloidogyne* spp. were among the nematodes found on cucumber field in Libya [70]. Aminu-Taiwo and Fawole [71] identified the effect of *Meloidogyne incognita* on cucumber in Nigeria bringing about remarkable yield reduction.

4.1.1 Root Knot disease

Root-knot is caused caused by *Meloidogyne* spp. All members of Cucurbitaceae family are susceptible. Typical symptoms observed on affected plants include stunted growth, pale green to yellow leaf colouration and wilting during the hot periods of the day [72]. This is due to reduced water uptake. Yield and quality of the fruit are greatly reduced. In heavy infections, plants will completely wilt and die as the nematode populations increase. When infected plants are removed from the

soil, knobby, wart-like galls caused by the nematode can be seen singly or in clumps on the roots. Secondary infection by other soil organisms is common.

4.1.1.1 Management of Root knot disease

Measures that have been used to manage root knot disease include the use of chemically formulated nematicides, crop rotation, soil fumigation, practice of fallow period and using plant extract with nematicidal property.

5. Fungal diseases of cucumber

5.1 Genus: *Pseudoperonospora*

Members of the genus *Pseudoperonospora* are water moulds which include several species known for causing downy mildew infections on plants.

5.1.1 Downy mildew of Cucumber

Downy mildew is one of the important foliar diseases of members of *Cucurbitaceae* family. Unlike other cucurbits, cucumber is more susceptible to downy mildew [73]. *Pseudoperonospora* spp. is the causative pathogen of downy mildew on cucurbits generally [74]. The disease was reported on *C. sativus* L. in Egypt [75].

Serious losses result from downy mildew of cucumber under unfavourable environmental conditions. Temperature and humidity have been identified as important factors for disease infection and development [76]. The transmission of the fungus is dependent on the presence of infected cucurbit hosts in cultivated fields. Symptoms of downy mildew in cucurbits are almost exclusively confined to the leaves. In cucumber, characteristic symptoms are angular chlorotic lesion on foliage. The underside of leaf turns grey-brownish to purplish black with high humidity.

5.1.1.1 Management of Downy mildew

Planting should be planned to coincide with the time that environmental factors are less favourable to disease infestation. Crop should also be closely monitored for early identification of incidence of the disease. Adoption of good phytosanitary measures, use of healthy planting materials, chemical fungicides and bio-control agents are other effective means of managing the disease.

5.2 Genera: *Erysiphe, Sphaerotheca*

Two genera (Erysiphe, Sphaerotheca) have been identified to cause powdery mildews which affect economically important crops, herbs and woody species [77, 78]. Members of the genera are obligate plant pathogenic fungi. *Erysiphe* is the largest in the family Erysiphaceae, comprising about 873 species. About 806 plant species are found in the genus *Sphaerotheca*.

5.2.1 Powdery mildew of Cucumber

Powdery mildew of cucumber is caused by either *Erysiphe cichoracearum* or *Leveillula taurica* (Erysiphales) and *Sphaerotheca fuliginea* [76]. Powdery mildew had been identified on cucumber fields in Nigeria [79]. There are reports on the presence of *Leveillula taurica* on cucumber fields in Kenya, Libya, Morocco and

Senegal [80]. Powdery mildew infection is one of the easiest to spot because of the specificity of the symptoms. Transmission of the fungus occurs when conidia are dispersed over long distances by wind, through the movement or planting of infected cucurbits or by alternate hosts. Typical symptoms include white powdery growth in the upper leaf surfaces and stems of infected plants [81]. The lower or young leaves are most affected but mildew can be seen on any upper part of the plant. Infected plants are usually stunted and distorted. Fruits may also experience stunted growth.

5.2.1.1 Management of Powdery mildew

Planting resistant varieties, application of fungicides to delay infection and reduce disease incidence are common measures to manage powdery mildew. Additionally, use of non- hazardous biopesticide such as cinnamon oil, effective phytosanitation and regular weeding have also been recommended.

5.3 Genus: *Alternaria*

Species in the genus *Alternaria* have worldwide distribution because they are capable of existing in a variety of habitats, which explains their commonness and abundance. Members of the genus *Alternaria* are ascomycete fungi with major plant pathogens [82]. Lack of suitable hosts and unfavourable environment have been identified as some of the probable reasons for absence of *Alternaria* spp. in any environment [83]. The key distinguishing feature of the genus *Alternaria* is the production of dark coloured conidia with longitudinal and transverse septa. The spores are airborne and found in soil, water and on surfaces.

5.3.1 Alternaria leaf blight of Cucumber

Alternaria leaf blight of cucumber is caused *by Corynespora casiicola*. Although, cucumber is reported to be more susceptible to Alternaria leaf blight disease among the cucurbits, there are reports of wide host range distribution for the disease and evidences of infection abound in several other crops and weeds. Transmission of infection is carried out through wind over long distance and by splashing of water from diseased plants to previously unaffected ones over short distance. Lesions tend to appear first on older leaves in form of small circular spots. The spots are brown with light center which form dark concentric rings as they enlarge. Lesions formed on lower leaf surface tend not to be focused [84]. Fruit infection starts out as sunken brown spots and may later develop dark powdery appearance. The infection may also begin at the growing end while the entire fruit eventually turns brown. Spots on stems and petioles elongates more to distinguish the disease from other diseases such as angular leaf spot and anthracnose. In recent times, target spot has emerged with alarming severity and incidences on agriculturally important crops such as cotton (*Gossypium hirsutum*), soybean (*Glycine max*) and tomato (*Solanum lycopersicum*) in the Southeastern United States [85], causing losses of between 5–40%. In Africa, there seems to be scanty report of the disease on cucumber but it has been reported on such crops as tomato and tobacco in Nigeria [86], on potatoes in South Africa [87] and as a biocontrol agent of weed in Egypt [88]. *Corynespora casiicola* which was considered as a minor issue to production of major crops such as cotton, soybean is now causing epidemics in US by expanding its host range to previously non-host crops, it is therefore of importance considering it an emerging fungal disease which needs more attention in Africa.

5.3.1.1 Management of Alternaria disease of Cucumber

Alternaria disease of cucumber can be effectively managed by using resistant varieties for planting and practising crop rotation with non-cucurbitaceous crops. Also, destruction of volunteer alternate hosts, application of commercially recommended fungicides and adoption of good sanitation practices should be encouraged.

5.4 Genus: *Fusarium*

Members of the genus *Fusarium* are ubiquitous saprophytes which can be isolated from debris, roots, stems and seeds of a wide variety of plants [89]. *Fusarium oxysporum* is one of the important phytopathogen causing Fusarium wilt disease in more than a hundred species of plants [90]. *Fusarium* wilt of cucurbits is caused by *Fusarium oxysporum* f. sp. *niveum* which affects watermelon, *Fusarium oxysporum* f. sp. *melonis* which affects muskmelon and *Fusarium oxysporum* f. sp. *cucumerinum* which affects cucumber.

5.4.1 Fusarium wilt of Cucumber

Yield loss due to the infection of Cucumber Fusarium wilt disease has been estimated to be between 10–30%. Poor quality of harvested product also results causing huge economic losses [91]. *Fusarium* spp. cause wilt and root rot of affected plants. Invasion by the fungi starts from the root of the plant and progresses into the stems. Damping-off is the symptom of early infection which develops due to lower stem infections. Wilting generally starts on the older leaves and proceeds to the young ones. Wilt symptoms develop on one or few lateral vines in the beginning, while other branches remain apparently unaffected. However, under high inoculum conditions or in highly susceptible host species, the whole plant may wilt and die within a short time. Older plants may experience vascular browning, gummosis, and tylosis in xylem vessels [84]. Transmission of infection over short distances occur by the movement of infested soil, while the spread over long distances occur by using infected equipment and planting propagules. The disease may invade the fruits through the stem end.

5.4.1.1 Management of Fusarium wilt

Treatment of seed with chemical fungicides and planting resistant varieties are measures that can be used to manage the disease. Hot water treatment of seed at 52 °C for 30 minutes and crop rotation with distantly related crop is also helpful.

5.5 Genus: *Pythium*

Members of the genus *Pythium* are common worldwide [92]. Many species in the genus *Pythium* are important soil-borne pathogens which affect economically important crops such as cereals and vegetables [93]. Several other *P*ythium spp. are saprophytic, with some enhancing plant growth and displaying potential as a biocontrol agent [94]. About 8 *Pythium* species have been identified in Africa, *P. aphanidematum* being the commonest. Pythium-induced damping-off and root disease of cucurbits cause huge losses, sometimes as much as 100% [95].

5.5.1 Damping-off in cucumber

Damping-off caused by *Pythium* spp. constitute major constraint to cucumber production worldwide [96]. *Pythium* spp. were associated with wilt and root rot

of hydroponically grown crops, including cucumber in South Africa [97]. The infection can occur before or after seeds germination. At pre-emergence, rotting of seed inside seed coat occurs. At post-emergence, damping-off appears as yellow to dark brown and water-soaked lesions are noticed on the root and hypocotyl tissue. With time, further root decay occurs, the hypocotyl shrivels and the seedling wilt. Inoculum of *Pythium* spp. can be transmitted from one place to another through airborne dust, soil, water, farm tools and equipment.

5.5.1.1 Management of Pythium spp

Chemical treatment, crop rotation, prevention of fruit contact with soil surface, reduction of fruit injury and biological control are being used to manage Pythium spp. Avoidance of overcrowding is also advisable.

6. Insect pest of cucumber

Three insect pests are of high importance to cucumber production. They are cucumber beetle (striped and spotted), green peach and melon aphids. Cucumber beetle cause direct feeding damage and can vector bacterial wilt. Aphids on the other hand vector viruses.

6.1 Striped and spotted cucumber beetles

Striped cucumber beetles, Acalymma vittata (Fabricius), and spotted cucumber beetles, *Diabrotica undecimpunctata howardi* (Barber) share a similar life cycle, and inflict similar damage to host plants. Both species of cucumber beetles not only feed on the roots, stems, foliage and fruit of cucumbers they also vector diseases of cucumber [98]. Cucumber beetles vector bacterial wilt and can transmit another important disease, however, spotted cucumber beetles do not vector bacterial wilt disease but can spread squash mosaic virus and there are reports that they can increase the incidence of powdery mildew, black rot, and Fusarium wilt [99]. The feeding injury and disease transmission takes place from emergence until they form runners. Beetle cause growth retardation and destruction of young seedlings causing loss to the farmers.

6.1.1 Management

There is usually a peak in beetle activity each spring that lasts two to four weeks. This is the most important time to control beetles. Monitoring is as important as control which should be done as soon as seedlings emerge because early treatment is essential for beetle management in cucumber fields. Treatment should be carried out at the peak of beetle activity with foliar insecticides to protect cucumber plants from beetle feeding and transmission of bacterial wilt.

6.2 Aphids (*Myzus persicae* and *Aphis gossypii*)

A number of aphid species which include green peach aphid (*Myzus persicae*) and melon aphid (*Aphis gossypii*) feed on cucumber and cause similar damage. The aphids suck plant fluids from stems, leaves, and other tender plant parts using their slender mouthpart to pierce. Downward curling and crinkling of the leaves of infested plants is part of the first sign of aphid damage. The aphids are often found on lower leaves, soft-growing tips, flower buds, and in some cases flowers. The feeding activity of the aphids usually causes a variety of symptoms, which can

include reduced plant growth and vigour, mottling, yellowing, browning, curling, or wilting of leaves. All these can result in low yields and sometimes death of plant [100].

The Saliva that is injected into plant tissues by aphids can cause puckering and curling of leaves and such can protect them from natural enemies and help them evade substances applied for their control. Aphids feeding on flower buds and fruits can cause malformed flowers or fruits. Aphid is very prolific so populations can increase rapidly as each adult reproduces numerous nymphs in a very short period of time. It takes the green peach aphid just 10–12 days to complete one generation and can reproduce over 20 generations annually under mild climates [100]. Aphids generally are considered the most important vector for the transmission of viruses throughout the world with equal capability of both nymphs and adults [101].

6.2.1 Management

The first step to management is early identification. The ability of aphids have to multiply rapidly must be taken into account while monitoring for this pest. Plants should be checked on a regular basis, at least twice a week with special attention to the undersurface of the leaves in most cases problems occur toward the end of the growing season. There are a number of cultural and biological options available depending on environmental factors and available resources. Yellow sticky traps would be helpful in detecting aphids 2–3 weeks prior to planting and can also help in management afterwards. The use of a detergent and vegetable oil solution before destroying old crops can avoid winged virus-infected aphids from getting to nearby crops to overwinter. Chemicals both organic such as potassium soap and petroleum oil or primicarb. Endosulfan, Dimethoate, Lannate, Fulfil, and Actara and inorganic like Cypermethrin (0.01%), acetamiprid (0.01%), bifenthrin (0.01%) and malathion (0.05%) are used to control aphids.

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