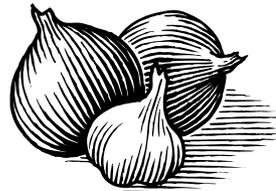


Research and Regulatory Wrap Up

Bob Ehn
CEO/Technical Manager
CA Garlic & Onion
Research Advisory Board



WHITE ROT UPDATE

- Registration Status
- Grant-In-Aid Program
- White Rot Master Plan
- GPS Mapping Program Grant



2013 Research Projects

WHITE ROT

1. **Davis/Ferry (UCDavis)**- Sensitivity of white rot to various fungicides.
2. **Oregon State**- New strategies for managing white rot. (*program delayed until new pathologist on board at Madras Station*)
3. **Eady (New Zealand Crop & Food Research)**- Biotech development white rot resistance. *Program on hold.*
4. **Turini/Biscaro**- White Rot mapping and site specific management for garlic & onion fields in Fresno Co.
5. **Wilson (Tulelake)**- Tank mixes and late season control of white rot.

White Rot Mapping Plan

- Utilize GPS mapping system
- Use software to allow mapping of infected sites
- Use computer software to treat, when possible, infected sites plus offset
- Obtain additional grant \$\$ to expand program and purchase additional hardware and software for mapping and application.

EZ-OFFICE MOBILE SOFTWARE AND THE TRIMBLE NOMAD HANDHELD COMPUTER

AN EFFECTIVE TOOL FOR GROWERS, CROP CONSULTANTS, SOIL SAMPLERS AND SCOUTS

EZ-Office[®] mobile

SIMPLE USER INTERFACE:

- Familiar and easy to use. Client, Plant, Field, and Job data management
- Customizable text display on screen
- Touch screen provides large buttons and map area for faster selection

SCOUTING:

- The field inquiry tool allows scouts to collect data such as GPS location and digital photos on the Trimble[®] Nomad handheld computer to capture and communicate pictures of problems, such as weeds and insects
- Enter an unlimited number of attributes, such as location, name, or type of weeds, for mapped areas, times, and photos

SAMPLING:

- Create and sampling grids in any size, pattern, and orientation
- Export pre-made grid sampling targets to more than 20 different software or other GIS programs
- Easy navigation in real sample locations and other features

HARDWARE:

- Rugged handheld is easily in the field
- Versatile and rugged system designed for all day use
- Versatile built-in GPS receiver, digital camera, and wireless technology

MAPPING:

- Map a field boundary in color for a future area of change
- Store or measure distances
- Record soil sample points or other points of interest
- Display background Shapefiles, GPS, and camera-enabled UNIFORM aerial photos

DATA STORAGE:

- Store data in text or database records or transfer to your Digital data card

VIEWING DATA:

- Data from EZ-Office mobile software transfer easily to EZ-Office desktop software using standard data synchronization
- Data can be exported in Shapefile format to use with other mapping software



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WHITE ROT MASTER PLAN

- Inspection of all garlic seed fields
- Garlic seed field maintenance
- Policy for planting and harvesting from areas known to have white rot
- Reporting of fields with white rot infection
- Treatment for known infestations (all Allium producers)
- Certified Garlic Seed Programs
- Development of methods to reduce soil populations of white rot sclerotia

CDFA Certification of Garlic Field



White Rot of Onion and Garlic: Symptoms and Controls

Bob Ehn, Allison Ferry, Tom Turini, and Fred Crowe

SYMPTOMS



Photo by Jack Kelly Clark



CAGORAB Photo, showing a comparison of healthy and diseased bulbs

Above ground symptoms include death of leaves, starting at the outer leaves and continuing inward. It eventually leads to premature plant death. Diseased areas can be seen as patches of dead leaves or plants, usually any time from mid-season to harvest. Below ground symptoms include a rotting of bulbs and roots. There may be fuzzy white material present in the rotted area, which is the fungal mycelium. You may also see sclerotia (the overwintering structure of the fungus), which are tiny round structures that resemble poppy seeds, around the size of the head of a pin. Infected bulbs are not marketable.

DISEASE CYCLE

White rot is caused by the soil-borne fungus *Sclerotium cepivorum*. It can infect all plants in the Allium family (including leeks and chives) but garlic and onions are the most susceptible. Currently, there are no available resistant varieties. White rot spreads and overwinters as sclerotia, which are small round, black fruiting structures similar in appearance to poppy seeds. The sclerotia are highly resistant to adverse temperatures and conditions, and can remain alive in the soil for thirty or more years, even in the absence of a host. A very small number of sclerotia can cause significant disease, and it is very difficult to control. Multiple controls are needed to produce a sufficient yield in infected fields. Ideally, the disease needs to be controlled both by reducing the number of sclerotia in the soil, and slowing fungal growth (i.e. with both a sclerotia germination stimulant and fungicides.)

CONTROLS

SANITATION

Only use clean seed or transplant stock. Infected planting stock is responsible for spreading the disease over large areas. Any time infected soil is moved, sclerotia will be moved as well. They can move in water, on equipment, on shoes, and in the wind. It is very important to reduce the spread of the fungus by practicing good sanitation. Wash tractors, spray rigs, harvesting equipment, etc. when moving between infected and uninfected fields. Wash equipment with water only, and make sure all soil is washed off. If muddy, wash off boots between fields.

CULTURAL CONTROLS

White rot grows the best under the same conditions that are good for onions and garlic (cool weather and moist soil), so it is difficult to avoid the pathogen by changing planting dates. In areas with hot summers, planting in the Spring and harvesting in the Fall will reduce potential disease. This strategy is not effective in areas with cool summers. If you see white rot infections in the field, reducing irrigation may slow spread of the disease.

SCLEROTIA GERMINATION STIMULANTS

Sclerotia germination stimulants are extremely effective in reducing the numbers (and initial inoculum) of sclerotia in the soil. They can reduce numbers of sclerotia in the soil by over 90%. The active ingredient is the chemical diallyl disulfide (DADS), which is the same chemical that is naturally exuded by Allium roots. This chemical triggers sclerotia to germinate. When DADS is applied artificially in the field in the absence of Alliums, sclerotia germinate and cannot find an Allium host. This causes them to germinate and die, rather than lying dormant. DADS is available as a commercial product, called All-up. Garlic oil/extract (which also contains DADS) is also equally effective.

DADS (in the form of either All-up or garlic oil) is applied at the rate of 1 gallon per acre in a fallow field. It is essential to shank apply DADS during cool weather in moist soil. Otherwise, the sulfur compounds will volatilize and the application will be ineffective. There can be no Alliums planted in the treated area for at least a year after application. However, it's fine to grow other crops, such as wheat, corn, etc. during the one-year Allium-free period. After this period, Allium crops can be grown again. It is however, still very important to apply a fungicide at planting, even after DADS treatment.

CHEMICAL CONTROLS

Currently, three fungicides are registered for white rot control: tebuconazole, fludioxonil and boscalid. Regardless of which fungicide is used, they need to be applied in a 4-6" bandwidth, at planting, and in the seed furrow. Later fungicide applications are ineffective in controlling disease. Multiple applications are not significantly more effective than a single application to control disease. Tebuconazole is the most effective fungicide for white rot control. Please note that tebuconazole is phytotoxic on onions if it is applied at a higher concentration than the recommended 20.5 fl oz/acre. Phytotoxicity can also occur if the bandwidth is narrowed, even at the recommended rate per acre. If a narrower bandwidth is applied, then the tebuconazole concentration per acre must also be reduced. Fludioxonil and boscalid are also effective in reducing white rot.

ORGANICALLY ACCEPTABLE PRACTICES

Organic growers should follow sanitation and cultural control practices. Sclerotia germination stimulants from natural sources (such as garlic oil/extract and powder) are acceptable for organic use. Currently, there are no other organically acceptable controls which have proven to be effective.

SUMMARY—CONTROLLING WHITE ROT OF ONION AND GARLIC

To Prevent New Infected Fields:

- Use clean, disease free garlic seeds and onion transplants
- Clean tractor equipment, shoes, etc. between infected and uninfected fields
- Don't let irrigation water in infected fields to spread to clean fields

When You Find a New Infected Field:

- Reduce further spread of the disease to new areas
 - Wash equipment between healthy and infected fields
 - If possible, prevent the spread of irrigation water between healthy and infected fields
 - After harvest, do not compost or till under infected bulbs; dispose of them
- Reduce irrigation, which may slow disease progress
- Once infected plants are found, there are NO chemical controls which will stop or reduce disease during the current season.
- Note the field location and disease severity, and report it to Bob Ehn. This is very important for providing funding and justification for new control research.

When You Want to Plant Alliums in a Field that is Known to have White Rot:

- Apply a sclerotia germination stimulant (such as garlic oil), 1 year before planting any Allium crop. Shank apply 1 gallon of product per acre in moist soil under moderate temperature conditions (50-70F). There cannot be any garlic or onion plant debris in the field during application, or the fungus can complete another life cycle and produce more sclerotia. After application, other crops can be grown in the treated area (but not Allium crops). After at least 1 year, Alliums can be planted in the treated area.
- At planting, apply a fungicide in furrow. Apply chemical in a 4-6" bandwidth. Options include:
 - tebuconazole (Folicur, Orius, Tebuzole)-20.5 fl oz/A
 - fludioxonil (Cannonball)- 8 oz/A
 - boscalid (Endura)-6.8 oz/A
- Tebuconazole is the most effective fungicide for white rot control. Please note that tebuconazole is phytotoxic on onions if it is applied at a higher concentration than the recommended 20.5 fl oz/acre. Phytotoxicity can also occur if the bandwidth is narrowed, even at the recommended rate per acre. If a narrower bandwidth is applied, then the tebuconazole concentration per acre must also be reduced.
- Fludioxonil and boscalid are also effective in reducing white rot.
- It is not effective to apply fungicides multiple times throughout the season, and once white rot symptoms are visible, no controls are available

Want to Know More? Check out these Resources:

UC IPM White Rot Management Guidelines

<http://www.ipm.ucdavis.edu/PMG/r584100511.html>

California Onion and Garlic Research Advisory Board Resources

<http://cagarlicandonion.com/page/1003/resources.html>



Garlic Rust Management

- First observed CA 1934
- Severe outbreak spring 1998
- Section 18 for Folicur 1999 (7 years except 2003)
- Azoxystrobin (Quadris) is only other registered compound
- Steve Koike/Richard Smith (Monterey) to screen new products & evaluate management plan.
- Koike & Board Task Force developed Management Plan



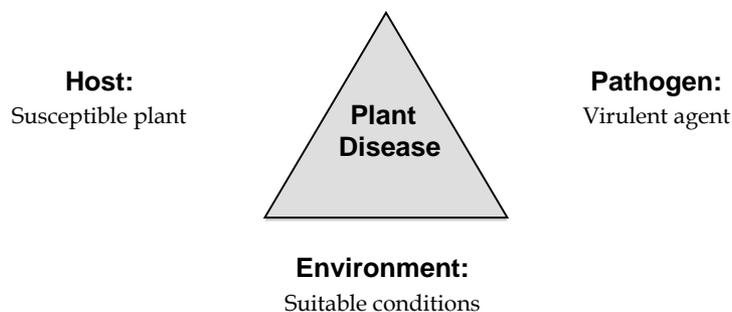


Garlic Rust

I. Principles of Disease Management

To maximize the management of garlic rust and to best control plant diseases in general, one should be familiar with the concepts of (1) the plant disease triangle and (2) integrated pest management (IPM) for diseases.

(1) Plant disease triangle: In order for a plant disease to occur on a crop, three requirements must be met. There must be present a susceptible plant (the host) that is subject to infection. There must be a virulent or infectious agent (the pathogen) that is able to infect a host. Finally, there must be suitable conditions (favorable environment) that allow the host-pathogen interaction to take place. If one or more of these components are missing, then the plant disease will not occur.



(2) Integrated pest management (IPM) for diseases: IPM is the management strategy that combines, as much as possible, diverse means of controlling pests. IPM does not rely on only one course of action but integrates a series of measures such as the following:

- ☑ Monitor, survey, and accurately diagnose the disease.
- ☑ Plant genetically resistant cultivars.
- ☑ Select sites that maximize plant growth but minimize pathogen development.
- ☑ Rotate crops and avoid over-planting any one commodity.
- ☑ Time crop planting and other production steps so as to favor healthy plant growth.
- ☑ Use plant materials that are free of the pathogen and disease.
- ☑ Prevent the introduction or spread of pathogens by using sanitation and exclusion measures.
- ☑ Manage other pests (weeds, arthropods) that harbor or vector pathogens.
- ☑ Judiciously apply effective disease control pesticides, chemicals, and bio-control agents.
- ☑ Modify the growing environment to favor the crops (= cultural controls).
- ☑ Monitor the environmental conditions and weather.

Information for “II. A Disease Management Strategy for Garlic Rust” (back page) was compiled by the following:

Mike Mantelli (Christopher Ranch), Kevin Ruble and Kevin Lehar (Woolf Farming), David Grimes (Sequoia Pack), Ryan Mask and John Duffus (The Garlic Co.), Larry Hanson and Matt Willson (Olam), Ryan Bounds and Louis Hearn (Syngenta Crop Protection), David Anderson (Valley Garlic), Justin Dutra (Stone Land Co.), Steven Koike (UCCE Monterey County), and Bob Ehn (CEO CAGORAB).



IYSP and Thrips Control

- Researchers:
 - Hanu Pappu (WA State Univ.Virology)
 - Eric Natwick (UCCE Imperial Valley)
 - Donna Henderson (UCCE Imperial Valley)
 - Steve Orloff/Larry Godfrey (Tulelake)
 - Tom Turini (UCCE Fresno County)
 - Mike Davis (UC Extension Pathologist, Davis)
 - Howard Schwartz (CSU)



IYSP and Thrips Control

- Determine effects of early season preventative treatments
- Identify thrips species during season
- Evaluate an alternating programmed spray program for thrips
- Determine overwintering sites for thrips
- Evaluate new chemistries for control

Seed Corn Maggot



- Rob Wilson/Larry Godfrey (UCCE – IREC)
 - Evaluation of seed treatment products
- Mary Ruth McDonald (Univ. of Guelph, Ontario)
- Commercial evaluation of FarMor seed treatment

Weed Control Processed Onions

- Weed Control
 - Rob Wilson (IREC)
Herbicide programs
for weed control in
processed onions





Onion Insect Pests

Thrips (*Thrips tabaci*, *Frankliniella* species),
Maggots (*Delia antiqua*, *D. platura*),
Leafminers (*Liriomyza* species)



FIGURE 1



FIGURE 2



FIGURE 3



FIGURE 4

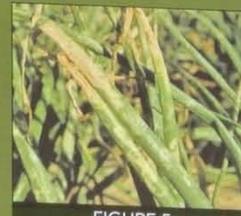


FIGURE 5



FIGURE 6

Storage Fungal Diseases

Black mold (*Aspergillus niger*), Blue mold
(*Botrytis* species), Grey mold or neck rot
(*Botrytis* species), Fusarium rot (*Fusarium*
oxysporum f. sp. *cepae*)



FIGURE 1



FIGURE 3



FIGURE 5



FIGURE 2



FIGURE 4



FIGURE 6

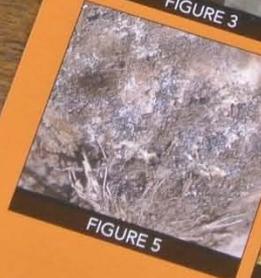


FIGURE 5



FIGURE 3



FIGURE 2



FIGURE 4

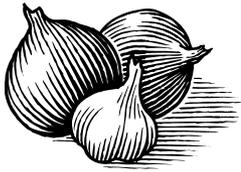


FIGURE 3

Thank you to:

- Syngenta
- Dow Chemical
- Bayer CropScience
- DuPont
- Valent
- MANA
- BASF
- Bejo Seeds
- John Deere Water
- Nichino America





QUESTIONS???

THANKS FOR YOUR TIME