

Healthy Hydroponics Health+ Report

Healthy Hydroponics eDNA monitoring

Questions? contact info@healthyhydroponics.ca

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Introduction

The Health+ report aims to provide pathogen and beneficial detection through environmental DNA (eDNA) sequencing. Sequencing allows us to simultaneously screen for many hundreds of pathogens, potential pathogens (e.g., opportunistic), and beneficial organisms in a mixed sample. The pathogens screened and the sensitivity of Health+ are discussed in [Appendix 2. F.A.Q.](#)

Beneficial organisms

Plant growth promoting bacteria (PGPB) and fungi (PGPF) are organisms that have the potential to enhance plant growth through mitigating biotic and abiotic stress, aiding nutrient availability and uptake, and defending the plant against diseases, pests, or competition.

The Healthy Hydroponics Beneficials Scan is a sequence-based screen of eDNA for organisms commonly recognized to promote plant growth.

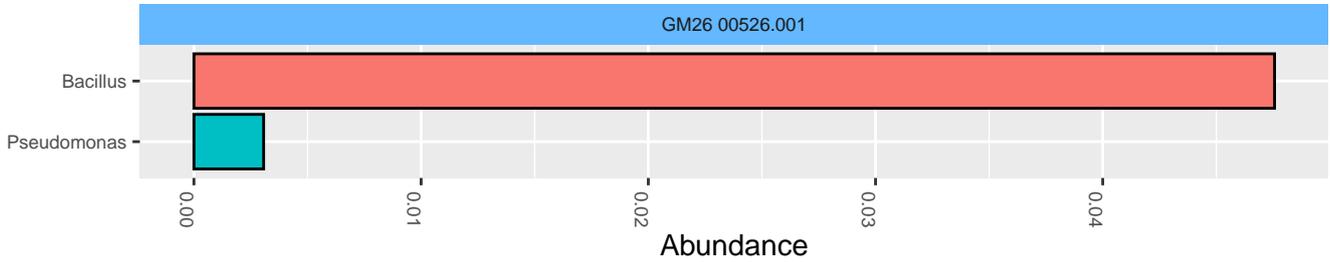
Bacteria

Potential pathogens

No significant pathogen hits

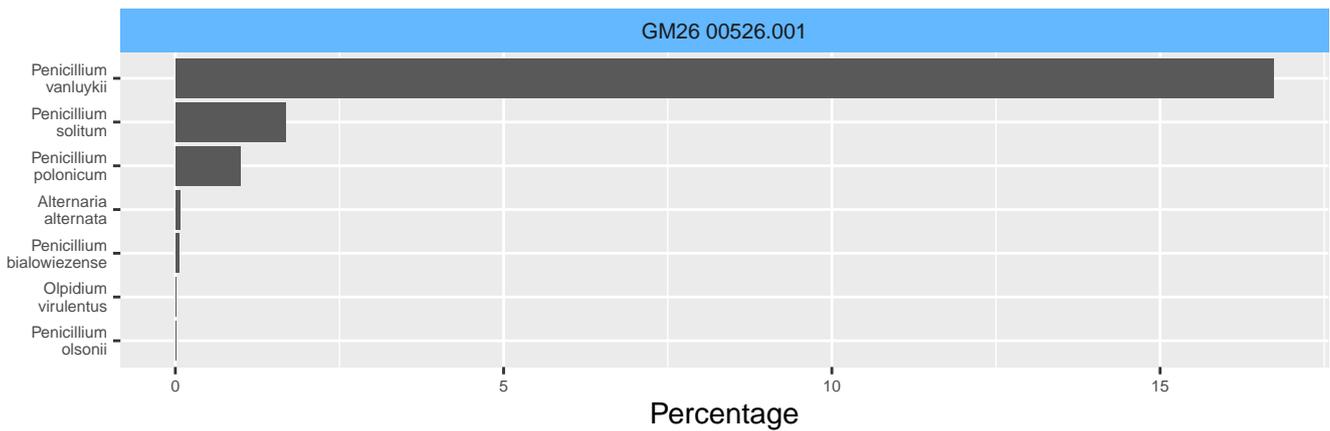
Plant Growth Promoting Bacteria (PGPB)

A wide diversity of bacterial species have potential plant beneficial functions. Here, we visualize the distribution of common plant beneficials. Note that the group of closely related organisms, Allorhizobium-Neorhizobium-Pararhizobium-Rhizobium, is labeled as the A-N-P-R Group.



Fungi and water molds

Potential pathogens



Plant Growth Promoting Fungi (PGPF)

Plant growth promoting fungi (PGPF) promote plant growth in many of the same ways as some bacteria, including increasing nutrient availability, mitigating stress, and stimulating growth. Some fungi can also form significant symbioses, such as the Arbuscular mycorrhizal fungi (AMF), which help plants access nutrients and water.

Arbuscular mycorrhizal fungi (AMF)

Arbuscular mycorrhizal fungi (AMF) are a type of fungal symbiont that forms a mutualistic relationship with the roots of most plants. In this symbiosis the fungus forms structures within the plant roots that help the plant capture nutrients and micronutrients from the soil.

- **No arbuscular mycorrhizal fungi (AMF) observed.**

General beneficial fungi (strong evidence)

Some fungi have clear supporting evidence for plant growth promotion, such as *Aspergillus flavus* or *Trichoderma harzianum*.

- **No strong beneficial fungi observed.**

General beneficial fungi (other)

Fungi have complex biochemistry and in some situations can directly or indirectly promote plant growth. Here the data is screened for fungi that have conditional or moderate evidence for plant growth promotion.

- **No general beneficial fungi observed.**

General Microbiome Analysis

Presented below are the top 20 Species by average count in the sample to provide a snapshot of the general microbiome composition of your sample(s). Please contact us at info@healthyhydroponics.ca if you are interested in further microbiome analysis.

Composition, Bacteria and Archaea (top 20 species overall)

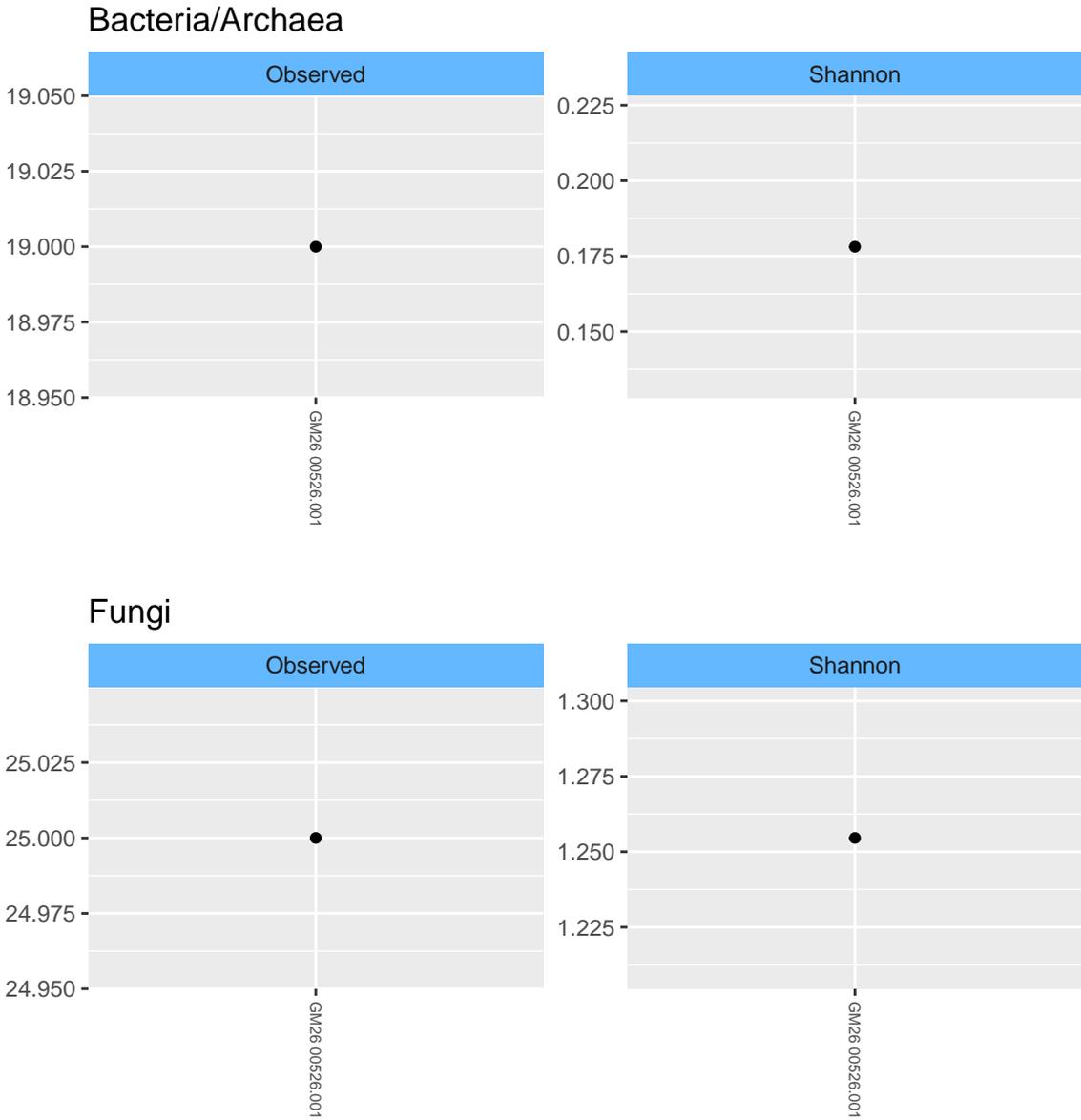
GM26 00526.001	Genus	Species
97.14	Staphylococcus	equorum
1.26	Staphylococcus	equorum
0.58	Staphylococcus	NA
0.40	Romboutsia	ilealis
0.26	Staphylococcus	NA
0.13	Aerococcus	urinaeequi
0.06	Turicibacter	NA
0.05	Bacillus	NA
0.03	Romboutsia	NA
0.02	Ligilactobacillus	NA
0.02	Lactobacillus	amylovorus
0.02	Corynebacterium	stationis
0.01	Oxalophagus	NA
0.01	Planifilum	NA
0.01	Desulfofundulus	NA
0.01	NA	NA
0.00	CHKCI001	NA
0.00	Pseudomonas	NA
0.00	Tumebacillus	NA

Composition, Fungi (top 20 species overall)

GM26 00526.001	Genus	Species	Binomial
65.34	Aspergillus	NA	Aspergillus sp.
16.73	Cortinarius	NA	Cortinarius chrysogenum
5.86	Wallemia	NA	Wallemia canadensis
2.56	Cladosporium	NA	Cladosporium sp.
2.26	NA	NA	NA sp.
2.14	NA	NA	NA sp
1.68	Penicillium	NA	Penicillium sp.
0.99	Penicillium	polonicum	Penicillium polonicum
0.72	Aspergillus	ochraceus	Aspergillus sesamicola
0.67	Cladosporium	NA	Cladosporium sp.
0.58	Aspergillus	intermedius	Aspergillus intermedius
0.08	Fusarium	NA	Fusarium commune/oxysporum
0.08	Microascus	NA	Microascus sp.
0.07	Aspergillus	NA	Aspergillus sp.
0.07	Alternaria	tenuissima	Alternaria prunicola
0.05	Penicillium	NA	Penicillium sp
0.04	Olpidiaceae gen Incertae sedis	NA	Olpidiaceae gen Incertae sedis sp.
0.03	Gymnoascus	NA	Gymnoascus sp.
0.02	Dianthus	masmenaeus	Dianthus masmenaeus
0.01	Olpidium	NA	Olpidium sp.

Alpha-diversity

It is important to measure the total number of species and their spread (are a small number of species dominant, or are the species more equally distributed). For example, an effective cleaning treatment such as UV will eliminate many species, but species that survive will have a higher signal in this report. Two measurements are included here, **Observed** (the number of species in a sample) and **Shannon's** (measure combining the number of species and their spread).



Appendices

Appendix 1. eDNA sequencing summary

Client	Sgs
Crop	mixed feeds
Sample Start Date	2026-02-17
Sample End Date	2026-02-17

Detection Threshold

Appendix 2. F.A.Q.

Community marker sequencing generates a large amount of data comprised of a sequence of letters, called nucleotides (the DNA sequence). The sequence of letters changes as species evolve, such that different species have different markers. We can use these differences to match sequences in your sample with pathogen or beneficial species in our curated reference database. The abundance of an organism in the environment (percentage here) is approximately equal to the number of sequences assigned to that organism in the sequencing data.

The hits to our pathogen or beneficials database are presented as bar plots where the size of the bar corresponds to the percentage of sequences matching to the pathogen or beneficial organism.

Q1. Is there a percentage at which a pathogen will cause problems in my crop? There is no one-size fits all answer to this question as different species have different growth rates, impact, detection sites, and resistance to mitigation strategies. However, either exceeding a threshold generally accepted as rare (usually 0.01%) or persistence across multiple sampling periods, especially if increasing over time is concerning.

Q2. Should I be worried about a pathogen is below this threshold? Some pathogens are a significant risk any time they are present, such as some water molds (e.g., *Pythium* or *Phytophthora*) while others are relatively harmless unless abundant enough to overload the plant. You should closely monitor any pathogen above 1% abundance. Our website is also a good resource for further information about our pathogen list.

Q3. Which pathogens tend to be most damaging to hydroponic systems? This question is largely dependent on your crop. For example, the presence of a pathogen with a host crop different from your own may be something to watch for but may not be of immediate concern. An example is *Fusarium* head blight (*Gibberella zeae*), a serious disease of cereals and corn, which is common in rural groundwater and often detected in some controlled environment agriculture facilities. This pathogen is often of minimal concern for most hydroponic crops. As growers you will know which pathogen species focus on.

Q4. How do we determine which pathogens are priority pathogens? Our priority pathogen list is made up of widely accepted, damaging plant pathogens, including Bacteria, Fungi, water molds (e.g., Oomycetes such *Pythium*). At Healthy Hydroponics, we have also observed pathogens that are especially prominent under hydroponic conditions, such as various pathogenic *Pseudomonas* species. We have incorporated some of these hydroponic-associated pathogens to our priority pathogens list.

Q5. There are only X number of pathogens in the report. Are these all the pathogens you screen for? No, we only present pathogens that were observed in your samples. Since Health⁺ can potentially detect all bacteria, fungi, and water molds we screen for many hundreds of pathogen species. The full list of pathogens we screened is included in Appendices 2 and 3 and the website (<https://healthyhydroponics.ca/pathogens-we-detect>)

Q6. What diseases are caused by these organisms? The list of screened pathogens on our website also includes disease or pathology information (<https://healthyhydroponics.ca/pathogens-we-detect>).

Q7. How sensitive is the Heath⁺ approach? Using eDNA for pathogen and beneficial detection is inclusive: we use universal amplification and match resulting sequences to a curated database. The sensitivity of the test depends on how much sequence data is generated. Our minimum sequencing depth is 15,000 sequences and the corresponding sensitivity is 2/15,000 (or approximately 0.01%). The sensitivity of each test is included in Appendix 1.

Appendix 2. List of plant pathogens screened by Healthy Hydroponics

Table 4: Pathogenic Bacteria species screened by Healthy Hydroponics community analysis

Acidovorax citrulli	Agrobacterium rhizogenes
Agrobacterium tumefaciens	Candidatus Liberibacter solanacearum
Clavibacter michiganensis	Clavibacter michiganensis subsp. michiganensis
Clavibacter michiganensis subsp. sepedonicus	Dickeya chrysanthemi
Dickeya dadantii	Dickeya solani
Erwinia spp.	Erwinia tracheiphila
Pantoea ananatis	Pectobacterium atrosepticum
Pectobacterium carotovorum	Pectobacterium carotovorum subsp. carotovorum
Pseudomonas amygdali pv. lachrymans	Pseudomonas cichorii
Pseudomonas corrugata	Pseudomonas marginalis
Pseudomonas syringae	Pseudomonas syringae pv. maculicola
Pseudomonas syringae pv. porri	Pseudomonas syringae pv. syringae
Pseudomonas syringae pv. tomato	Ralstonia solanacearum
Rhizomonas spp.	Rhizorhapis suberifaciens
Streptomyces acidiscabies	Streptomyces scabiei
Streptomyces turgidiscabies	Xanthomonas campestris
Xanthomonas campestris pv. campestris	Xanthomonas campestris pv. musacearum
Xanthomonas campestris pv. raphani	Xanthomonas campestris pv. vitians
Xanthomonas cucurbitae	Xanthomonas euvesicatoria
Xylella fastidiosa	Acidovorax citrulli

Table 5: Pathogenic Eukaryota species screened by Healthy Hydroponics community analysis

Albugo candida	Albugo occidentalis
Aphanomyces raphani	Bremia lactucae
Peronospora belbahrii	Peronospora farinosa
Peronospora parasitica	Peronospora tabacina
Phytophthora capsici	Phytophthora cinnamomi
Phytophthora citricola	Phytophthora cryptogea
Phytophthora drechsleri	Phytophthora erythroseptica
Phytophthora idaei	Phytophthora infestans
Phytophthora megasperma	Phytophthora nicotianae var. parasitica
Phytophthora parasitica	Phytophthora root rot
Phytophthora sp.	Phytophthora spp.
Plasmopara lactucaenaradicis	Pseudomonas viridiflava
Pseudoperonospora cubensis	Pythium aphanidermatum
Pythium arrhenomanes	Pythium debaryanum
Pythium deliense	Pythium myriotylum
Pythium spp.	Pythium tracheiphilum
Pythium ultimum	Pythium ultimum var. ultimum
Trachysphaera fructigena	Albugo candida

Table 6: Pathogenic Fungi species screened by Healthy Hydroponics community analysis

Acremonium spp.	Acrodontium simplex	Aecidium cantensis
Alternaria alternata	Alternaria alternata f. sp. cucurbitae	Alternaria alternata f. sp. lycopersici
Alternaria brassicae	Alternaria brassicicola	Alternaria cucumerina
Alternaria raphani	Alternaria solani	Alternaria sonchi
Alternaria spp.	Alternaria tenuis	Angiosorus solani
Aphanomyces euteiches	Armillaria mellea	Armillaria tabescens
Ascochyta phaseolorum	Asteromella brassicae	Athelia rolfsii
Bipolaris spp.	Blumeria graminis	Botryosphaeria ribis
Botryosphaeria spp.	Botryotinia fuckeliana	Botryotinia fuckeliana
Botrytis cinerea	Botrytis spp.	Botrytis tulipae
Cephalosporium sp.	Ceratocystis paradoxa	Cercospora brassicicola
Cercospora capsici	Cercospora citrullina	Cercospora concors
Cercospora fuliginea	Cercospora hayi	Cercospora longissima
Cercospora solani	Cercospora solanina-tuberosi	Chalara paradoxa
Choanephora cucurbitarum	Cladosporium cucumerinum	Cladosporium fulvum

Cladosporium musae	Colletotrichum acutatum	Colletotrichum atramentarium
Colletotrichum capsici	Colletotrichum coccodes	Colletotrichum dematium
Colletotrichum fragariae	Colletotrichum gloeosporioides	Colletotrichum graminicola
Colletotrichum higginsianum	Colletotrichum lindemuthianum	Colletotrichum musae
Colletotrichum orbiculare	Colletotrichum spp.	Coniothyrium fuckelii
Cordana johnstonii	Cordana musae	Corynespora cassiicola
Curvularia eragrostidis	Cylindrocarpon musae	Cylindrocladium spp.
Deightonella torulosa	Dematophora sp.	Diaporthe melonis
Didymella bryoniae	Didymella lycopersici	Didymella spp.
Diplocarpon rosae	Drechslera gigantea	Drechslera musae-sapientum
Drechslera spp.	Erysiphe betae	Erysiphe cichoracearum
Erysiphe polygoni	Erysiphe spp.	Eutypa lata
Fusarium acuminatum	Fusarium avenaceum	Fusarium crookwellense
Fusarium culmorum	Fusarium equiseti	Fusarium graminearum
Fusarium lactis	Fusarium moniliforme	Fusarium oxysporum
Fusarium oxysporum f. sp. albedinis	Fusarium oxysporum f. sp. asparagi	Fusarium oxysporum f. sp. batatas
Fusarium oxysporum f. sp. benincasae	Fusarium oxysporum f. sp. betae	Fusarium oxysporum f. sp. cannabis
Fusarium oxysporum f. sp. capsici	Fusarium oxysporum f. sp. cepae	Fusarium oxysporum f. sp. ciceris
Fusarium oxysporum f. sp. citri	Fusarium oxysporum f. sp. coffea	Fusarium oxysporum f. sp. cubense
Fusarium oxysporum f. sp. cubense Races 1, 2 and 4 na inc. Tropical Race 4 (TR4) and Subtropical Race 4	Fusarium oxysporum f. sp. cucumerinum	Fusarium oxysporum f. sp. cyclaminis
Fusarium oxysporum f. sp. dianthi	Fusarium oxysporum f. sp. gladioli	Fusarium oxysporum f. sp. herbemontis
Fusarium oxysporum f. sp. lactucae	Fusarium oxysporum f. sp. lagenariae	Fusarium oxysporum f. sp. lentis
Fusarium oxysporum f. sp. lini	Fusarium oxysporum f. sp. luffae	Fusarium oxysporum f. sp. lycopersici
Fusarium oxysporum f. sp. medicaginis	Fusarium oxysporum f. sp. melonis	Fusarium oxysporum f. sp. momordicae
Fusarium oxysporum f. sp. narcissi	Fusarium oxysporum f. sp. nicotianae	Fusarium oxysporum f. sp. niveum
Fusarium oxysporum f. sp. palmarum	Fusarium oxysporum f. sp. passiflorae	Fusarium oxysporum f. sp. perniciosum
Fusarium oxysporum f. sp. phaseoli	Fusarium oxysporum f. sp. pisi	Fusarium oxysporum f. sp. radices lycopersici
Fusarium oxysporum f. sp. radices-cucumerinum	Fusarium oxysporum f. sp. ricini	Fusarium oxysporum f. sp. strigae
Fusarium oxysporum f. sp. tuberosi	Fusarium oxysporum f. sp. tulipae	Fusarium oxysporum f. sp. vasinfectum
Fusarium pallidoroseum	Fusarium sacchari	Fusarium semitectum
Fusarium solani	Fusarium solani f. sp. cucurbitae	Fusarium solani f. sp. eumartii
Fusarium spp.	Fusarium verticillioides	Gaeumannomyces graminis
Galactomyces geotrichum	Ganoderma orbiforme	Geotrichum candidum
Geotrichum klebahnii	Gibberella intricans	Gibberella pulicaris
Gibberella zeae	Glomerella cingulata	Glomerella lagenarium
Gnomonia comari	Guignardia musae	Haplobasidium musae
Helminthosporium solani	Ilyonectria radicola	Junghuhnia vincta
Laetisaria fuciformis	Lasiodiplodia theobromae	Leandria momordicae
Leptosphaeria korrae	Leptosphaeria maculans	Leptosphaeria musarum
Leptosphaerulina spp.	Leveillula taurica	Limacinula tenuis
Macrophomina phaseolina	Magnaporthe grisea	Magnaporthe oryzae
Marasmiellus inoderma	Marssonina panattoniana	Melampsora lini
Microdochium nivale var. nivale	Microdochium panattonianum	Monosporascus cannonballus
Monosporascus eutypoides	Mycosphaerella brassicicola	Mycosphaerella eumusae
Mycosphaerella fijiensis	Mycosphaerella graminicola	Mycosphaerella musae
Mycosphaerella musicola	Mycovellosiella concors	Myrothecium roridum
Nattractia mangiferae	Nectria foliicola	Nectria haematococca
Neoscytalidium dimidiatum	Nigrospora sphaerica	Oidiopsis haplophylli
Oidiopsis sicula	Oidiopsis taurica	Olpidium bornovanus
Olpidium brassicae	Olpidium virulentum	Passalora fulva
Penicillium digitatum	Penicillium expansum	Penicillium spp.
Periconiella musae	Pestalotia spp.	Pestalotiopsis disseminata
Pestalotiopsis leprogena	Pestalotiopsis palmarum	Phaeoseptoria musae
Phakopsora meibomiae	Phoma andigena var. andina	Phoma cucurbitacearum
Phoma destructiva	Phoma exigua	Phoma exigua f. sp. foveata
Phoma exigua var. exigua	Phoma exigua var. foveata	Phoma foveata
Phoma lingam	Phoma solanicola f. foveata	Phoma strasserii
Phomopsis cucurbitae	Phomopsis obscurans	Phomopsis sclerotioides
Phyllachora musicola	Phyllosticta cucurbitacearum	Phyllosticta musarum

Phymatotrichopsis omnivora	Phymatotrichum omnivorum	Phytophthora cactorum
Plasmodiophora brassicae	Plectosporium tabacinum	Pleospora herbarum
Pleospora lycopersici	Pleospora tarda	Podosphaera xanthii
Polyscytalum pustulans	Pseudocercospora fijiensis	Pseudocercospora fuligena
Pseudocercospora musae	Pseudocercospora capsellae	Puccinia angustata
Puccinia dioicae	Puccinia extensicola var. hieraciata	Puccinia menthae
Puccinia pittieriana	Puccinia spp.	Pyrenochaeta lycopersici
Pyrenopeziza brassicae	Pyricularia grisea	Pythium dissotocum
Pythium graminicola	Pythium irregulare	Pythium polymastum
Pythium sylvaticum	Pythium uncinulatum	Ramichloridium musae
Ramularia menthicola	Rhizoctonia fragariae	Rhizoctonia solani
Rhizoctonia spp.	Rhizopus nigricans	Rhizopus stolonifer
Rhynchosporium orthosporum	Rhynchosporium secalis	Rigidoporus vinctus
Rosellinia bunodes	Rosellinia sp.	Sclerotinia homoeocarpa
Sclerotinia minor	Sclerotinia sclerotiorum	Sclerotinia spp.
Sclerotinia trifoliorum	Sclerotium bataticola	Sclerotium cepivorum
Sclerotium rolfsii	Septoria cucurbitacearum	Septoria eumusae
Septoria lactucae	Septoria lycopersici	Septoria lycopersici var. malagutii
Septoria menthae	Sphaeloma menthae	Sphaerotheca fuliginea
Spongospora subterranea	Spongospora subterranea f.sp. subterranea	Stemphylium botryosum
Stemphylium botryosum f.sp. lycopersici	Stemphylium consortiale	Stemphylium cucurbitacearum
Stemphylium floridanum	Stemphylium herbarum	Stemphylium lycopersici
Stemphylium solani	Stemphylium spp.	Synchytrium endobioticum
Thanatephorus cucumeris	Thecaphora solani	Thielaviopsis basicola
Trichoderma afroharzianum	Trichoderma asperellum	Trichoderma hamatum
Trichoderma harzianum	Trichoderma spp.	Trichothecium roseum
Typhula spp.	Ulocladium atrum	Ulocladium consortiale
Uredo musae	Uromyces musae	Uromyces spp.
Ustilago maydis	Ustilago spp.	Venturia inaequalis
Venturia pyrinia	Veronaea musae	Verticillium albo-atrum
Verticillium albo-atrum var. menthae	Verticillium dahliae	Verticillium spp.
Verticillium theobromae	Zopfiella leucotricha	Acremonium spp.