

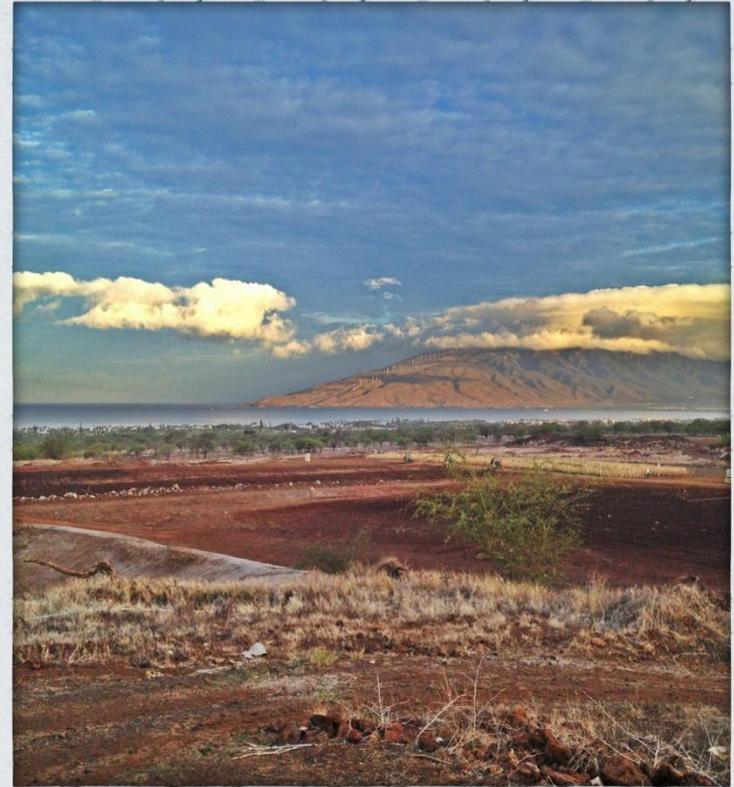
Field Guide to Maize Diseases in Hawaii Seed Corn Nurseries

By David Case



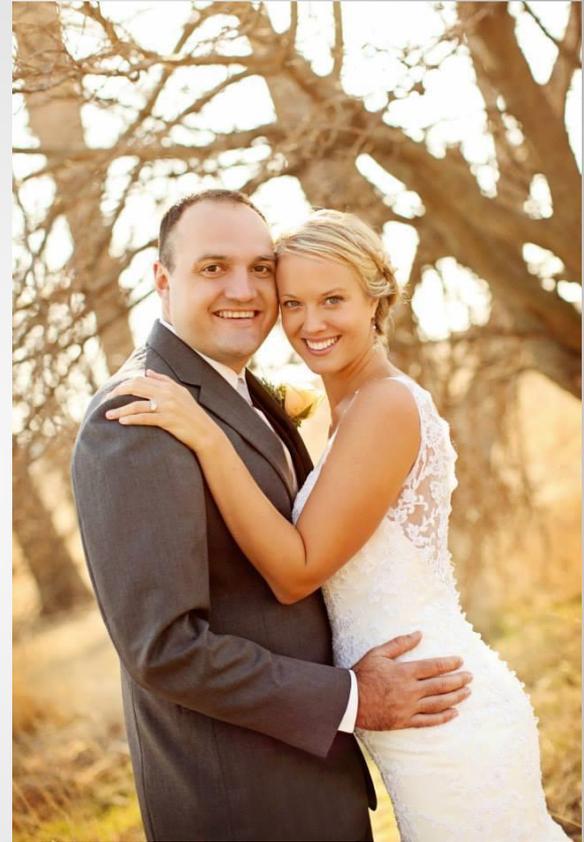
Sections

- My Background
- Why a module?
- Value of the module
- About the module
- Summary
- Conclusion



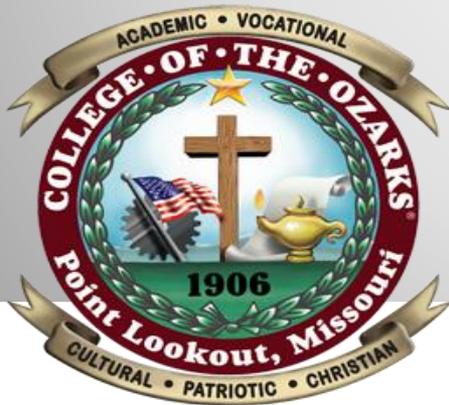
My background

- Hometown: Bradleyville, Mo
- Current Location: Kihei, Hi
- Family: 1 Wife + 1 Dog



My background

- College of the Ozarks (2002-2006)
 - Wildlife Management
 - Agronomy
- Iowa State University (2007-present)
 - Masters of Science (Agronomy)
- Monsanto (2008-present)



- **Monsanto**

- Trait integration
- Trait development/characterization
- Planting/shelling/shade houses



Hobbies

- Camping
- Hiking
- Spear fishing
- Scuba
- Whale watching

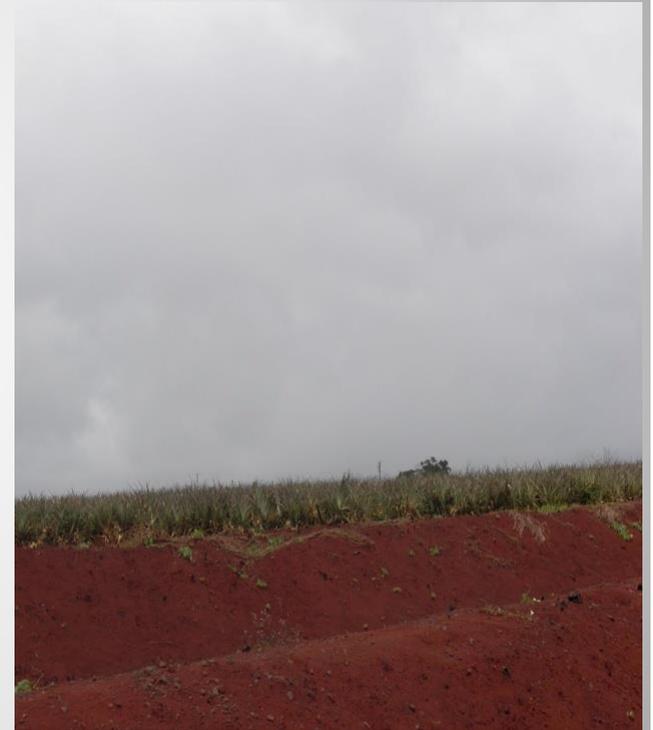


Why a module?

- **Relevancy** - Addresses a problem encountered every day
- **Prioritization** - Easy access information
- **Ease of Use** - Electronic media is comfortable

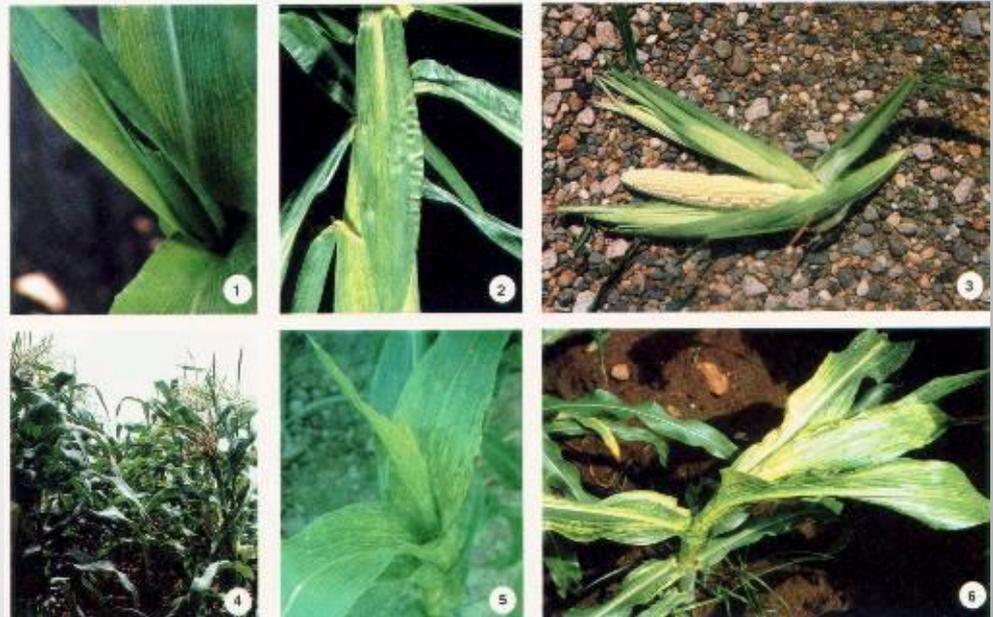
Value of the module (The Problem)

- Corn Belt Trained
- High Employment Turnover
- Continuous Cropping
- Tropical Environment



Disease Categories

- Nutrient Deficiencies
- Viral Diseases
- Fungal Diseases



Nutrient Deficiencies

- Soils in the Hawaiian Islands are volcanic in origin. As one would expect, nutrient deficiencies encountered here differ somewhat from what is regularly encountered in the mainland. As with any soil, a nutrient deficiency of any type can occur.
- In order to keep this section brief and useful, only deficiencies less commonly encountered in corn belt agriculture are included. The five nutrient problems addressed are:
 - Boron
 - Magnesium
 - Calcium
 - Sulfur
 - Salt effects



Sulfur Deficiency in Corn



Tattered leaf margins - boron deficiency.

Nutrient Deficiencies

Sulfur Deficiency

- Sulfur (S) deficiencies commonly occur in soils with a low amount of organic matter.
- In addition to low organic matter, Hawaiian seed production regions are also where soils are high in iron which can lead to additional leaching of sulfur because of nutrient binding.
- Detection of sulfur deficiency visually is done though scouting for yellowing of leaves not unlike that found in nitrogen deficient plants. Yellowing of the upper leaves and interveinal necrosis are the most common symptoms of sulfur deficiency.
- Because sulfur is not translocated as readily as nitrogen, sulfur deficiency can be distinguished from nitrogen deficiency because it only effects the upper leaves.



Leaf yellowing, sulfur deficiency.

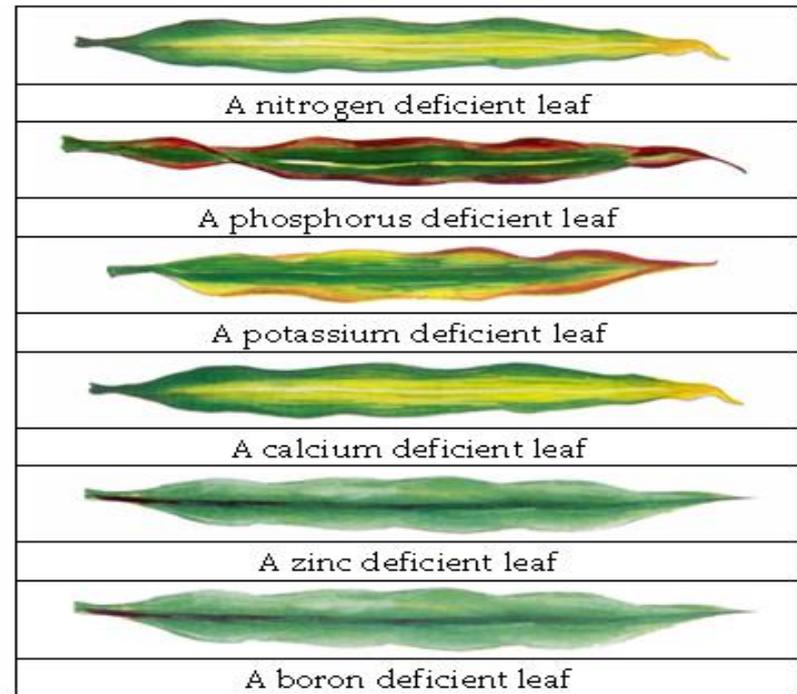


Intervenial necrosis, sulfur deficiency.

Nutrient Deficiencies

Boron Deficiency

- Like sulfur, boron (B) is likely to be a problem in soils with low pH, and soils that are low in organic matter. Boron deficiency has also been linked to sandy soils, and continuous cropping situations. Typical Hawaiian seed corn production areas are known for all of these scenarios.
- Boron has been shown to affect the uptake of other essential nutrients so while it is a micronutrient, it should not be overlooked.
- Boron is also involved in reproductive development in maize. It can affect anther extrusion and most notably silk tube elongation causing nick issues.



Vegetative symptoms of corn nutrient disorders.



Seed set effects of boron deficiency.

Nutrient Deficiencies

Calcium Deficiency

- Herbicide injury can also cause buggy-whipping so an examination of herbicide applications should also be considered if Ca levels are suspect to being low.
- If your soils are acidic and plants show other symptoms, a soil test is a good indicator of available calcium. Plant sampling is also useful, but vegetative stage must be indicated because the amount of Ca found in leaves increase as the plant ages.
- Application of limestone or gypsum is the most common soil amendments for adding calcium, but in a time of need, a foliar Ca fertilizer may be necessary.

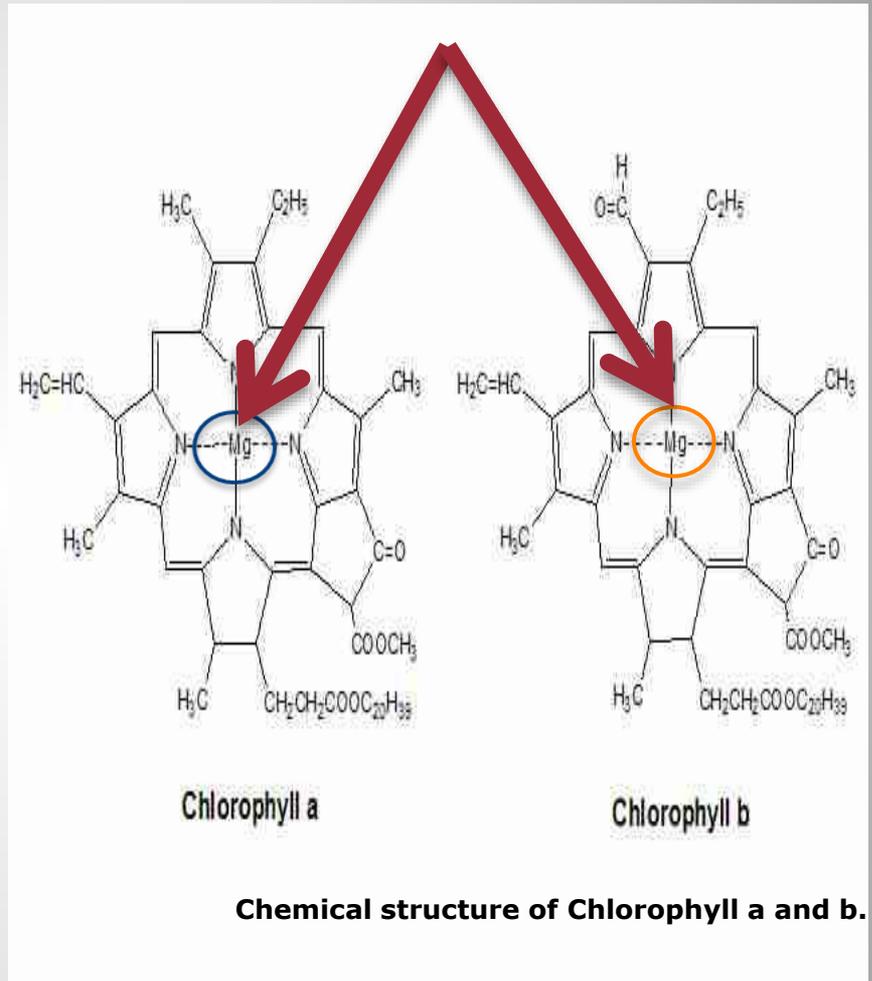


Calcium deficiency - buggy-whipping.

Nutrient Deficiencies

Magnesium Deficiency

- Magnesium (Mg) deficiency is not commonly found in corn belt states but is a problem regularly encountered in Hawaii.
- Magnesium deficiency is commonly found in acidic soils. Sandy soils (commonly found in Hawaii), and areas of high rainfall or continuous irrigation are most susceptible to magnesium deficiency.



Nutrient Deficiencies

Salt Toxicity

- Salt, unlike the nutrients listed before, is a problem only when in excess. Salt toxicity can be a problem in the islands for two reasons:
 - First, some wells that source irrigation water can have seepage from the ocean and be slightly saline.
 - Secondly, water sourced from reclaimed waste water has a higher salt content than well or rain sourced water.
- Saline soils interfere with nutrient uptake of nutrients, such as zinc, iron, and phosphorus. So symptoms of these deficiencies can actually insinuate a salt problem. In addition, plants will likely show drought stress and necrotic leaf margins. Additionally, a white film may be present on the soil surface. Root growth will be stunted and plants will be very susceptible to lodging.



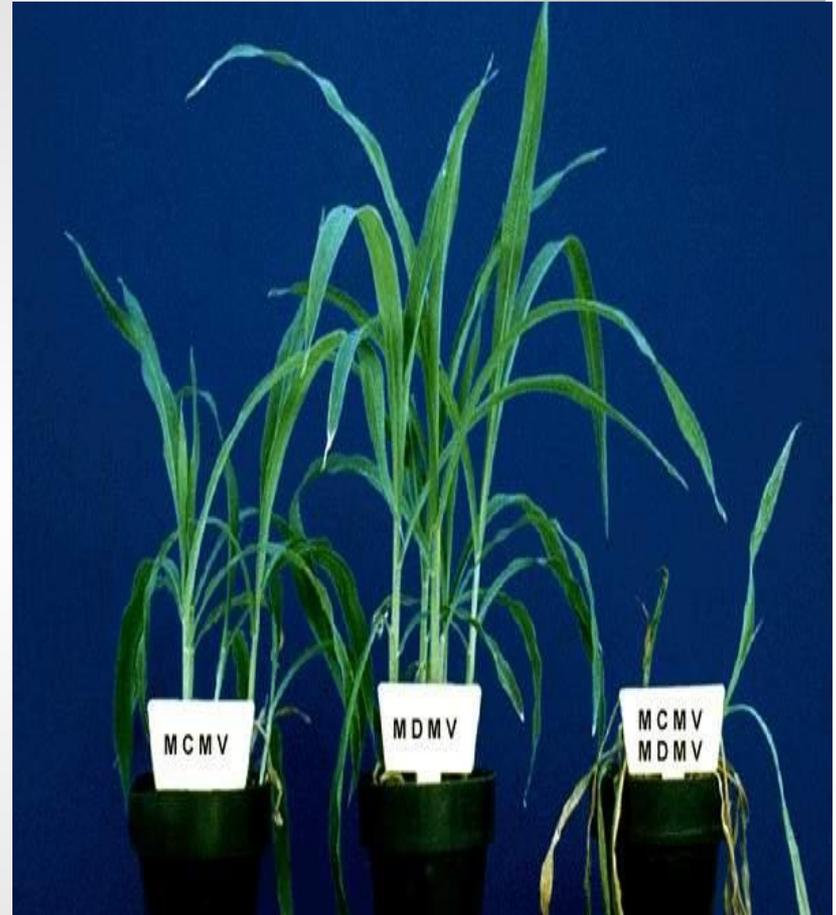
Salt burnt corn leaf edges.



Water stress from saline soil.

Viral Diseases

- Virus disease in Hawaii are an important consideration in corn nurseries. Unlike production fields where individual plants are of small significance, in corn nurseries individual plants can be extremely valuable and represent many years of breeding work and research.
- Four viruses cause nursery problems in the islands. Listed in order of importance:
 - **Maize Chlorotic Mottle Virus (MCMV)**
 - **Maize Mosaic Virus (MMV)**
 - **Maize Dwarf Mosaic Virus (MDMV)**
 - **Sugar Cane Mosaic Virus (SCMV)**
- MCMV and MDMV can also interact synergistically to produce corn lethal necrosis (CLN) which is more serious than either virus on its own.



Maize Virus - MCMV, MDMV, and CLN.

Viral Diseases

MDMV and SCMV

- Maize Dwarf Mosaic Virus (MDMV) and Sugar Cane Mosaic Virus (SCMV) are viruses in the Potyviridae family. There are 14 different strains but all show similar symptoms. The viruses are easily transmitted by aphids that first feed on an infected plant and then move to non-infected plants.
- Over 250 species of plants can host MDMV, so controlling the sources of inoculum can prove extremely difficult.
- Twelve species of aphids have been shown to transmit the virus disease. The only course of prevention in Hawaii is to control the aphid vector of the disease. Regular applications of insecticides, such as chlorpyrifos or malathion, will help control aphid populations.



MDMV/SCMV - corn leaves.

Viral Diseases

Maize Mosaic Virus

- Maize Mosaic Virus (MMV) is of great importance in Hawaii. Inbreds developed in Hawaii have had resistance bred into them. However, the same cannot be said for inbreds coming from non-Hawaiian locations.
- MMV is transmitted by a single species of leaf hopper, the corn delphacid (*Peregrinus maidis*). Therefore, a combination of aggressive rouging and regular pesticide application are best used to fight the disease.



MMV infected corn tassel.



**Corn
delphacid leaf
hopper.**

Viral Diseases

Maize Chlorotic Mottle Virus

- Maize Chlorotic Mottle Virus (MCMV) is in the family Tombusviridae. Historically, MCMV has not been a big problem on the Hawaiian Islands or globally. However, in the last 5 years MCMV has been severely affecting seed corn nurseries in Hawaii.
- MCMV resistances is not currently bred into most non-Hawaiian inbreds.
- MCMV does not seed transmit well but is moved mechanically in Hawaii by thrips (*Frakliniella williamsi*).
- Fallow periods (if possible), very aggressive rouging, plant matter burial, and regular insecticide application are the only hopes for control of the thrips and MCMV.



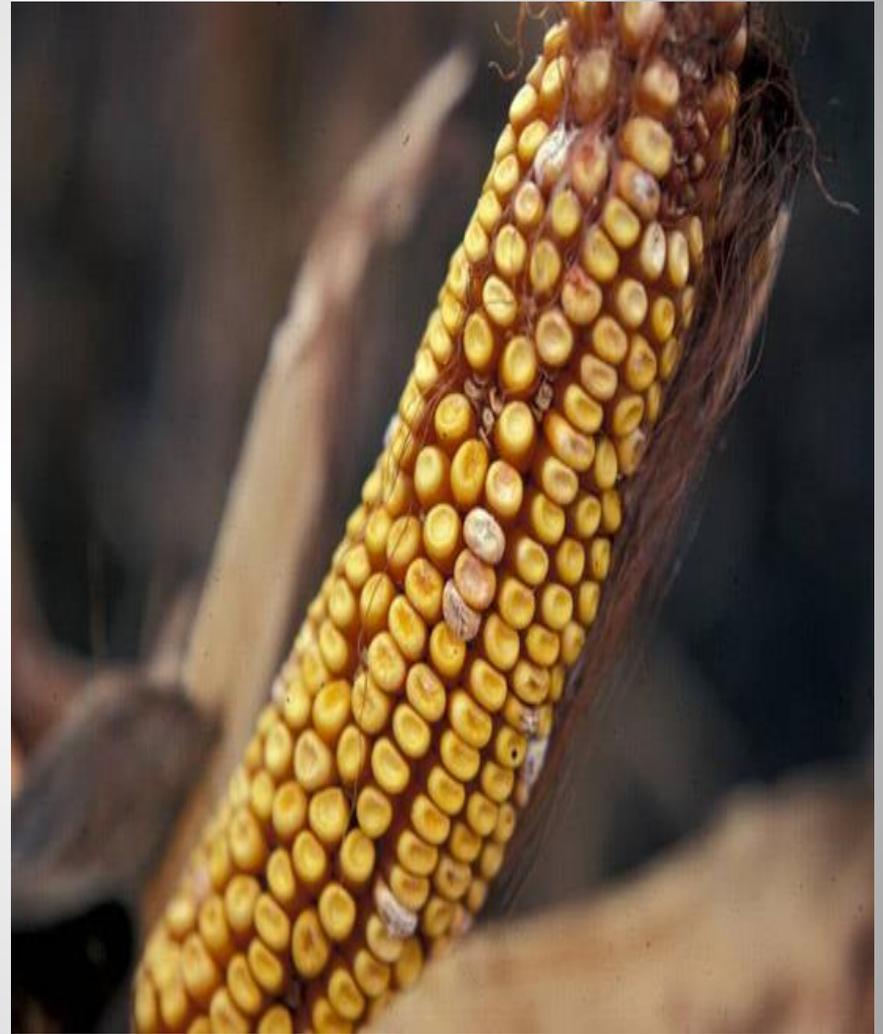
MCMV infected corn leaf.



***Frakliniella williamsi* thrip that carry MCMV.**

Fungal Diseases

- Due to Hawaii's isolation and more recently its very strict agricultural quarantine, the number of problematic fungi for corn production is small when compared to mainland agriculture.
- The following diseases are commonly found in corn nurseries.
 - Aspergillus
 - Fusarium
 - Northern corn leaf blight
 - Southern corn leaf blight
 - Common rust
 - Southern rust



Fusarium infected corn ear.

Fungal Diseases

Aspergillus flavus

- *Aspergillus* is one of the primary fungus associated with mycotoxin production. However, since seed from nurseries on the islands are not intended for commerce, toxin production is of less concern.
- *Aspergillus* infected kernels have lower germination than non-infected ears and in cases of early infection can reduce seed set. Since advancing genetics is the primary goal, germination is of key importance.
- *Aspergillus* development is favored by temperatures above 80° degrees (every day in Hawaii) and periods of drought and heat stress.



Aspergillus - beginning sporulation.



Advanced Aspergillus infection.

Fungal Diseases

Fusarium

- *Fusarium* sp. can infect both the stalk and ear of a corn plant causing Fusarium stalk rot and Fusarium ear rot, respectively. Fusarium also produces mycotoxins. As with *Aspergillus*, the primary concern with Fusarium is its effects on seed germination.
- Fusarium is spread season-to-season in corn debris and stubble. This is particularly problematic because of the corn-on-corn rotation used in the Hawaiian nursery environment. The pathogen can also be seed born. The fungus also moves plant-to-plant through damage caused by insects.



Fusarium ear rot damage.



Fusarium stalk rot damage.

Fungal Diseases

Northern Corn Leaf Blight

- Northern Corn Leaf Blight (NCLB) is a foliar disease affecting corn caused by the fungal pathogen *Exserohilum turcicum*. In cases of early infection, NCLB can cause yield reductions of 30% or greater. It is detrimental because the disease causes leaf lesions that effect the overall amount of plant leaf area able to photosynthesize.
- NCLB is spread through corn residue so the continuous cropping of corn in Hawaii is potentially favorable for the disease. The fungus also requires over half a day of plant wetness and lower temperatures (64° to 81° F) for infection to occur. These conditions are rarely present in Hawaii seed corn nurseries except in the winter months when wet weather is more common.



Northern corn leaf blight - primary leaf symptoms are necrotic, cigar shaped lesions (left) and fungal spore (right).

Fungal Diseases

Southern Corn Leaf Blight

- Southern Corn Leaf Blight (SCLB) (caused by the fungus *Bipolaris maydis*) is a foliar disease affecting corn in Hawaii. It is unlike the other diseases mentioned since does not typically cause yield loss in Hawaii. However, SCLB is of concern because seed that comes from an infected plot is quarantined from importation to South Africa which is a major corn producing country on the African Continent.
- SCBL is favored by warm environments (65-85° F) and overwinters on plant debris. This is of particular concern in seed nurseries because of the corn-on-corn rotation and very short re-plant times. Moist conditions are also favorable for the disease, with Hawaiian winters being more problematic for SCLB infection.



SCLB has small, irregular lesions on a corn leaf.

Fungal Diseases

Common Rust (*Puccinia sorghii*)

- Common rust is severe problem affecting Hawaii's seed corn nurseries. It is more common in areas of higher humidity (<95%) and lower temperatures between (60-70° F) so it is favored by Hawaii's winter months and higher elevation/higher rainfall production areas.
- Year round "green bridging" of corn, and the abundance of a weed species called Oxalis, which serves as an alternative host for the pathogen, make the disease more common in the islands.



Oxalis acetosella .



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Common rust pustules on a corn leaf.

Fungal Diseases

Southern Rust (Puccinia polysora)

- Southern rust is less severe in Hawaii because the disease is favored by high humidity and high temperatures (greater than 80°F), a combination that is basically not experienced in the islands.
- Southern rust does, however, occur at low frequencies. Southern rust can be differentiated from common rust because its pustules are lighter in color. The pustules of southern rust also only occur on the upper leaf surface. Pustules will also be more circular and smaller. Southern rust typically does not need control in Hawaii but was included to differentiate it from common rust.
- Control options of both rusts is by an application of a broad mode of action fungicide.



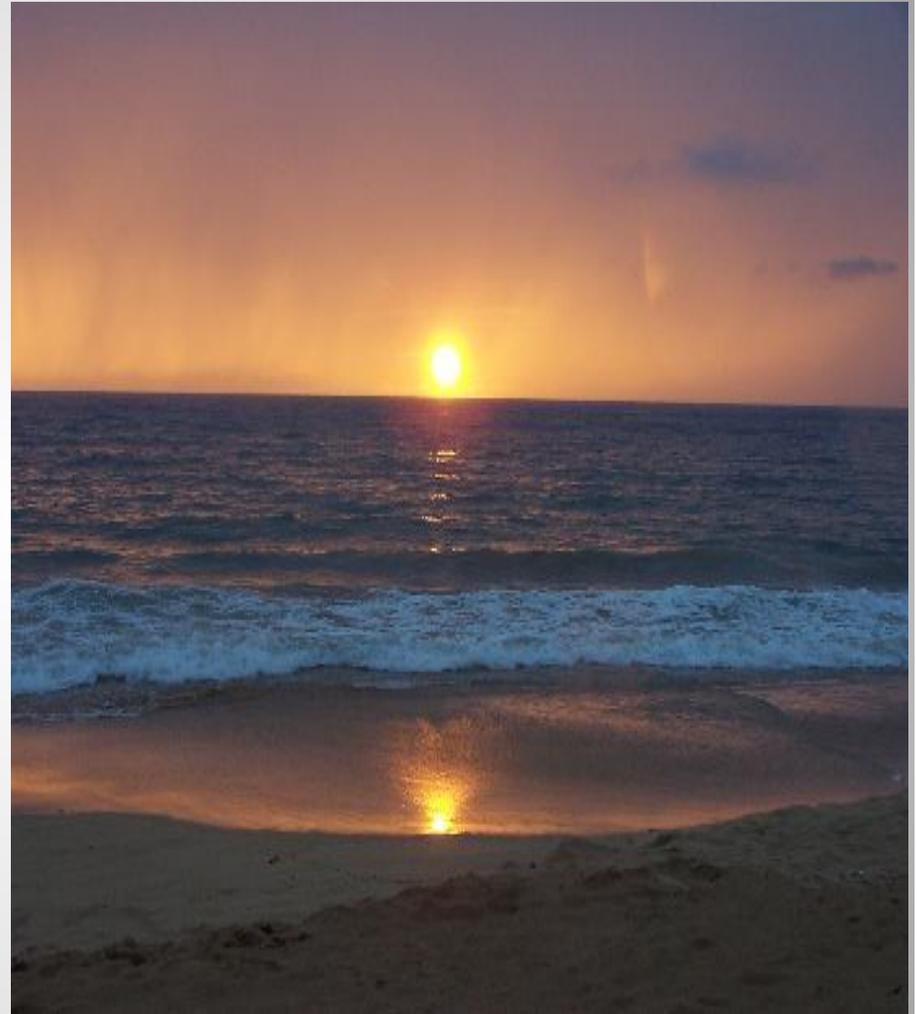
Southern rust on a corn leaf.



Southern rust vs. common rust appearance differences.

Summary

- This module outlined and defined many diseases/deficiencies that are common in corn seed nurseries in the Hawaiian Islands. While not comprehensive in nature, this module provides an effective and efficient way to identify diseases that are likely to cause issues.
- The module should be an effective tool to assist in educating new employees to corn diseases common seed nurseries on the island.
- In addition, the module sheds light on disease issues that are important due to import/export of inbred corn seeds to and from the islands of Hawaii.



Quiz

How can sulfur deficiency be differentiated from a nitrogen deficit?

- *a. No-translocation - upper leaves yellow first
- b. Translocation - lower leaves show symptoms first
- c. Tattered leaf margins
- d. Cigar shaped necrotic lesions

What soil characteristic makes sulfur deficiency common in the islands?

- *a. High iron content
- b. High soil pH
- c. Low CEC
- d. High clay content

What is the primary vector of Maize Dwarf Mosaic Virus (MDMV) in Hawaii?

- *a. Aphids
- b. Thrips
- c. Mites
- d. Leaf hopper

Questions?

