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Significance of Phytoptora Disease with Special Emphasis to Avocado and Pine Apple in South Western Ethiopia: A Review

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Abstract
Avocado was introduced to Ethiopia by private orchard owners around Hirna and Wondogenet in 1938. Gradually its cultivation spread nation-wide with satisfactory adoption to different agro ecologies. Pineapple also grows successfully around Gojeb, Jimma, Mizan, Bebeka, Teppi and Dilla areas. Avocado and pine apple root rot was observed in Ethiopia during 1990 and in 2010 at the Jimma Research centre (JARC) and Gojeb farm Southern Nations, Nationalities and Peoples Region (SNNPR), Kaffa zone, Gimbo district respectively. The survey result of Jimma Agricultural Research revealed avocado root rot caused by *phytoptora cinnamomi* was observed in avocado producing areas of Jimma, Iluabbobora, Kafa and Sheka Zones. At Gojeb farm Smooth cayenne introduced from Kenya in 1980 and South Africa in 2005 was found highly susceptible to pine apple root rot as compared red Spanish cultivar. The notorious nature of *Phytoptora* as pathogens probably lies on their capacity to cause diseases in broad range of hosts covering crop plants, ornamentals, and woody trees horticultural and forestry value. Management of *phytoptora* disease is based on a number of principles such as avoiding infections through basic hygiene limiting susceptibility through drainage and irrigation, improving soil health, use of disease resistant germplasm. Management practices for the control of *Phytoptora* diseases vary and no complete management program can totally eradicate diseases caused by *phytoptora* species. Once an area is infested with *Phytoptora,* total eradication is difficult. While total eradication is not possible, well developed management plans can assist in restricting intensification and spread of known infestations and limits its spread to new sites. Lack of concerted research interventions and limited knowledge of the pathogen aggravate the situation. Therefore increase awareness among stakeholders through trainings, search for varietal resistance are considered critical components of an effective avocado and pine apple root rot management strategy in South West Ethiopia.
Keywords: *Phytoptora,* Avocado, Pineapple.

Introduction

The genus *Phytoptora* is a microscopic oomycete plant pathogen in the order *pernosporales,* family *phytaciae* which includes the fast growing *phytium,* which consists of more than 80 different species that have been identified, and most are phyto pathogens.Thier notorious nature as pathogens probably lies on their capacity to cause diseases in broad range of hosts covering crop plants, ornamentals, and woody trees horticultural and forestry value. Additionally, *phytoptora* species are responsible for many pre- and post harvest problems of vegetables and fruits such as late blight of potatoes, brown rots of citrus and black pod of cocoa (Huberli Daniel, 2001).

The genus *phytoptora* first become known worldwide because of devastating effects of *P. infestans*, the casual agent of the 1840's Irish famine. *P.infestans* destroyed the potato crops in Ireland by attacking both the tubers and foliage irrespective of the stage of the crop development resulting in black potato rot in the fields, this caused mass starvation and poverty attributed to the high economic losses and prompted the emigration of a huge population to the United States of America and elsewhere (Gregory, 1983). This pathogen has made another come back with the migration of virulent and fungicide resistant strains. The appearance of these highly aggressive and fungicide resistant strains in North America and Europe posed a new problem as they were more difficult to manage than the older fungicide sensitive strains.

Another *phytoptora* caused disease that has also made its impact in domestic and global economics is attributed to four *phytoptora* species; *P. palmivora*, *P. megakarya*, *P. capsici* and *P. citrophtora* (Appiah et al., 2004). Black cocoa pod disease and has managed to cause huge economic losses to West African cocoa growers through infection of cocoa pods by one or more of these species. Infection of the pathogen leads to fruit rot where the cocoa fruit or pods develop black and whitish coloration and growth of infected plants to become stunted. Disease control measures such as spraying copper based fungicides have been taken. However, the multiple *phytoptora* species currently known have differing disease impacts and severity and this is challenging the disease management authorities. Also lack of funds and educational information available to the cocoa growers contribute to crop losses of 4 to 100% and loss revenue for exporting countries (Appiah et al., 2004). This review paper is aimed to review significance of *phytoptora* disease on some horticultural crops grown in South-west of Ethiopia.

The importance of Avocado

In the case study/survey conducted in Jima zone Mana district (Southwest Ethiopia) to identify the most important horticultural crops; Avocado stands second after Coffee (Table 1). In the same survey *Phytopthora cinamoni* serious disease of Avocado appeared to be the first production constraints that hinder important horticultural crops (Table 2).

Table 1. The most important horticultural crop in Jima zone (Mana District) South-western Ethiopia

No.	Horticultural crop	Rank
1	Coffee	1
2.	Avocado	2
3.	Enset	3
4	Banana	4

Source: Case study report in Jima zone (Mana District) South-western Ethiopia. JARC, 2012.

Table 2. Major constraints of important horticultural crops in Jima zone(Mana Distrct) South –western Ethiopia

No.	Constraints	Rank
1	Avocado root rot disease	1
2.	Coffee wilt disease	2
3.	Cigar End Tip Rot of Banana	3
4	Enset bacterial wilt diseae	4

Source: Case study report in Jima zone (Mana District) South-western Ethiopia .JARC, 2012.

***Phytoptora* root rot of avocadoes**

Symptoms of avocado root rot were first described in the 1920s, in a number of different countries and they were initially associated with high soil humidity. However the isolation of *P.cinnamomi* from declined avocado root rots in Puerto Rico confirmed that the pathogen was the casual agent of the decline symptoms (Zentimeyer, 1980). During 1940s, different authors confirmed that *P.cinnamomi* was the primary factor in the decline of avocado trees and that excess water assists pathogen development. It was also established that water is an important factor for formation, dispersal and germination of spores. The spread of *P.cinnamomi* from the possible centre or centres of origin to other continents (America, Australia, West Europe and Africa) could have been caused by European explores during transportation of soil and vegetal material and plants have favoured the dispersal of *P.cinnamomi*

Now a day, *phytoptora* root rot is the main disease affecting avocados across all continents around the world causing severe loss in fruit production (Maria Rosa, 2008).

Generally, the primary symptom caused by *P.cinnamomi* is root rot: avocado feeder roots present necrotic lesions, the pathogen progresses penetrating the epidermis and cortex, killing underling tissues and invading the entire feeder root system (Zentmeyer, 1980, Maria Rosa, 2008). In advanced stages of the disease, only, scarce small roots, blackened and brittle are present in the soil. Secondary symptoms resembling those of drought are a consequence reduced uptake of water and nutrients. Plants become chlorotic; with smaller leaves and fruit size than normal, which frequently and drop prematurely new growth is limited giving the diseased trees a sparse appearance.

Life cycle of *Phytoptora cinnamomi*

The life cycle of *phytoptora* consists asexual and sexual stages depending on the environment conditions where it persists. In the asexual component, the vegetative structure, Sporangium germinates by a germ tube producing a mass of thread-like mycelia. The sporangium germinates directly when the environment's free water is optimum with temperatures between 15-38^{0}c releasing mobile flagellated zoospores that can infect new hosts. The zoospores which are short-lived vegetative spores spread to their hosts through soil, ground water and surface water. Zoospores penetrate roots of susceptible plants by producing a germ tube. This germ tube will form hypha which gradually spreads to other parts of the plant. They also spread actively through standing water where they are chemo tactical attracted to roots (Zentmeyer, 1980, Huberli, 2001).

Under warm, moist conditions, the life cycle continues with *Phytoptora* producing via its microscopic fruiting bodies (sporangium) that will produce and release zoospores. In harsh conditions (such as hot dry summers or droughts), the asexual component produces the resting hard-coated structure, the chalamydospore, which can reside in the soil for few months. These resting structures enable phytoptora to survive these harsh conditions. When conditions are favourable (warm and mist), the long surviving chalamydospores can germinate and release zoospores which will spread through moving water to infect the plants' roots.

In the sexual component, gametes known as the oogonium and antheridium mate to produce sexual spores known as the oospores, the production of sexually derived oospores is primarily dependent on the presence of both mating types at the site. Oospores can survive for many years in soil. These Oospores behave as

resting structures where they are dormant when environmental conditions are unfavourable. When conditions are optima, these oospores germinate to produce mycelia. This will be followed by the formation of sporangium and zoospores, thus continuing the pathogen's lifecycle (Zentmeyer, 1980, Bijzet, 2002).

Avocado production and its constraints

Avocado is cultivated in tropical and sub-tropical regions, it is unique among fruit trees in that it is neither sweet nor acidic but of bland nature with remarkably high nutritional value. Avocados are known internationally for their high vitamin content and versatility for use in different dishes. Avocado consumption has seen high growth in different world markets, given the trend to consume products with natural fat, increased knowledge of its properties and the perception that it is a healthy food.

Avocado was introduced to Ethiopia by private orchard owners around Hirna and Wondogenet in 1938.Gradually its cultivation spread nation-wide with satisfactory adoption to different agro ecologies. Most wet parts of Ethiopia provide favourable weather conditions for avocado cultivation (Etissa, 1999). In 1979 a collection program was established at Jimma Agricultural Research Centre by planting few collections. When these collections started bearing more seeds were planted to promote genetic recombination. That was how utilization of avocado fruits started at South Western Ethiopia. Jimma Agricultural Research (JARC) has taken the responsibility to introduce and disseminate avocado seedlings to farmers. According to the report of seed multiplication and centre development of Jimma Research Centre, 283,000 seed and seedlings of avocado have been multiplied and distributed to farmers and other stake-holders in South Western part of the country (Jimma Agricultural Research Centre, 2004).

Avocado root rot caused by *phytoptora cinnamomi* was observed in avocado orchards in the early 1990s at the Jimma Research centre (JARC). Surveys conducted since then confirmed that avocado root rot is widely distributed in all districts of Jimma and Iluababor zones (South-western Ethiopia) causing heavy crop damage. For instance at JARC three to five avocado orchards consisting of around 100-200 very productive trees were destroyed by the disease between 1990 and 2005. As coffee diversification program the Limmu coffee plantation enterprise planted 44 hectares of land in three different farms namely Suntu, Gojeb and Cheleleki. 74 % of trees were lost due to avocado root rot (Table 3). The survey results of JARC also indicate that avocado root rot is distributed in major avocado producing woredas of Jimma zone (Table 4).

Table 3. Incidence of avocado root rot in Limu coffee enterprise

Zone	District	Area Planted (ha)	Loss due to avocado root rot (ha)	% loss	Source of Plant Material
Jimma	Suntu	2	1.5	75%	JARC
Keffa	Gojeb	30	30	100%	JARC
Jimma	Cheleleki	12.4	6.08	49%	JARC

Source: JARC Crop Protection department, 2010.

Table 4. Incidences of avocado root rot in farmer's orchards in different districts of Jimma zone.

District	Kebele (PA)	No. of sample orchards	Incidence (%)
Seka	Meti	2	20.8
	Atero Gafesa	4	18.2
	Shashamane	2	20
	Gibe Bosso	2	6.6
	Boyo kechema	4	9.6
	Kofe	8	18.5
	Sub total	22	15.6
Kersa	Tikur Balto	5	33.3
	Babo Sarte	3	11.6
	Merewa	3	20
	Bedabuna	3	15.6
	Sub total	14	20.1
Mana	Dewa	3	20.0
	Haro	2	0.0
	Bilida	4	1.3
	Sombo	7	12.0
	Eladale	4	17.6
	Doyotoli	5	20.6
	Doyobikila	6	27.4
	Sub total	31	14.1
	Total	67	

Source: JARC Crop Protection department, 2009.

Pineapple production and its constraints

Pineapple (*Annanas comosus* L.), a member of the family Bromeliaceae, is a perennial herb native to the American tropics. It is cultivated in all tropical and subtropical countries. The crop is one of the most important American fruits, and the third most important tropical fruit, after banana and mango (citrus fruits being produced mainly in subtropical areas) (Samson, 1986). Among the varied groups of pineapple produced in different areas, the "Cayenne group" has a wide acceptance on the world market, since they are suitable for fresh consumption in addition to their canning quality. Of the members of the Cayenne group grown worldwide, "Smooth Cayenne" is highly favoured whenever the production is targeting canning, as it is characterized with big fruits and suitable fruit shape (cylindrical) for industrial processing.

In Ethiopia, pineapple grows successfully around Gojeb, Jimma, Mizan, Bebeka, Teppi and Dilla areas. So far, yielding potential of some 50 tonnes/ha was recorded at the Gojeb state farm (IAR, 1996). Except in some areas like Dilla (Southern Ethiopia), where the Spanish type grows dominantly, the major pineapple cultivar produced in most parts of Ethiopia is Smooth Cayenne. Fruits of the Smooth Cayenne are distinguished by their yellow-orange colour, high juice content and sweet flavour.

Pine apple root rot caused by *phytoptora* was observed at Gojeb Horizon plc farm in 2010 (Table 5). Surveys conducted at Gojeb confirmed that pineapple root rot is widely distributed specially in smooth cayenne varieties as compared to Red Spanish.

Table 5. The mean percent infected pineapple plants in the field at Gojeb.

Variety	Source	Percent infected
Smooth cayenne	South Africa	14.4
Smooth cayenne	Kenya	16.91
Red Spanish	Local	4.85
Mean		12.05

Source: JARC Crop protection department, 2010.

Symptoms field observation and laboratory diagnosis

Infected plants at the early stage show chlorosis and yellowing of the leaves. The leaves slowly turn to brown and start dying back starting from the leaf tip which progress towards the main stem of the plant. Uprooting plants with such symptom revealed destruction of the root system beyond its capability to support the growing plant leading to death of the plant at advanced stage. Apparently healthy plants also indicate dry rotting of the root systems but struggling to survive due to drought tolerance of the crop. Most of the plants that suffered from such infection show poor/stunted growth. The fruits of infected plants fail to progress toward proper ripening and may become unmarketable. The newly introduced smooth cayenne was highly affected followed by local smooth cayenne. The damage on red Spanish was less as compared to the two varieties. The results of laboratory diagnosis indicated the existence of phytoptora and nematode.

Phytophthora is known to be a soil borne pathogen. The pathogen is also commonly aggravated by long periods of excessive soil moisture. It easily disperses by movement of symptom-free infected plants, irrigation water, infected soil, farm equipment and workers. *Phytophtora cinnamomi* has also more capabilities for survival as a saprophyte than most other *Phytophtora* species and is known to survive for as long as 6 years in moist soil. Hence; designing short and long term research strategy is very important for successful disease management and increasing avocado and pineapple production in South western Ethiopia.

Summary and Conclusions

The notorious nature of *Phytoptora* as pathogens probably lies on their capacity to cause diseases in broad range of hosts covering crop plants, ornamentals, and woody trees horticultural and forestry value. Additionally, *phytoptora* species are responsible for many pre- and post harvest problems of vegetables and fruits such as late blight of potatoes, brown rots of citrus and black pod of cocoa. Diseases caused by phytoptora species are widespread and found in a range of hosts with high socio, economic and environmental impacts. *P.cinnamomi* is a problem in the farming of species such as pine apple and avocado.

The results of Jimma Agricultural Research Centre laboratory confirm the avocado production in South west Ethiopia and Pineapple production at Gojeb farm is challenged by *Phytophthora* which could be the major problem of production of these important fruit crops.

Management of *phytoptora* disease is based on a number of principles such as avoiding infections through basic hygiene limiting susceptibility through drainage and irrigation, improving soil health, use of disease resistant germplasm. Management practices for the control of *Phytoptora* diseases vary and no complete management program can totally eradicate diseases caused by *phytoptora* species. Once an area is infested with *Phytoptora,* total eradication is difficult. While total eradication is not possible, well developed management plans can assist in restricting intensification and spread of known infestations and limits its spread to new sites. The field and laboratory experiment conducted for the management of avocado root rot (Canon injection,

mulching, application of compost and effective microorganism) reveals none of the treatments tested were effective as remedial treatments for trees already infected and showing moderate to severe Phytophthora symptoms (Demelash and Getachew, 2015). In short term program Fences around plantations, Disinfection at the entrance of the orchard, provision of drainage ditches for the prevention of flooding, compost application, growing of plants in drained medium and disinfection of soil mixture and thermal disinfection of seeds/ sucker/slips are urgently to be implemented to infected orchards. Strict quarantine activity especially for *phytoptora* is very imperative when introduction of avocado and pineapple is planned.

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