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Inventory and incidence of plant diseases affecting vegetables in selected areas in the Visayas and Mindanao

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ABSTRACT

The identification of different vegetable diseases in a particular area is key to managing them. An inventory of diseases affecting important vegetables was conducted in selected areas in the Visayas, and Mindanao. The vegetable diseases were documented in Leyte, Samar, Biliran, Bohol and Claveria Misamis Oriental. Disease surveys were conducted and samples were brought to the laboratory for diagnosis. Pathogenicity tests were conducted for uncommon diseases and PCR and nest PCR assays were done for suspected *Phytoplasma* diseases. The most common and major disease that affect vegetables in Eastern Visayas is bacterial wilt caused by *Ralstonia solanacearum* which attacked tomato, pepper, eggplant, bittergourd and was also detected in a wilt infected lettuce. Downy mildew is another which affected bittergourd and pechay. Cercospora diseases were found to commonly affect pepper, eggplant, tomato and bittergourd. *Phytophthora* diseases were common in tomato, eggplant, pepper and pechay. Fusarium wilt had affected tomato and pepper in Claveria Misamis Oriental, but not common in Eastern Visayas. Emerging diseases were recorded such as *Phytoplasma* and *Corynespora cassiicola* which affected tomato and bittergourd, bacterial canker, bacterial speck, target spot, Septoria leaf spot and pith necroses were also found affecting tomato. Information gained from the inventory informed the production of extension materials aimed at farmers and farm extension officers.

Keywords: Phytoplasma, tomato, ampalaya, eggplant, lettuce, pechay, sweet pepper, emerging diseases

INTRODUCTION

Plant diseases are a major contributor to agricultural production losses. Vegetable production, especially in Eastern Visayas, is greatly hampered by the the occurrence of plant diseases causing yield and economic losses. The accurate

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diagnosis and identification of specific diseases attacking vegetable crops are necessary for the formulation of right and accurate management strategies. Most farmers do not know what specific diseases are occurring on their farms, do not know the correct control measures to apply, and rely mostly on pesticides. A basic knowledge of what diseases are present in an area is a pre-requisite for identifying an effective disease management strategy.

De la Cueva et al, published the book "Pests and Diseases of Economically Important Crops in the Philippines" in 2015. Similarly Tangonan & Quebral (1992) and Tangonan (1999) published the "Host index of plant diseases in the Philippines" (1992 & 1999 edition), but not all diseases of tomato, eggplant, pepper, bittergourd, pechay and lettuce were included in these publications.

New diseases emerge from time to time and they need to be monitored and identified to prevent them from causing epidemics. In this inventory, the major and emerging diseases of vegetables are identified. Identification of the causal organisms of diseases effecting vegetables and information on disease control measures is useful for vegetable researchers, agricultural technicians, disease management specialists and the vegetable farmers themselves.

MATERIALS AND METHODS

Areas and Period When Vegetable Diseases Where Sampled

Most of the diseases that are included in this paper were documented from the island of Leyte in Eastern Visayas, with some from the vegetable areas of Samar and Biliran islands and a few samples were also collected from collaborating sites of the ACIAR-ICM project, ie, Bilar, Pilar and Jagna in Bohol, Claveria, Misamis Oriental and Pamuhatan, Marilog, Davao City. The disease inventory was carried out between July 2013 - June 2017. A few diseases, identified in an earlier project (2010-2012) have been included in this paper.

Disease Collection and Pathogen Identification

Disease specimens were collected and brought back to the laboratory for clinical examination of the signs of pathogens. Symptoms were characterised, described and recorded. The associated pathogens were also documented and described. For common diseases, the associated microorganisms were identified using taxonomic keys, available printed references and the internet. Pathogen isolations and pathogenicity tests were conducted for uncommon diseases. Tomato, eggplant, bittergourd, pepper and pechay seedlings were maintained in the screenhouse for pathogenicity testing.

Molecular detection of Phytoplasma diseases were also conducted using the polymerase chain reaction (PCR) and nest PCR. DNAs were extracted from samples of suspected phytoplasma diseases and subjected to initial PCR using universal phytoplasma primer P1/P7 (Deng & Hiruki 1991) then nest PCR using $R_{16}F_2n/R_{16}R_2$ primers (Lee et al 1995). Immuno-diagnostic strips from AGDIA and Pocket Diagnostics were used to detect viruses such as cucumber mosaic virus (CMV), and tomato spotted wilt virus (TSWV) and tobacco mosaic virus (TMV) and bacteria particularly, *Clavibacter michiganensis subsp. michiganensis* and *Ralstonia solanacearum*.

RESULTS AND DISCUSSION

The different diseases that had been monitored from tomato, the places where they were collected, and causal organism identified are shown in Table 1. Six tomato diseases were caused by prokaryotic microorganisms, namely bacterial wilt, bacterial spot, bacterial canker, bacterial speck, pith necrosis and tomato stunt/little leaf disease which was caused by *Phytoplasma*. Bacterial wilt was very common and is a major problem in Eastern Visayas. Bacterial spot was also common, particularly during rainy months. Tomato showing bacterial leaf spots were once thought only to be caused by *Xanthomomonas axonopodis pv. vesicatoria*, but recent pathogenicity tests and diagnostic study show that smaller spots that do not reach more than 2mm diameter is actually bacterial speck which is caused by *Pseudomonas syringae pv. tomato*. Bacterial canker, an emerging disease was monitored only in Cabintan, in the highlands of Ormoc City and San Isidro, Leyte. Bacterial pith necrosis which is also an emerging disease was monitored in Panan-awan Maasin City and Sogod, Southern Leyte. It was once thought to be caused by *Ralstonia solanacearum* until this paper. Pith necrosis causes a hollow stem in tomato which is not seen in bacterial wilt. Tomato stunt little leaf was only collected from one farm in Gabas, Baybay City and was confirmed to be due to *Phytoplasma* through PCR and nest PCR analysis.

Table 1. Diseases of tomatoes, symptom description and causal organism

Disease due to Prokaryotes (True Bacteria & Mollicutes)		
Disease	Description/Symptoms	Causal Organism
Bacterial Wilt (major disease & commonly found in Eastern Visayas)	Plants wilt, internal stem turns brown, adventitious roots form on stems, spread in contaminated water and soil.	*Ralstonia solanacearum/ Ralstonia pseudosolanacearum*
Bacterial Spot (major, common during wet season)	Symptoms begin as small, angular or round lesions on young leaves and become dark and water-soaked and sometimes with a yellow halo. Infected green fruit also have small water-soaked spots. Severe infections cause premature yellowing and early senescence of plants. Spread with infected seed and contaminated water and soil.	*Xanthomonas axonopodis pv. vesicatoria (syn. Xanthomonas campestris pv. vesicatoria)*
Bacterial Canker (emerging, occasional Figure 1a-1b)	Scorched or "firing" spots/markings on leaflets and wilting of lower leaves; infection may advance to vascular system resulting to plant collapse; brown raised cankers on fruit which may have pale halos called "bird's eye spots".	*Clavibacter michigenensis sub* sp. *michiganensis*
Pith Necrosis (occasional Figure 1c)	Small pinpoint water-soaked spots appear on the stems that enlarge; stem becomes hollow with a rot in the center and sometimes crack. Spread in water and by handling plant. Bacteria enter through wounds. Disease is favoured by too much nitrogen fertiliser.	*Pseudomonas* sp.

Table 1 continued

Diseases due to Prokaryotes (True Bacteria & Mollicutes)		
Disease	Description/Symptoms	Causal Organism
Tomato Stunt/Little Leaf (emerging but rare Figure1d)	Leaves are small, curled upwards and yellowish-green or purple. Interveinal chlorosis seen on young leaves. Leaves along midrib do not expand properly. General stunting of the plant. Blooms fail to set in more severely affected plant	*Phytoplasma (*Mollicutes)
Bacterial Speck (occasional Figure 1e-f)	Necrotic spots/specks with not more than 2mm in diameter and initiation of marginal necrosis wherein yellowing of the leaf margin can be observed.	*Pseudomonas syringae pv.tomato*
Diseases due to Fungi and Fungal-Like Organisms		
Seedling Damping-off (major but occasional. common in unsterilized potting mix)	Patches of young plants wilt and die. Lower stems become thin and watery. Root systems turn brown and rot. Spread in contaminated water and soil, and with some flies.	*Pythium, Phytophthora, Fusarium*, *Rhizoctonia* spp.
Fusarium wilt Fusarium Crown and Root Rot (major fusarium wilt common in Claveria. Fusarium crown rot monitored in Leyte)	Older leaves turn yellow then dry out. Plants wilt and die. When cut open vascular tissue inside stems is brown. This may extend up to the flower stalks. For crown and root rot, there is brown discoloration of the base of basal part and rotting of the stem. Spread by spores that survive for years in contaminated soil.	*Fusarium oxysporum f.* sp. *lycopersici/ Fusarium oxysporum f.* sp. *radices lycopersici*
Sclerotium Wilt /Southern Blight (minor but prevalent)	Stunted plants will wilt and die. Dense white threads of fungal growth develops around the rotting stem base. Smooth white-brown spherical structures (~1-3mm in diameter) develop in this fungal growth.	*Sclerotium rolfsii*
Late Blight/Fruit rot (major, occasional common in humid climate)	Dark brown lesions develop on stems and fruit causing plant to wilt and die. White mycelia may cover dark lesions during humid weather. Spread by air-borne and water-borne spores.	*Phytophthora infestans*- cause both late blight and fruit rot-*Phytophthora capsici* –commonly cause fruit rot
Leaf Mold (major, common)	Light yellowish/brownish blotches appear on the upper leaf surface with furry brown fungal growth on the underside. Affected older leaves wither which may cause the entire plant to die. Spread by air-borne spores	*Pseudocercospora fuligena*
Powdery Mildew (major, occasional)	Pale spots first appear on the upper leaf surface. White powdery fungal growth develops on both sides of leaves. Leaves gradually turn yellow, die, and fall off, which can expose fruit to sunburn. Spread by air-borne spores.	*Oidium neolycopersici*

Table 1 continued

Disease due to Fungi and Fungal-Like Organisms		
Disease	Description/Symptoms	Causal Organism
Target Spot and early blight (target spot is emerging Early bight is common in the highlands Figure 1g)	Symptoms of these two diseases are similar and may be misdiagnosed. Lesions start as small pinpoint water-soaked frequently ringed spots on the upper surface which later turn brown and increasing in size. In early blight, however, lesions with rings are usually surrounded by yellow halo and may coalesce forming blighted leaves leading to premature defoliation. In the earlier stages, may be confused with bacterial spot. Brown Lesions may form on stems.	*Target spot* – caused by *Corynespora cassiicola* *Early Blight* – caused by *Alternaria tomatophila*
Septoria Leaf Spot (minor, common in highlands Figure 1h)	Small dark circular spots (~1-3mm) appear on older leaves and stems. These enlarge to 6 mm, turn greyish with dark fungal structures in their center. Spread with seed, and by air and water-borne spores.	*Septoria lycopersici*
Anthracnose (minor, occasional)	Small sunken water soaked circular spots on fruit which later become darker than the surrounding tissue. The spots later become depressed and develop concentric markings. Mainly affects ripe fruit.	*Colletotrichum coccodes*
Diseases due to Virus		
Tomato yellow leaf curl virus (major, occasional but common in certain areas)	Plants are stunted, young leaves yellow and curl. Spread by whitefly (*Bemisia tabaci*).	Tomato yellow leaf curl virus (TYLCV)
Tomato mosaic (major, occasional)	Leaves have patches of yellow or white marks. Growth can become twisted and young shoots stunted. Some virus strains cause dark marks to form inside the walls of fruit. Spread by handling plants and in contaminated soil where susceptible plants were previously grown.	*Tobacco mosaic virus* (TMV)
Tomato mosaic (major, common)	Plants are stunted with distorted and twisted young growth. Leaves have pale green and dark green areas. Leaves can have 'shoestring' appearance. Spread with infected seed and by aphids	*Cucumber mosaic virus* (CMV)
Tomato Spotted Wilt (occasional)	Plants are stunted and may wilt and die. Leaves have black streaks and ring markings. Fruit have yellow or dark blotches, often forming concentric rings. Spread by thrips.	Tomato spotted wilt virus (TSWV)

Table 1 continued

Nematode Diseases		
Root Knot (major, common)	Plants are stunted and may wilt during the day. Galls form on roots.	*Meloidogyne incognita* and other *Meloidogyne* species
Other Nematodes	Stunting of plants	*Rotylenchulus* sp. *Hemicyciophora* *Helicotylenchus* *Xiphinema*

Two fusarium diseases were monitored in tomato: fusarium wilt caused by *Fusarium oxysporum s.sp.lycopersici* which was common in Claveria, Misamis Oriental, and fusarium crown and root rot caused by *Fusarium oxysporum f.* sp. *radices lycoprsici* which was monitored at VSU, Baybay City in Leyte. Sclerotium wilt/Southern Blight was a common problem of tomato in Eastern Visayas. Two *Phytophthora* species were found infecting tomato: *Phytophthora infestans* causing late blight and fruit rot, and *Phytophthora capsici* which commonly caused fruit rot but not much blighting of shoots.

Five other diseases were caused by fungi namely: damping off which was caused by either *Pythium, Phytophthora, Fusarium* or *Rhizoctonia* spp., Sclerotium wilt or southern blight caused by *Sclerotium rolfsii,* leaf mold caused by *Pseudocercospora fuligena,* anthracnose caused by *Colletotrichum coccodes*, Septoria leaf spot caused by *Septoria lycopersici* and target spot caused by *Corynespora cassiicola*. Three virus diseases were identified: cucumber mosaic virus (CMV), tobacco and tomato mosaic virus caused by TMV and tomato spotted wilt virus (TSWV). Five nematodes were monitored at the Experimental site of the Visayas State University: *Meloidogyne incognita, Rotylenchulus*, *Hemicycliophora* sp, *Helicotylenchus* and *Xiphinema*.

Among the diseases of tomato, five are considered emerging because there are no previous published reports of them in the Philippines. They are: bacterial canker (Figure 1a-b), pith necrosis (Figure 1c), tomato stunt Phytoplasma (Figure 1d), bacterial speck (Figure 1e-f), target spot (Figure 1g) and Septoria leaf spot (Figure 1h). In terms of disease incidence, bacterial wilt, bacterial spot and leaf mould were the most prevalent in Eastern Visayas affecting tomato in different areas. Late blight and fruit rot caused by *Phytophthohra infestans* and *Phytophthora capsici,* respectively also occurred at high incidence, in a few of the sampled areas.

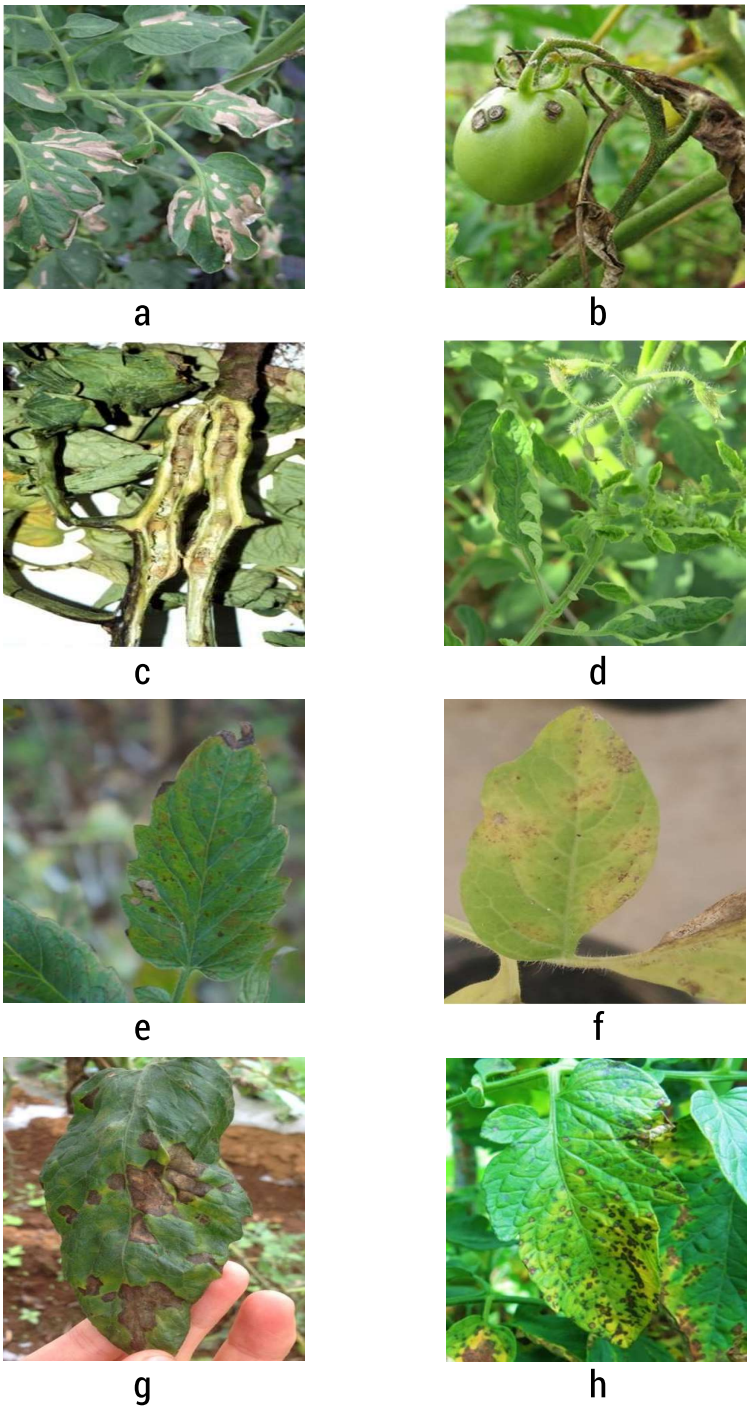

Figure 1. Identified emerging diseases of tomato: a-b) bacterial canker, c) pith necrosis, d) tomato stunt/little leaf, e-f) bacterial speck, g) target spot and h) Septoria leaf spot

Two bacterial diseases (bacterial wilt & bacterial spot), nine fungal diseases (damping off, fusarium wilt, sclerotium wilt, anthracnose, cercospora leaf spot, powdery mildew, basal stem rot, Choanephora blight & sooty mold) and three viruses were monitored from pepper (Table 2). The most wide-spread disease of pepper is Cercospora leaf spot or "frogeye spot" occurring in almost all areas sampled. Bacterial wilt is also common and is a major problem in sweet pepper production, particularly in Eastern Visayas. Fusarium wilt was common in Claveria Misamis Oriental. Powdery mildew was recorded in just two areas, ie, in Cabintan, Ormoc and at the VSU experimental site. Anthracnose, caused by different *Colletotrichum* species, was commonly infecting sweet pepper fruit. Sooty mold was commonly found in pepper grown under protective cultivation. Although not directly infecting sweet pepper, it covers the leaf surfaces and can reduce photosynthesis. Choanephora blight, caused by *Choanaephora cucurbitarum* and powdery mildew caused by *Leveillula taurica* are previously unreported in Eastern Visayas (Figure 2).

Table 2. Diseases of peppers, symptom description and causal organism

Diseases due to Bacteria and Mollicutes		
	Description/Symptoms	Causal Organism
Bacterial Wilt (major disease and commonly found in Eastern Visayas)	Sudden wilting of the foliage and the whole plant, internal vascular darkening of root and stem that leads to stem damage and death of the affected plant.	*Ralstonia solanacearum/ Ralstonia pseudosolanace arum*
Bacterial Spot (major, common during wet season)	Small, angular or round lesions on leaves and fruit. Spots become dark and water-soaked and sometimes with a yellow halo. Severe infections cause premature yellowing and early senescence of plants. Bacteria are seed borne and spread with water.	*Xanthomonas euvesicatoria,*
Diseases due to Fungi and Fungal -like Organisms		
Seedling Damping-off (major but occasional. Common in unsterilized potting mix)	Seeds rot before emergence of stem of seedlings at ground level brown, thin and plants fall over. Root systems turn brown and rot. Spread in contaminated water and soil, and with some flies.	*Pythium*, *Fusarium*, Sclerotium, *Phytophthora,* or *Rhizoctonia* spp.
Fusarium wilt (major, common in Claveria, Misamis Oriental)	Initial yellowing of the foliage which starts at the lower leaves, loss of turgidity and wilting of the whole plant. Internal browning of the stem.	*Fusarium oxysporum f* sp. *lycopersici*
Sclerotium Wilt /Southern Blight (major, occasional)	Rotting of the base and wilting of the plant. Whitish mycelia and tiny round white to brown sclerotial bodies are found at the base near the soil line.	*Sclerotium rolfsii*
Cercospora Leaf Spot/Frog-eye spot (major, common)	Leaf lesions with a dark margin. The centre can drop out leaving a hole in the leaf. Can also affect stems. Spread by air-borne spores and favoured by wet conditions.	*Cercospora capsici*

Table 2 continued

Disease due to Fungi and Fungal-Like Organisms		
	Description/Symptoms	Causal Organism
Anthracnose (major, common)	Sunken soft lesions on fruit, with pink fungal spores in the centre. Fruit rot as they ripen in wet conditions. Spores spread by water splash.	*Colletotrichum* spp. *(C. gloeosporioides, C. capsici, C. acutatum, and C. coccodes)*
Powdery Mildew (major, occasional: Figure 2a & 2b)	Powdery white appearance on older leaves, especially during warm humid nights. Severely affected leaves yellow and fall. Spread by air-borne spores and favoured by shaded conditions.	*Leveillula taurica*
Basal Stem Rot (major, occasional)	Darkening and girdling of the basal part of the stem and roots leading to wilting of the above ground parts of the plant base, with or without mycelial and sclerotial bodies	*Phytophthora, Sclerotium rolfsii, Rhizoctonia solani*
Choanephora Blight (minor, rare: Figure 2c & 2d)	Water-soaked leaf lesions appear on the leaves, blighting margins and leaf tips. Stiff, silvery mass of hairy strands grow out of the affected leaf tissue, topped with a black ball. Spread by air borne spores.	*Choanephora cucurbitarum*
Sooty Mold (minor, common in crops grown under protected cultivation)	Velvety grey-black, fungal coating on the leaf which is not pathogenic to plants but obtains its nourishment from honeydews secreted by small sucking insect pests like aphids, soft scales and mealy bugs. The mould cover reduces the plant's photosynthetic ability and leaves may fall prematurely	*Meliola sp, Capnodium* sp.
Diseases due to Virus		
Mosaic/Mottle (major, occasional)	Plants are stunted. Leaves and fruit are mottled and become misshapen. CMV is spread by aphids. TSWV is spread by thrips. PPMV is mechanically transmitted	Cucumber mosaic virus (CMV) Tomato spotted wilt virus (TSWV), Pepper Mild Mottle Virus (PPMV)

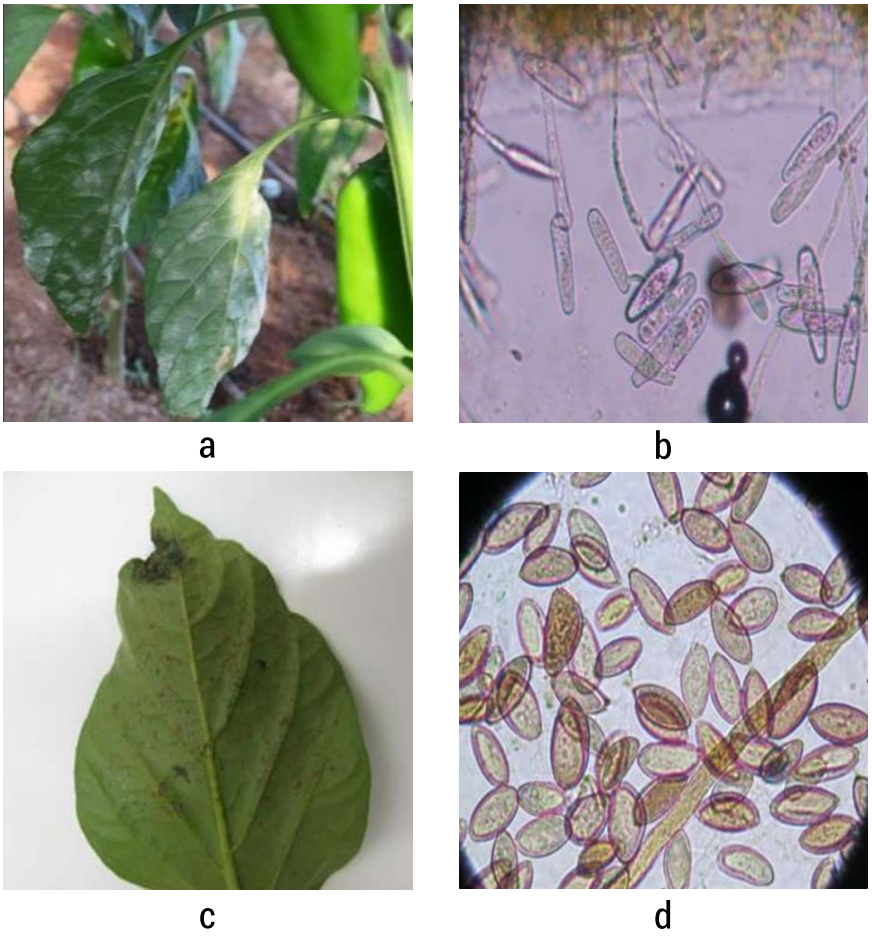

Figure 2. Powdery mildew diseases (a) Leveillula taurica (b), Choanephora blight (c) and the causal pathogen, Choanephora cucurbitarum (d)

In bittergourd, two diseases due to prokaryotes were monitored: bacterial wilt caused by *Ralstonia solanacearum* and little leaf/witches broom caused by *Phytoplasma* (Table 3). Six diseases were caused by fungi while only one virus disease was monitored. The most prevalent disease in Eastern Visayas is downy mildew caused by *Pseudoperonospora cubensis* which could be attributed to the wet climate. Bacterial wilt and "namamarako disease" were also common. Two diseases are considered emerging, little leaf/witches broom (Figure 3a-3b) and target spot caused by *Corynespora cassiicola* (Figure 3c & 3d). Bittergourd witches broom in Myanmar was reported to be caused by *Candidatus Phytoplasma asteris* (Win et al 2014). Furthermore, bacterial wilt of bittergourd was caused by *Ralstonia solanacearum* and not *Erwinia tracheiphila* as has been commonly reported as the cause of bacterial wilt of cucurbits in most references.

Table 3. Diseases of bittergourd, symptom description and causal organism

	Description/Symptoms	Causal Organism
Diseases due to Bacteria and Mollicutes		
Bacterial Wilt (major, common)	Plants wilt. Internal stem turns brown. Roots form on lower stem. Spread in contaminated water and soil.	*Ralstonia solanacearum/ Ralstonia pseudosolanacearum*
Little leaf/Witches Broom (emerging, getting more common: Figure 3a & 3b)	Small, thickened, yellowish green puckered leaves, the internodes thicken and shorten leading to a witches broom appearance, little and elongated fruits, flowers may show phyllody symptoms. Flowers are reduced in size, does not fully open at maturity and finally wither within a few days. Transmitted by leafhoppers, particularly *Ricania speculum* and a cicadellid leafhopper.	*Phytoplasma*
Diseases due to Fungi and Fungal-Like Organisms		
Seedling Damping-off (major, occasional)	Basal part of the stem becomes water-soaked and rotten which cause the seedling to damp-off. Affected area may be covered with mass of fungal growth. In pre-emergence damping-off, seeds are rotten and fail to germinate.	*Pythium, Phytophthora, Sclerotium, Rhizoctonia*
Downy Mildew (major and common in wet climate)	Yellow irregular patches on the foliage which may become necrotic and turn brownish. Whitish moulds may be seen present on lower leaf surface.	*Pseudoperonospora cubensis*
Fusarium wilt (major occasional)	Yellowing of leaves, initially from base of plant followed by wilting and death of the entire plant. Vascular bundles in the collar region becomes brown or yellowish.	*Fusarium oxysporum* f. sp. *momordicae*
Cercosora leafspot (major, occasional Common)	Small circular to irregular chlorotic spots with yellow halo around. White to light tan in the center with darker brown margin. The leaves may turn yellow and fall off.	*Cercospora citrullina*
Target spot (emerging, occasional: Figure 3c & 3d)	Lesions start as small pinpoint water-soaked spots on the upper surface which later turn brown and increasing in size. Lesions with concentric rings are usually surrounded by yellow halo which coalesce to form blighted leaves leading to premature defoliation. Target-like spots brown necrotic spots on leaves.	*Corynespora cassiicola*

Table 3 continued

	Description/Symptoms	Causal Organism
Disease due to Bacteria and Mollicutes		
Basal stem rot (major, occasional)	Loss of vigor, wilting leading to death of affected plants. Rotting of the stem which particularly start at the base, with the formation of a dense white mycelium which later turn into smooth spherical structures measuring ~1-3mm in diameter which start as which, then light brown and later dark brown structures called sclerotia.	*Sclerotium rolfsii, Rhizoctonia solani*
Diseases due to Virus		
"Namamarako Disease" (major, occasional)	Leaves thicken and wrinkled, sometimes leaf turn yellowish Vein banding and stunted plants. Produce male flowers or no flowers. Shiny and plastic-like appearance of leaves.	Cucurbit Aphid-Borne Yellows Virus (CABYV)

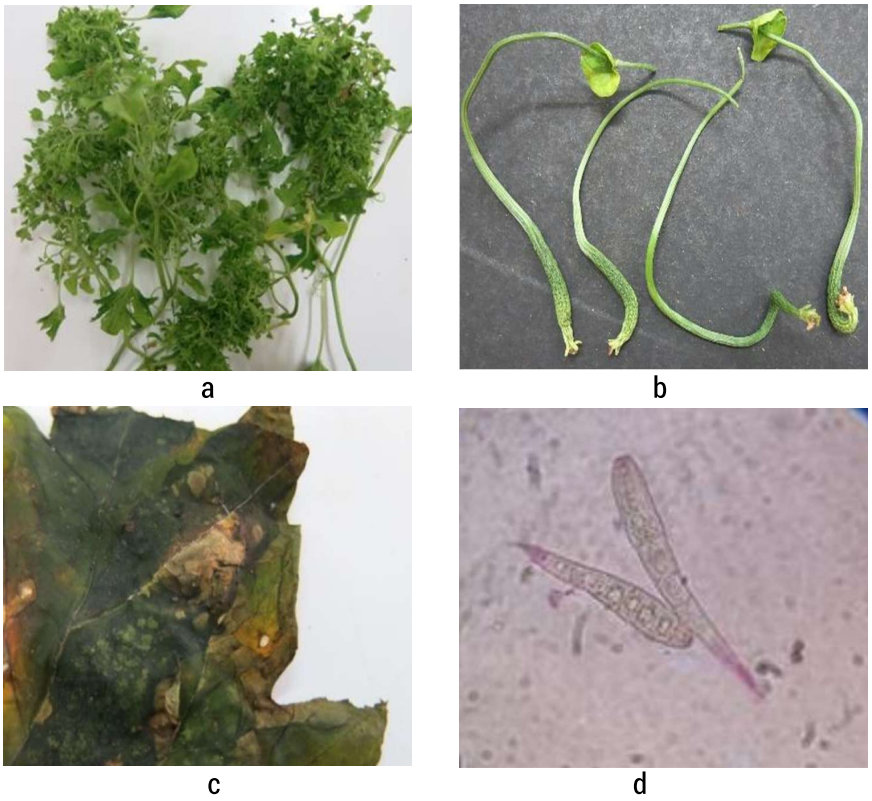

Figure 3. Emerging diseases of bittergourd, a-b) little leaf/witches broom caused by Phytoplasma and c-d) target spot caused by *Corynespora cassiicola*

In eggplant, bacterial wilt was the only disease found to be caused by bacterium (Table 4). A yellow's type disease, which was suspected to be due to *Phytoplasma* was monitored but the causal organism was not confirmed through PCR analysis. Eight fungal diseases were found in eggplant: Fusarium wilt, Sclerotium wilt, Cercospora leaf spot, Phomopsis blight, Phytophthora blight and fruit rot, powdery mildew, basal stem rot and Choanephora blight (Figure 4). The latter disease is previously unreported in the published literature for eggplant in the Philippines, hence considered emerging. Two species of *Phytophthora,* confirmed through PCR analysis, were found on eggplant: *Phytophtohra nicotianae* and *Phytophthora parasitica*.

Table 4. Diseases of eggplant, symptom description and causal organism

Diseases due to Bacteria and Mollicutes		
	Description/Symptoms	Causal Organism
Bacterial Wilt (major, common)	Sudden wilting of plant, plant can die, root system/stem damaged, dead, internal symptoms include brown discoloration of the vascular vessels	*Ralstonia solanacearum/ Ralstonia pseudosolanace arum*
Diseases due to Fungi and Fungal-Like Organisms		
Fusarium wilt (major, occasional)	Starts with yellowing of the lower leaves and wilting of the plant with brownish internal vascular discoloration.	*Fusarium oxysporum* f.sp. *melongenae*
Sclerotium Wilt/Stem Rot (major, occasional)	Wilting of the shoot, whitish mycelial mat can be seen at the base, going up to the stem of the plant, initial whitish round sclerotial bodies form which later turn brown	*Sclerotium rolfsii*
Cercospora leafspot (minor, occasional)	Small, circular to oval chlorotic spots with light to dark tan centers with dark spots that can be observed with a hand lens or dissecting microscope.	*Cercospora melongenae*
Phomopsis Blight/Fruit Rot (minor occasional)	Grey to brown lesions on fruit and may coalesce. Later develops as soft, spongy rot with concentric patterns and dark structures on the fruit surface. Yellowing of leaves is evident and drops prematurely.	*Phomopsis vexans*
Phytophthora Blight and Fruit Rot (major, common in wet climate)	The roots and crowns turn brown and rot causing plants to wilt. Infected fruits initially develop dark, water-soaked patches that become coated with fluffy white mycelia. Fruits may wither but remain attached to the plant. fruit rot	*Phytophthora nicotianae and Phytophtora parasitica*
Powdery Mildew (minor occasional)	Small irregular, whitish, powdery molds appear on upper and lower leaf surfaces, which start at the older leaves. Affected leaves eventually turn yellow and necrotic	*Erysiphe cichoracearum*

Table 4 continued

Diseases due to Fungi and and Fungal-Like Organisms		
	Description/Symptoms	Causal Organism
Basal stem rot (major, occasional)	Loss of vigor, wilting leading to death of affected plants. Rotting of the stem which particularly start at the base, with the information of a dense white mycelium which later turn into smooth spherical structures measuring ~1-3mm in diameter which start as which, then light brown and later dark brown structures called sclerotia.	*Sclerotium rolfsii, Rhizoctonia solani*
Choanephora Blight/Fruit Rot (minor, occasional: Figure 4)	Starts with yellowed patches on leaves which becomes blighted. In severe cases, blighting of the entire shoot may occur and which may also affect the fruits that appear rotten with mass of greyish fungal growth.	*Choanephora cucurbitarum*

Figure 4.Choanephora blight of eggplant

In pechay, one bacterial disease (soft rot) and five fungal diseases were monitored (Table 5). The fungal diseases were: damping off, Sclerotium wilt, basal stem rot caused by *Phytophthora* sp. downy mildew by Peronospora parasitica (Figure 5a), the causal organism (Figure 5b), leaf spot caused by *Curvularia lunata* (Figure 5c) land *Choanephora* blight caused by *C. cucurbitarum* (Figure 5d).

Table 5. Diseases of pechay, symptom description and causal organism

Diseases due to Fungi and Fungal-Like Organisms		
	Description/Symptoms	Causal Organism
Soft rot (major, common)	Bacterial soft rots cause water-soaked spots which eventually enlarge over time and become sunken and soft. A plant tissues breakdown and die they give off a strong odour.	*Pectobacterium carotovorum pv. carotovorum*
Damping Off	At seedling stage, stem at ground level becomes thin, brown and plants fall over. Root system becomes brown	*Pythium* spp, *Phytopthora*, *Sclerotium rolfsii* and *Rhizoctonia solani*
Sclerotium Wilt/Southern Blight (major, occasional)	Loss of vigor, wilting leading to death of affected plants. Rotting of the stem which particularly start at the base, with the formation of a dense white mycelium which later turn into smooth spherical structures measuring ~1-3mm in diameter which start as which, then light brown and later dark brown structures called sclerotia.	*Sclerotium rolfsii*
Basal stem rot (major, common in wet climate)	Rotting of the base and stem and blighting of leaves, shoots and the whole plant. White mycelial growth on the surface is present especially in very humid conditions. Plants under moist conditions become weak and die eventually.	*Phytophthora* sp.
Leaf spot (minor, occasional)	Light brown spot on leaves. Spots coalesce to form blighted areas	*Curvularia lunata*
Downy Mildew (major, occasional)	Yellow spots on leaves, turning brown. Grey mould present on lower leaf surface. Especially problem during rainy season	*Peronospora parasitica*

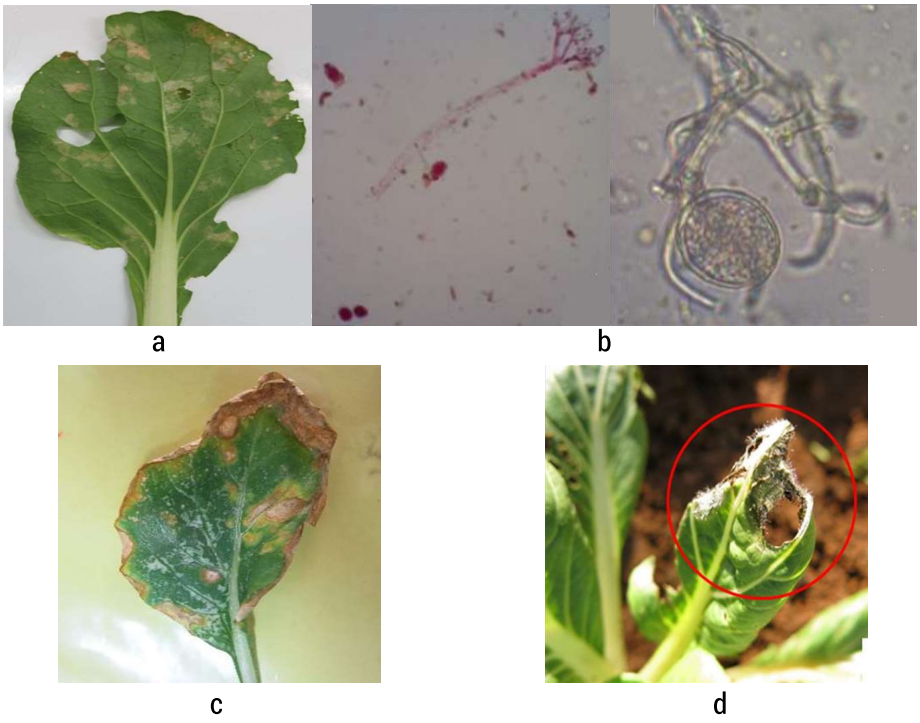

Figure 5. Diseases of pechay which are unreported particularly in Eastern Visayas Philippines (a) Downy mildew and (b) Peronospora parasitica the causal organism (c) Curvularia leaf spot and (d) Choanephora blight

In lettuce, a wilt disease was observed infecting the crop at the VSU experimental site where bacterial population is high . The disease was confirmed to be caused by *Ralstonia solanacearum* using an AGDIA immunodiagnostic strip. This wilt disease is considered emerging given that bacterial wilt has not been reported to infect lettuce in the Philippines.

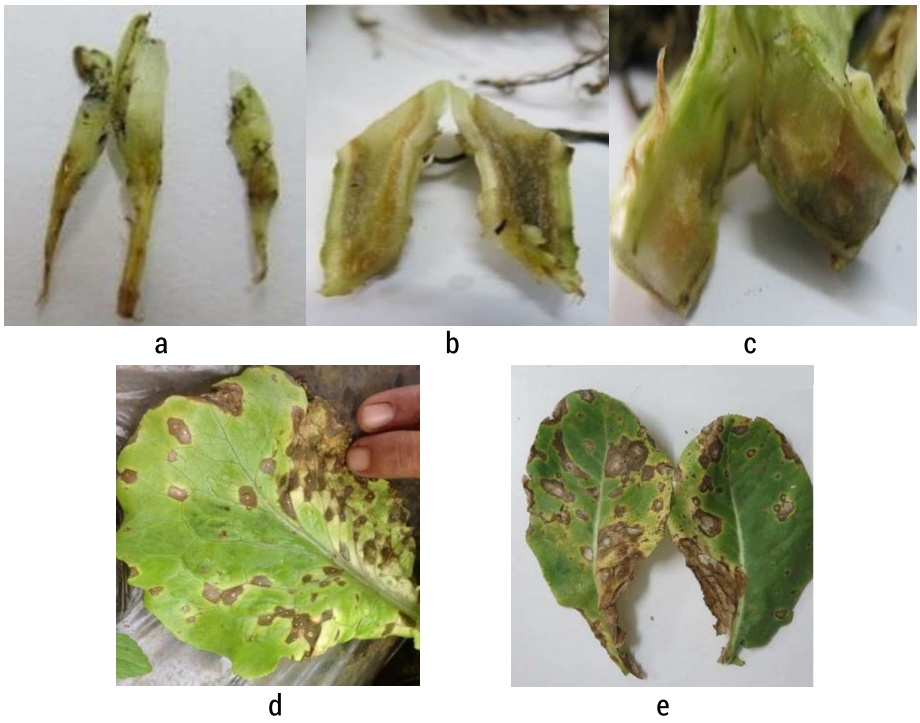

Figure 6. Wilt disease of lettuce with internal vascular discoloration diagnosed to be caused by *Ralstonia solanacearum* detected using an immunodiagnostic strip (Figure 6a-6c), and target spot caused by *Corynespora cassiicola*

Table 6. Inventoried diseases of lettuce, symptom description and causal organism

Diseases due to Bacteria		
	Description/Symptoms	Causal Organism
Bacterial Wilt (emerging, rare)	Lettuce plant showing browning of the basal part and internal vascular tissues. Bacterial ooze coming out from the symptomatic stem and positive result on *Ralstonia solanacearum* immunodiagnostic strip.	*Ralstonia solanacearum/*
Diseases due to Fungi and Fungal-Like Organisms		
Target Spot (emerging, occasional)	Brown to dark brown target-like spots on affected leaves of lettuce with light and dark concentric rings, circular to irregular, and 5–15mm in diameter. Small spots may increase in size, coalesce and may to blight of affected leaves	*Corynespora casiicola*
Sclerotium Wilt/Rot major, occasional	Rotting of leaves tissues that starts from the base with formation of visible white mycelia and sclerotial bodies which later turn brown	*Sclerotium rolfsii*

A catalog of vegetable diseases in Eastern Visayas was drafted as well as disease bulletins and factsheets, and translated into Cebuano and Waray-waray with disease management recommendations provided. These will guide farmers, and field technicians on how to manage these diseases.

CONCLUSION

The different diseases affecting tomato, pepper, eggplant, bittergourd, pechay and lettuce were documented, the causal organisms were identified and the major and emerging ones were also identified. This paper confirms that a wide variety of diseases affect vegetables and that new diseases are constantly emerging or vary in incidence from year to year, such that an inventory of diseases needs to be made from time to time to prevent possible outbreaks in the future.

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