Soil-borne Pest Management in Grape and Berry Production

UCDAVIS
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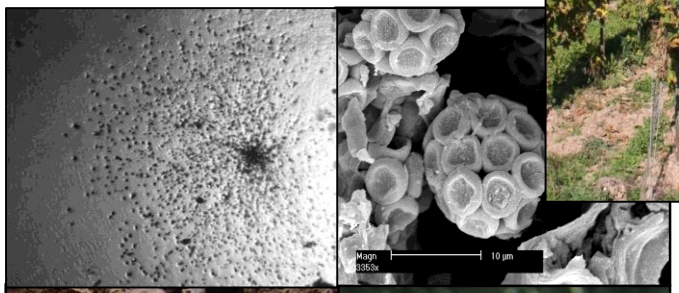


Visions, Research and Future Prospects

Overview

1.) Introduction

2.) Research

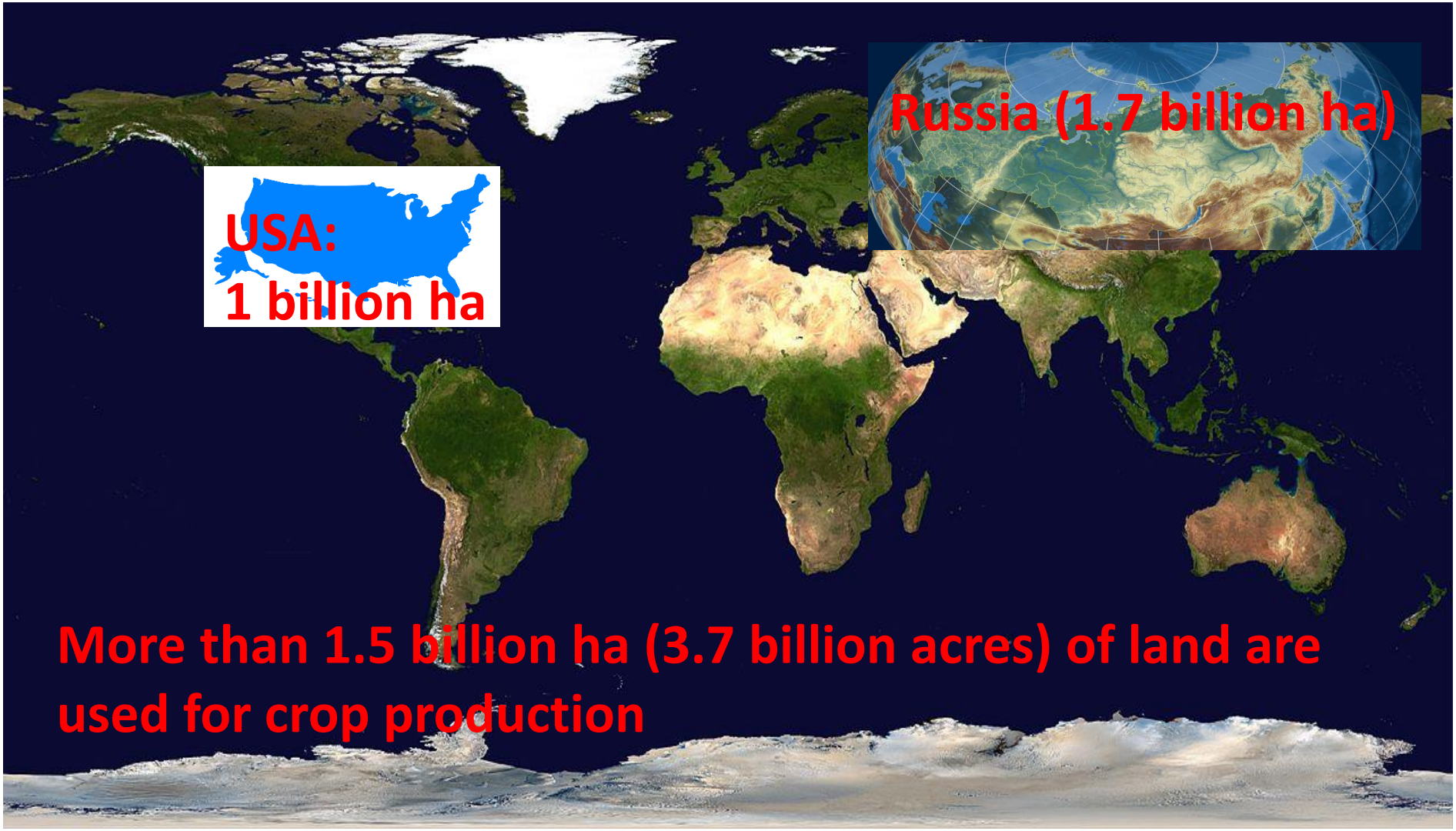
Approaches of non-chemical control of soil-borne pests and pathogens in German Viticulture

Weed and Pathogen Control with Steam in CA Strawberry

3.) Outlook

Short and Long-term Goals as Extension Specialist in New Mexico

Introduction



NASA/FAO

Introduction

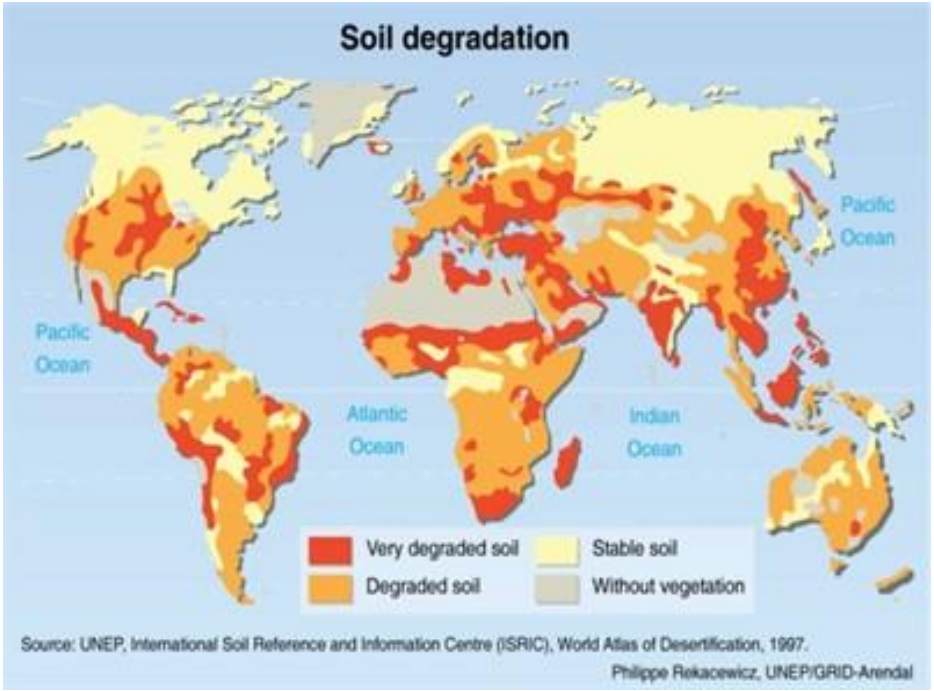
Soil – Limited Resource

Modernfarmer.com

Limited amount of land
Slow building process
Significant link in environment

Introduction

Soil – Limited Resource



UNEP 1997: World Atlas of Desertification

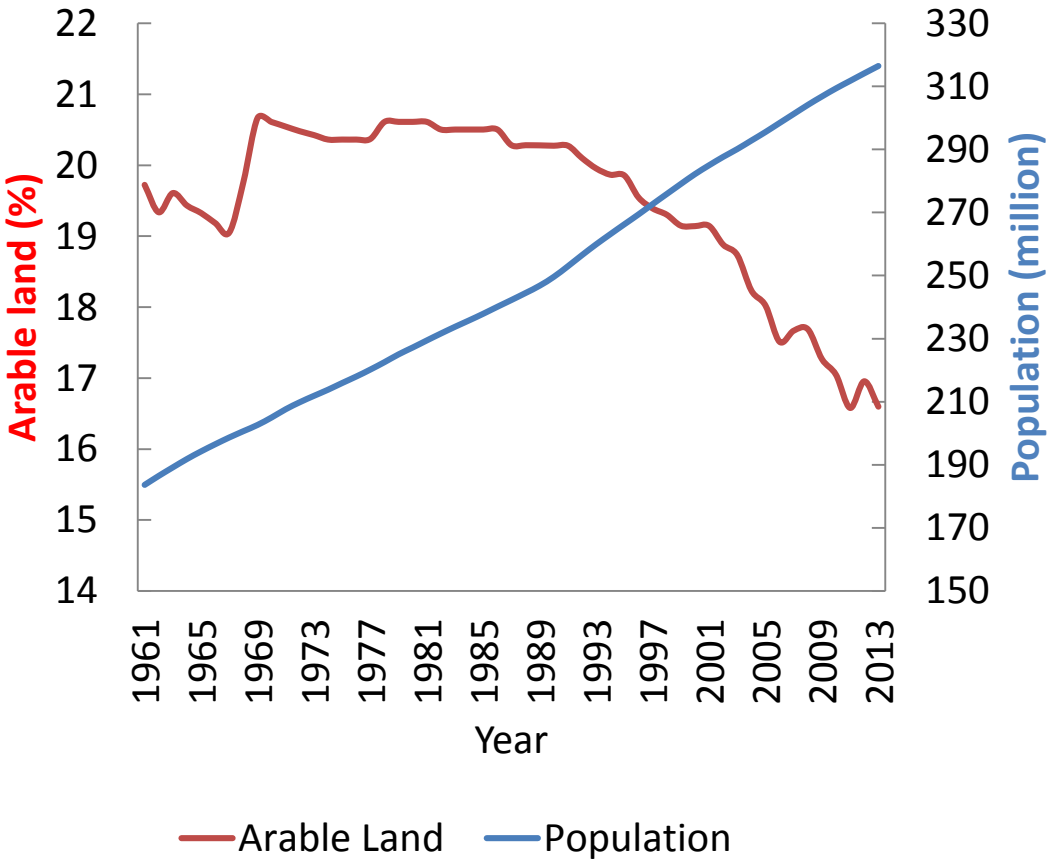
USA: farmland degradation: 10 times faster than regeneration

World: Estimated loss of arable land:
Approx. 0.7%/year
Approx. 30%/40 years

(FAO & Pimentel & Burgess 2013)

Introduction

Soil – Limited Resource



Data: World Bank

USA:

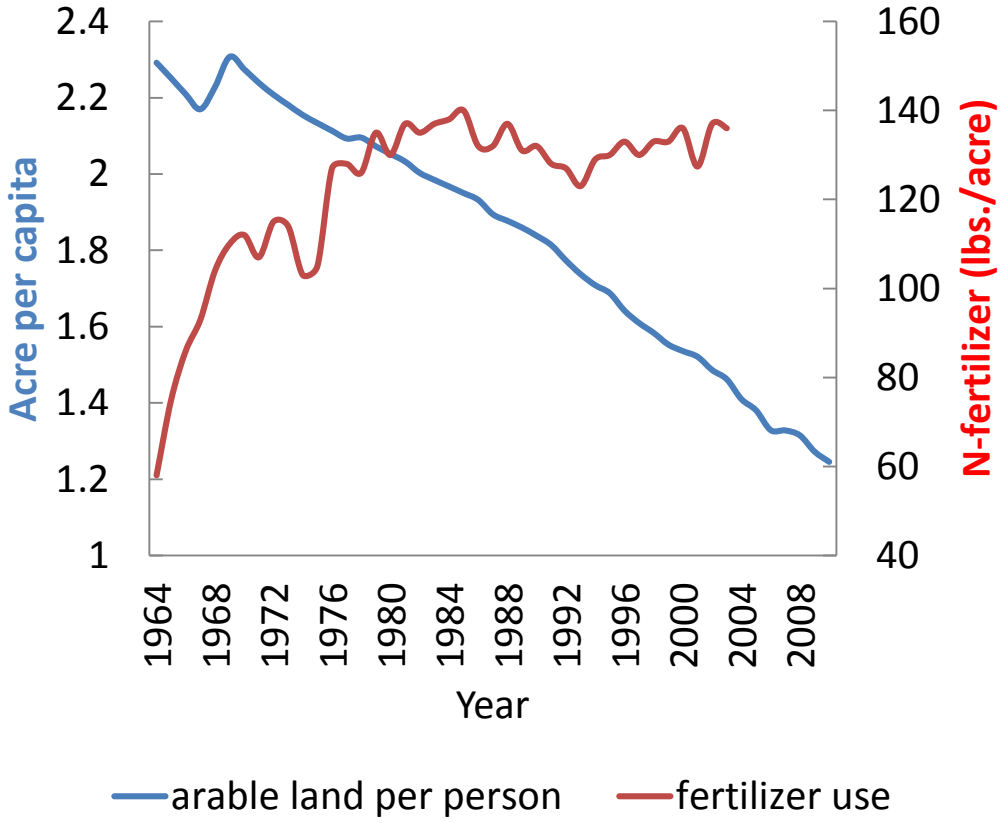
Increasing Population

Increasing demand

Loss of arable land (urban growth, soil degradation)

Introduction

Soil – Limited Resource



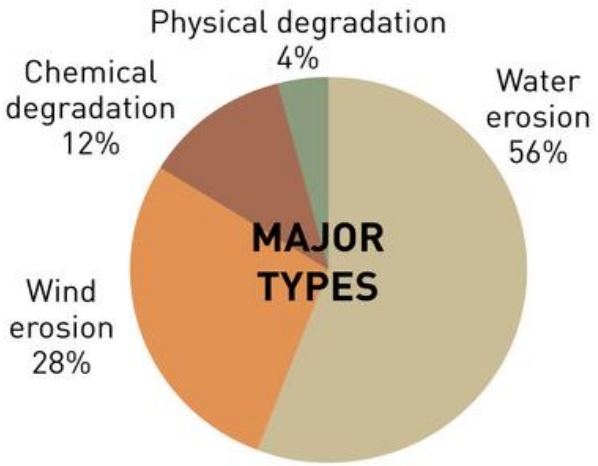
Estimated loss in revenue due to Soil Erosion for USA:

$ 100 million/a - $ 44 billion/a

Data: USDA and World Bank

Introduction

Soil – Degradation



Degradation of Soil Health → Biological Degradation

27 % due to agriculture

Data: FAO/UNEP

Introduction

Healthy Soil

Forces.si.edu

Millions of bacteria
Several thousands of fungi
Thousands of protozoa
Hundreds of invertebrats

'Healthy' Soil → Healthy Plants

Introduction

Soil Management – Precise and Integrated Future

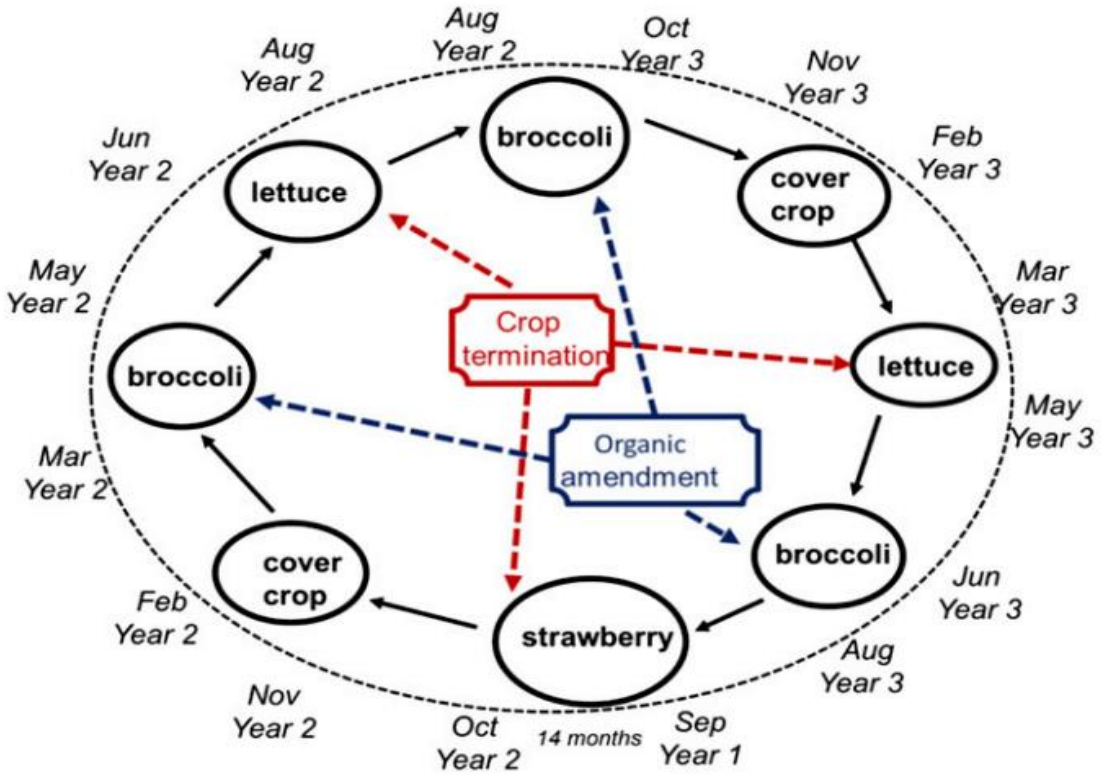
Teachhub.com

Build and maintain healthy soil by precise soil management

- Development of tools
- Integration of disciplines
- Adding value to land
- Education

Introduction

Soil Management is Complex



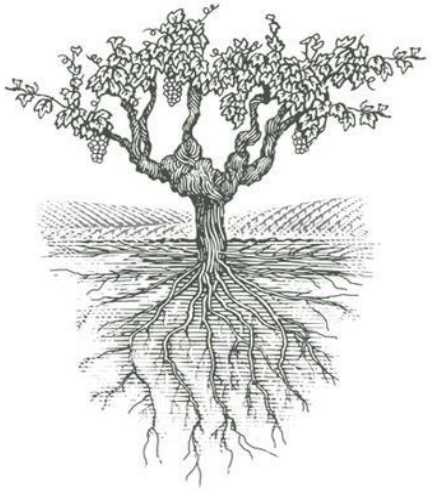
Verticillium dahliae Control in the Salinas Valley

Chellemi et al. 2016, Phytopathology 106(3): 216-255.

Research

Research

Soil-borne Pest Management in Viticulture

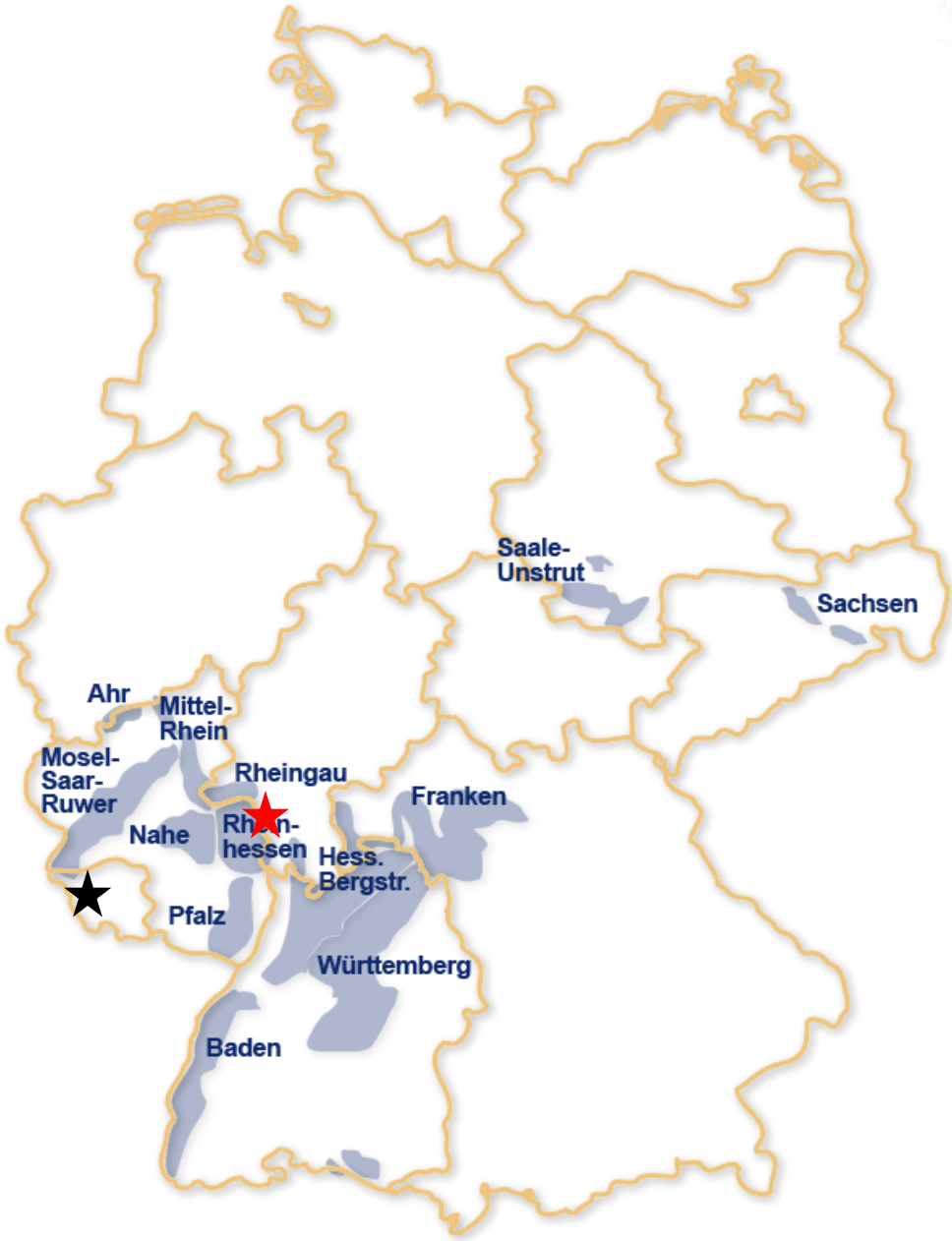


- Introduction
- Grape Root Rot
- Grape Phylloxera
- Conclusions

Research

Viticulture in Germany

Total: 260,000 acre
52 – 66 Million gal/a



Research

Soil-borne Threats

Grape Root Rot (*Roesleria subterranea*)

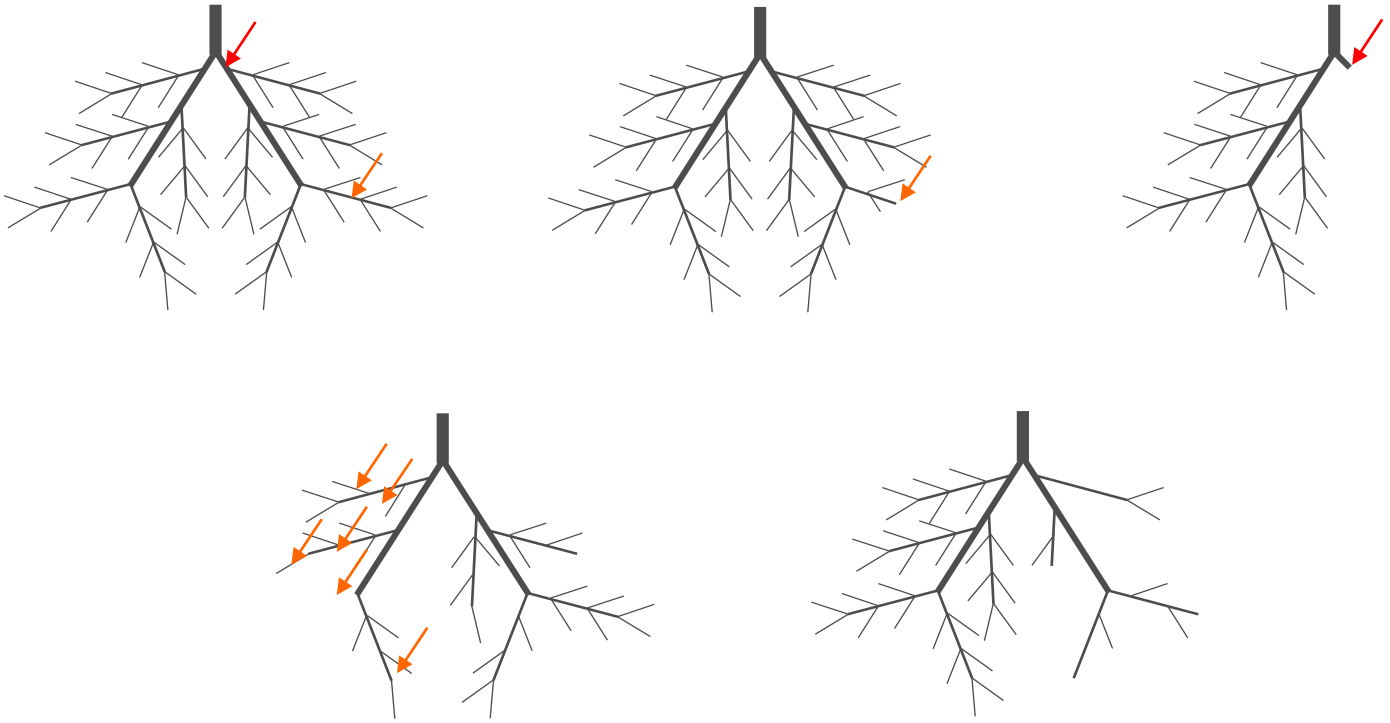
Infects healthy roots: plugs Xylem

Leads to die back and dead of plant

Lives as saprophyte and parasite

Research

Grape Root Rot – Mechanism



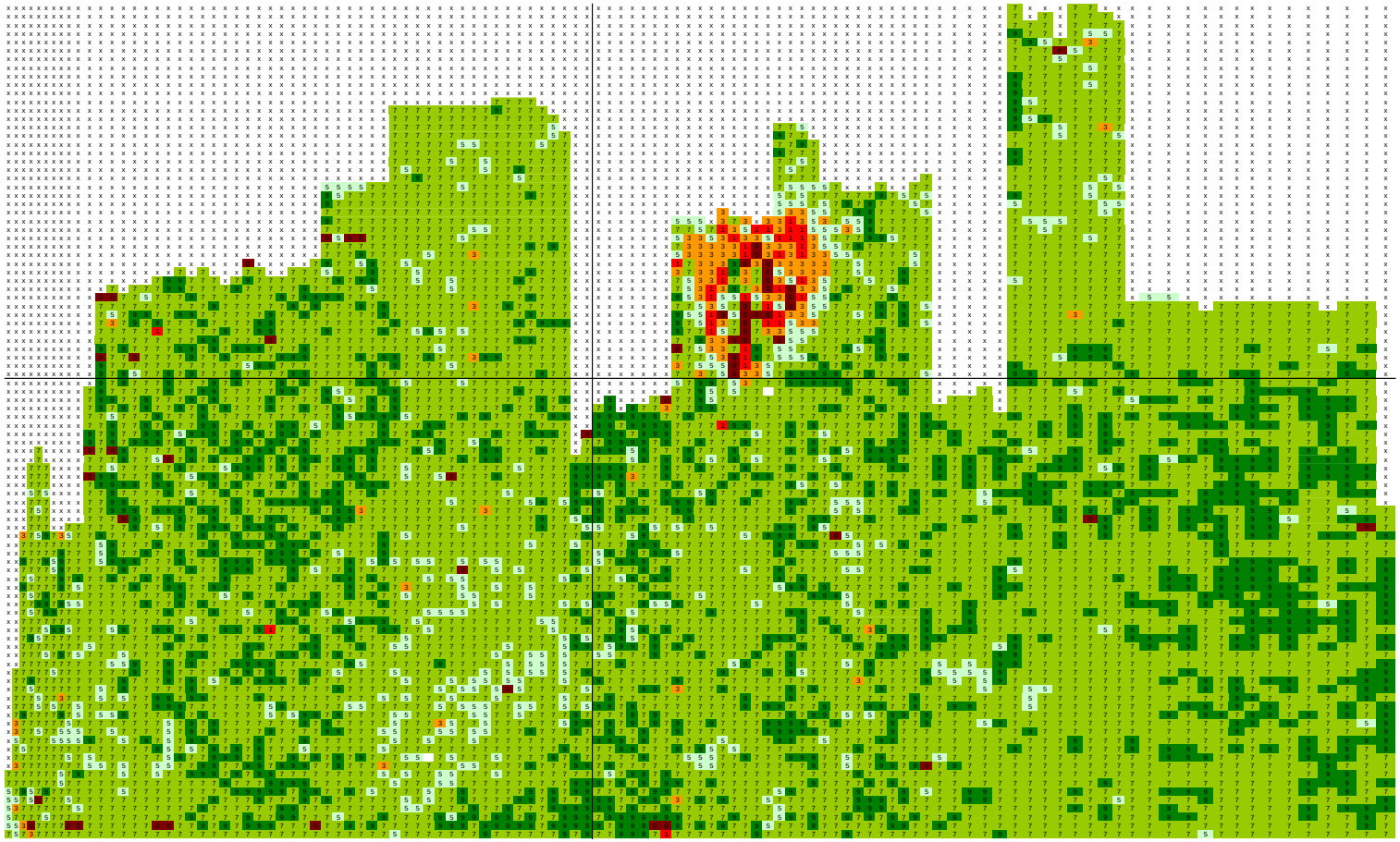
Research

Grape Root Rot – Dieback in mature vineyards

Wiltingen, Mosel, Germany, 2008

Research

Grape Root Rot – Dieback in mature vineyards



Wiltingen, Mosel, Germany, 2008

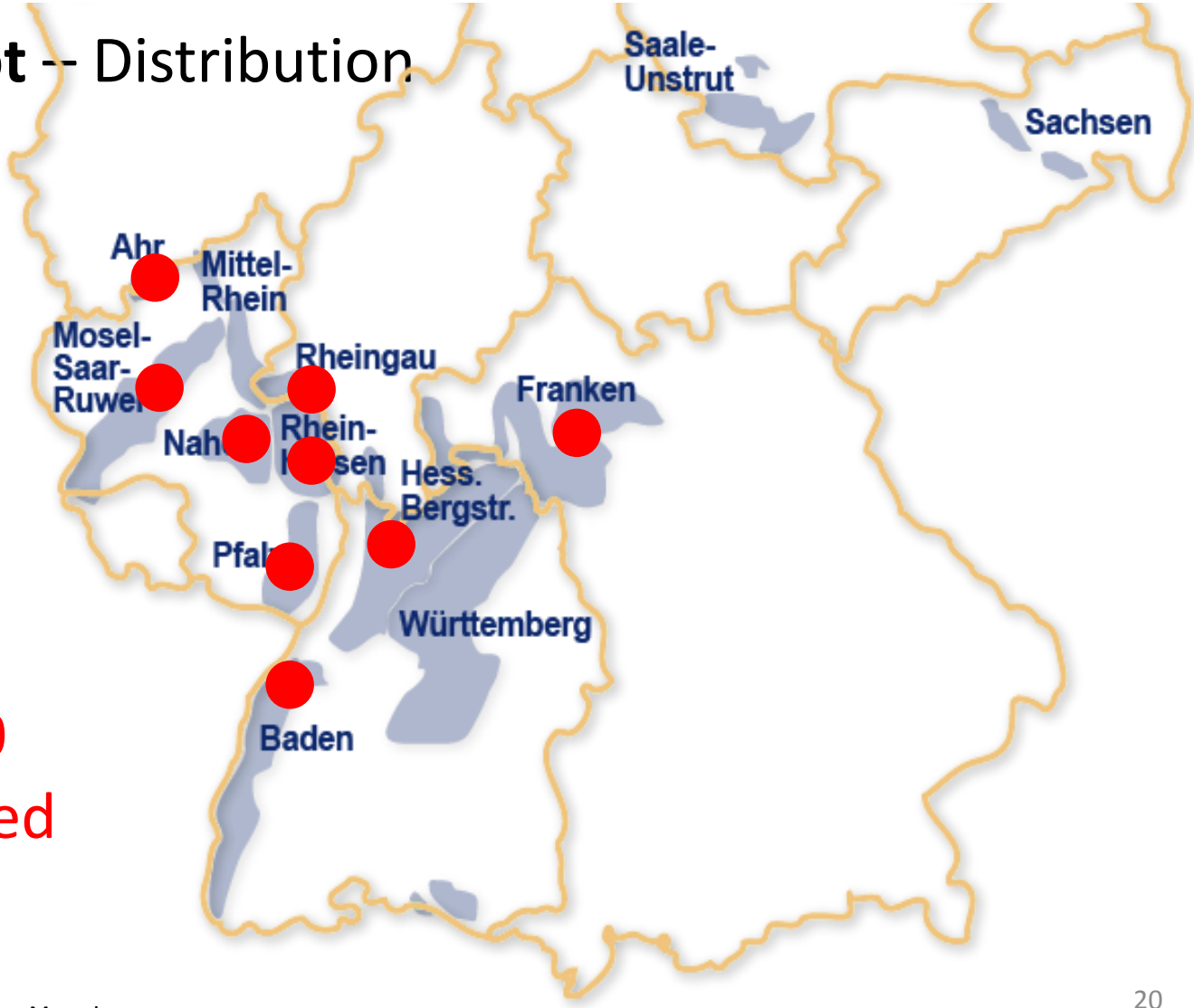
Research

Grape Root Rot – Replant Disease

Ahr, Germany, 2009

Research

Grape Root Rot -- Distribution (2010-2011)



More than 50 fields identified

Hoffmann et al. (2012), German Wine Grower Magazine

Research

Grape Root Rot – Control and Prevention

- Monitoring: molecular detection in root material (cost intensive) / visual survey of root material between October and January (no costs).
- Prevention: Clean machinery before entering another field. Remove infected plants NOT between September and February.
- Control: No established control method. Mature vineyards: Organic Material, intensive Monitoring, cover crops. Young vineyards: no replanting

Research

Grape Root Rot – Outreach between 2010-2011

- Print and online guidelines for growers to identify grape root rot in field*
- Call service to schedule appointments for identification purposes
- 4 publications in grower magazines
- 2 Grower meetings and field days

*Hoffmann et al. (2012), Hessian Ministry of Agriculture

Research

Grape Root Rot – Outlook?

- Biocontrol? Screening of *Trichoderma* species
- Trap Plants? Field trial with young peach plants
- Cover Crop? Field trials with Mustards
- Control via Soil Management?

Research

Soil-borne Threats

Grape Phylloxera (*Daktulosphaira vitifoliae*)

Aphid

Host-specific to *Vitis spec.*

Native North America

Root and Foliar Pest

Research

Grape Phylloxera (*Daktulosphaira vitifoliae*)

Population Dynamics

Three stages of population dynamics:

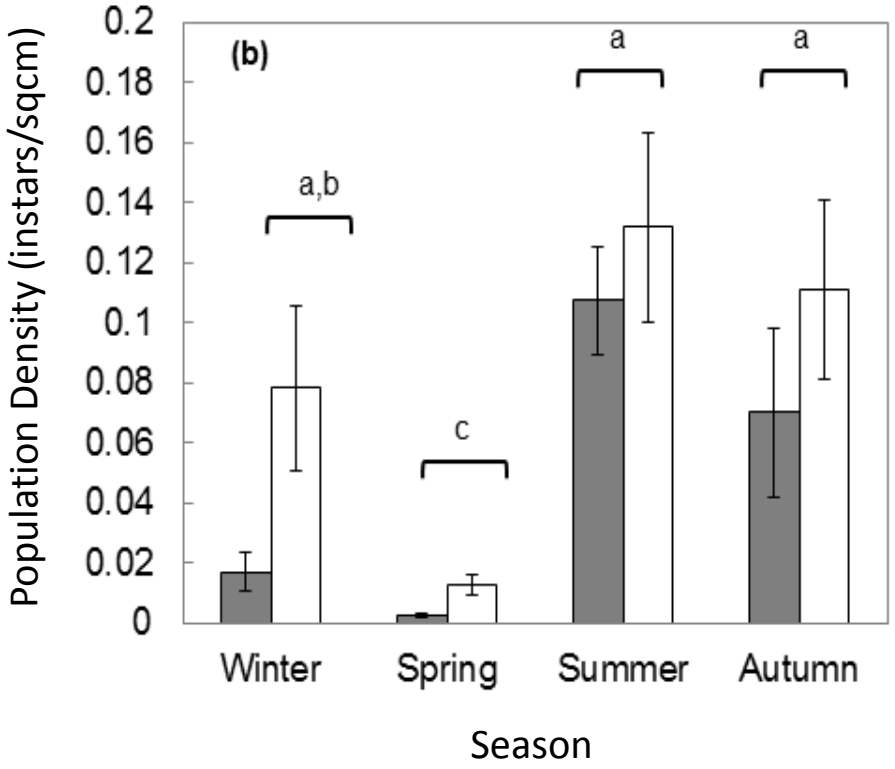
- Winter to Spring: Depletion
- Summer to Fall: Reproduction
- Fall to Winter: Overwintering

Hoffmann et al. 2016, Aus. J. Grape and Wine Res. 22: 271-278.

Research

Grape Phylloxera (*Daktulosphaira vitifoliae*)

Population Dynamics

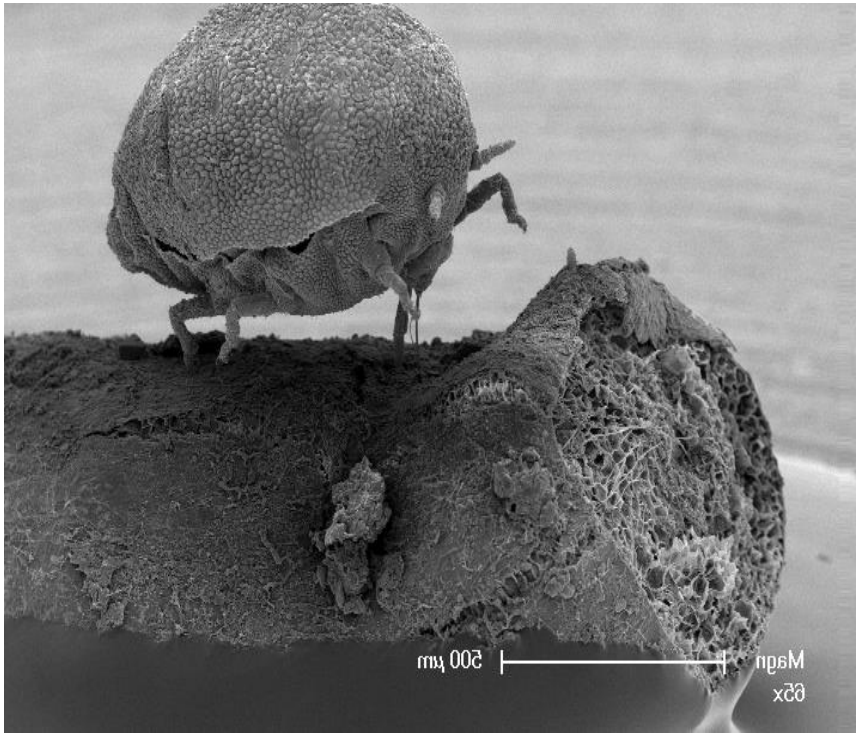


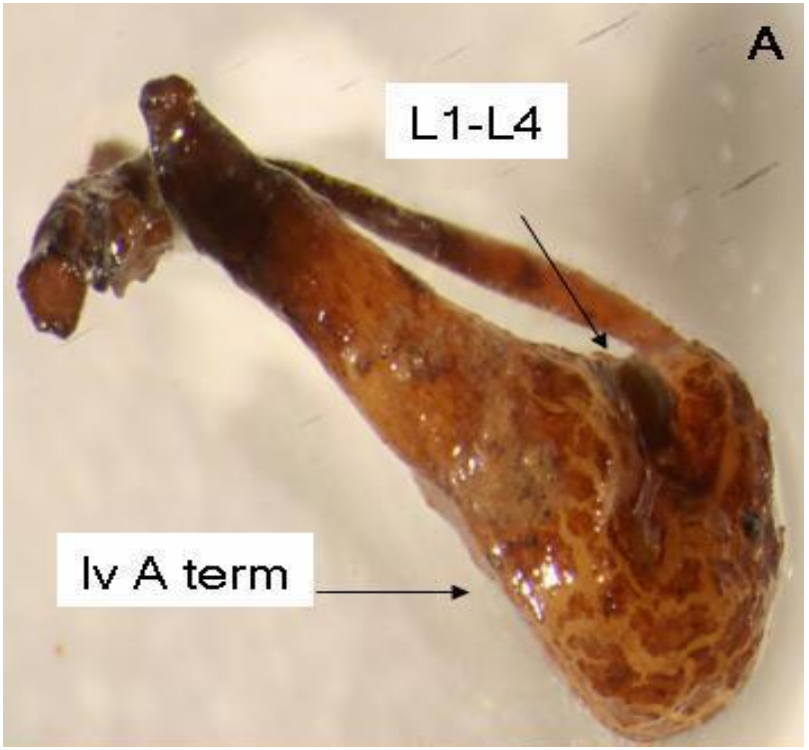
Hoffmann et al.,2011, Acta Hort. 904:101-110.
Hoffmann et al. 2015, Vitis 54, 137-142.
Hoffmann et al. 2016, Aus. J. Grape and Wine Res. 22: 271-278.

Research

Grape Phylloxera (*Daktulosphaira vitifoliae*)

Mechanism





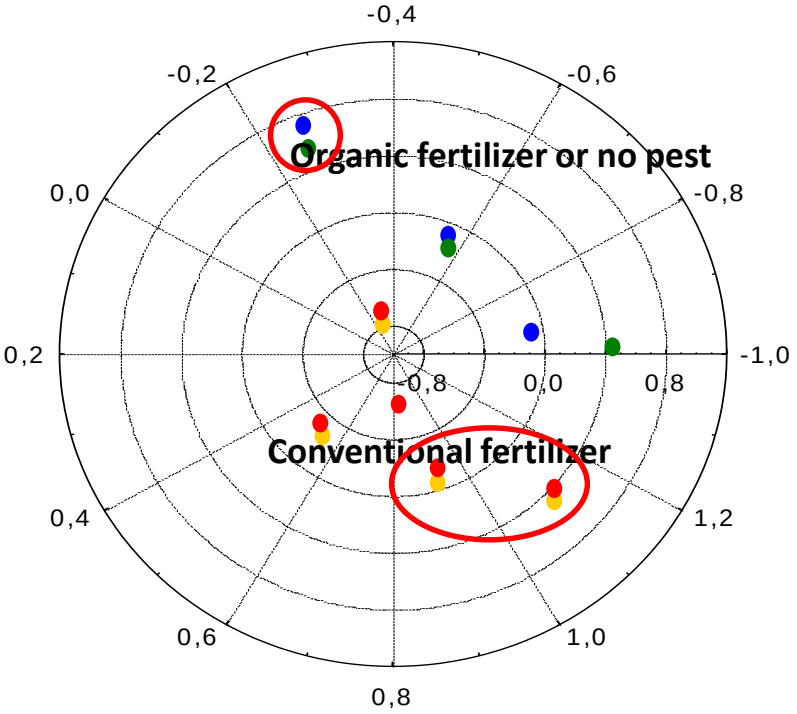
Research

Grape Phylloxera (*Daktulosphaira vitifoliae*)

Fungal Community: Species Composition

Field Sites:

Color	Management	Phylloxera	Growth
●	Conventional	Not present	No depression
●	Organic	Present	No depression
●	Conventional	Present	No depression
●	Conventional	Present	Depression



Based on isolations and classification

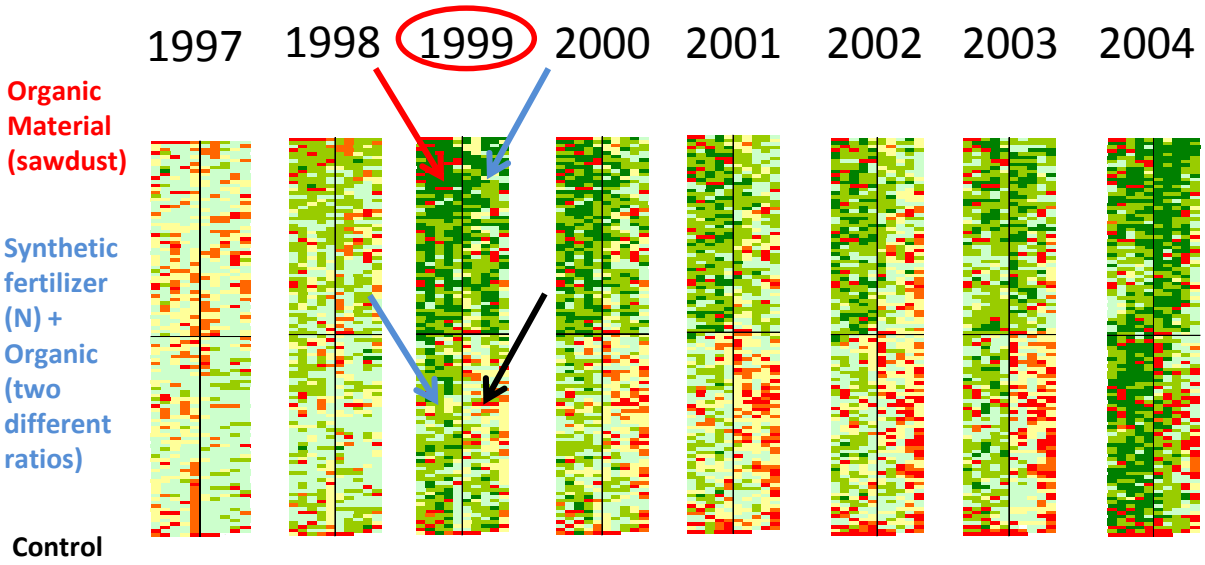
Huber, Hoffmann et al. 2009, Acta Hort 816: 41-51.

Research

Grape Phylloxera (*Daktulosphaira vitifoliae*)

Effects of Soil Management: Plant Vigor

Non-organic;
Phylloxera present at roots;
Disease symptoms;



very strong growth
strong growth
medium growth
weak growth
very weak growth
dead grapevine

Huber, Hoffmann et al. 2009, Acta Hort 816: 41-51.

Research

Grape Phylloxera (*Daktulosphaira vitifoliae*)

Conclusions

Conventional soil management:
higher abundance of secondary pathogens
→ More growth depression

Organic soil management:
higher abundance of antagonists
→ Less growth depression

Huber, Hoffmann et al. 2009, Acta Hort 816: 41-51.

Research

Grape Phylloxera (*Daktulosphaira vitifoliae*)

Conclusions

Damages in grafted vineyards are not related to grape phylloxera *per se*, but to soil microbial community!

Soil management can alter soil microbial community and decrease aboveground damages in grape phylloxera infested vineyards

Huber, Hoffmann et al. 2009, Acta Hort 816: 41-51.

Research

Soil-borne pest control in viticulture

Can damages related to grape root rot be managed with soil management methods?

Is precise management of root feeding grape phylloxera possible?

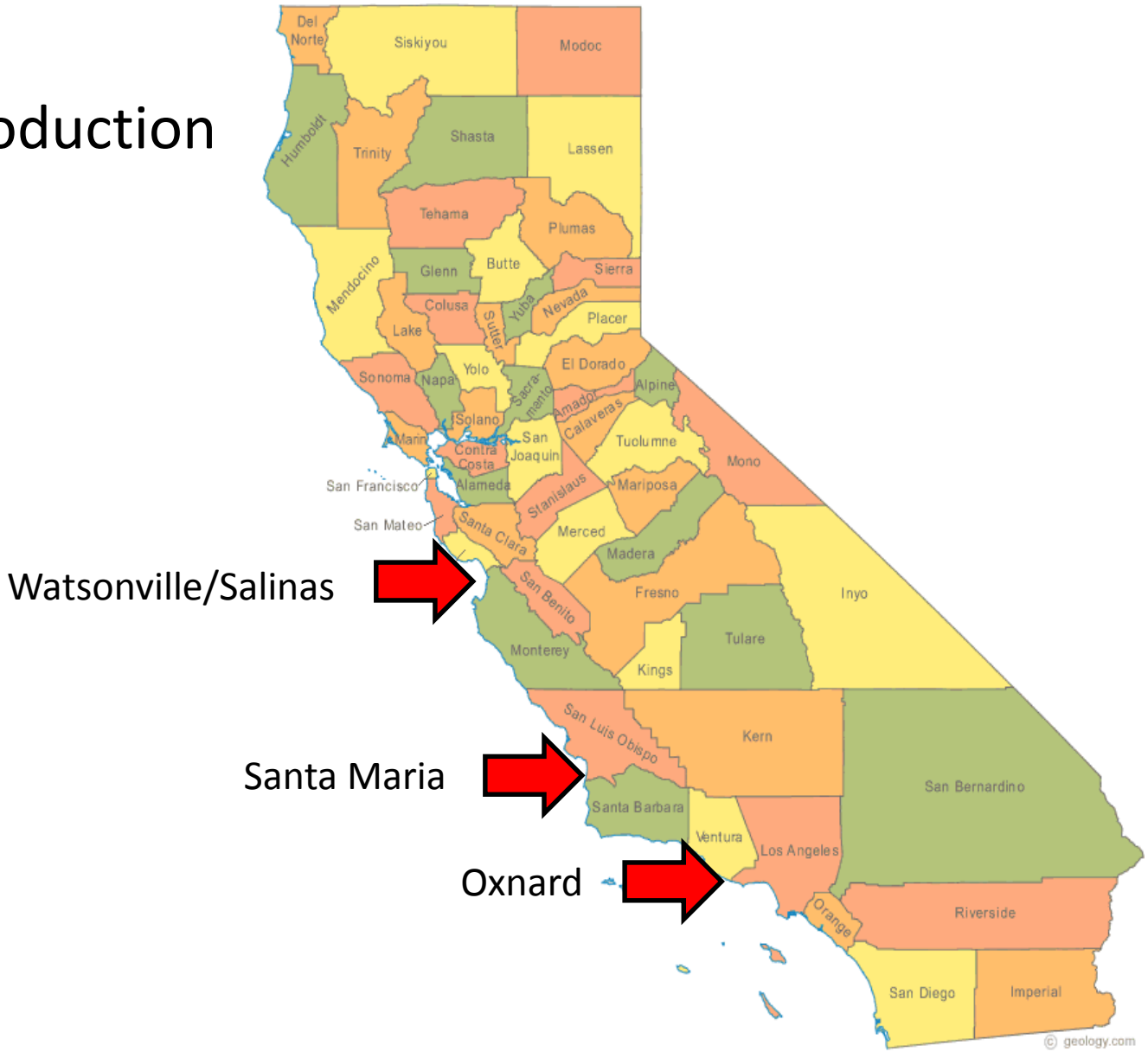
Research

Weed and Pathogen Control with Steam in CA Strawberry Production

- Introduction
- Phase I : Prototype 1 (2011-2015)
- Phase II: Prototype 2 (2015-current)
- Conclusions

Research

California – Production



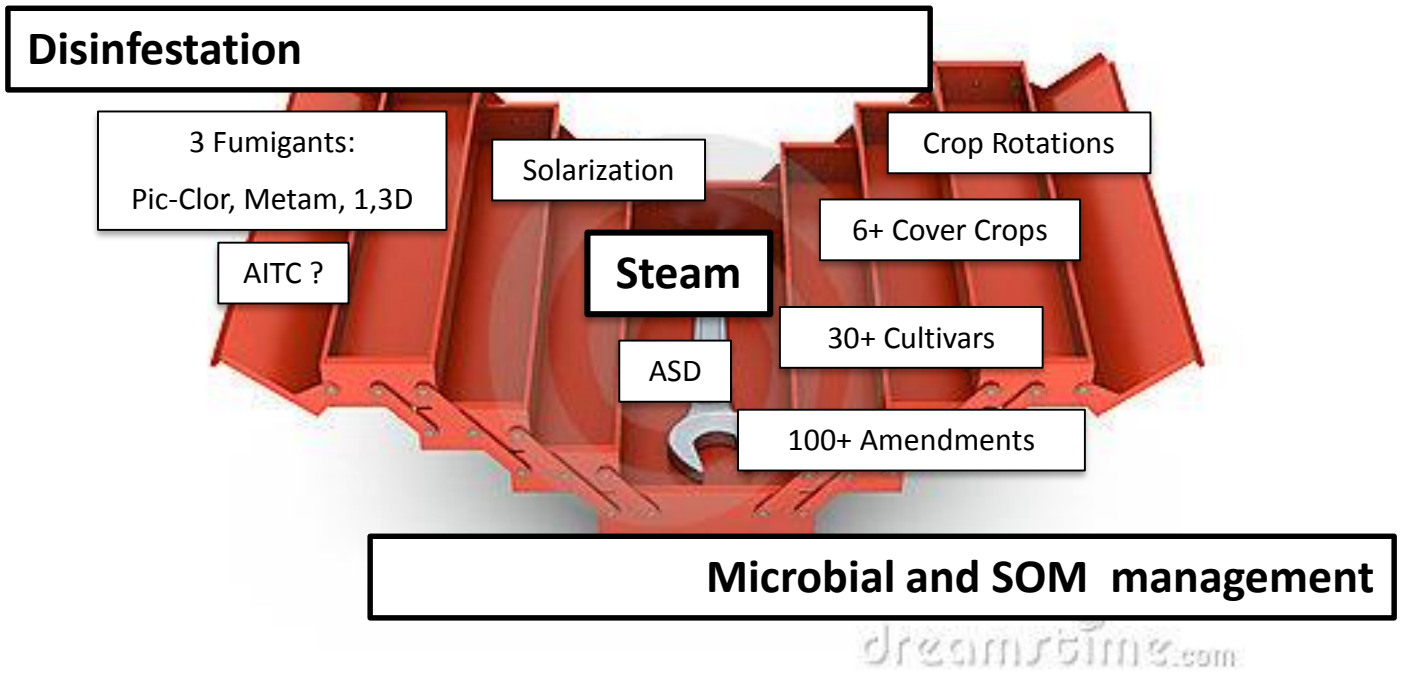
Research

California – Why need of non-chemical Alternatives?

Buffer-zones
Fumigant Regulations
Organic Production

Research

California – Tools in the Toolbox



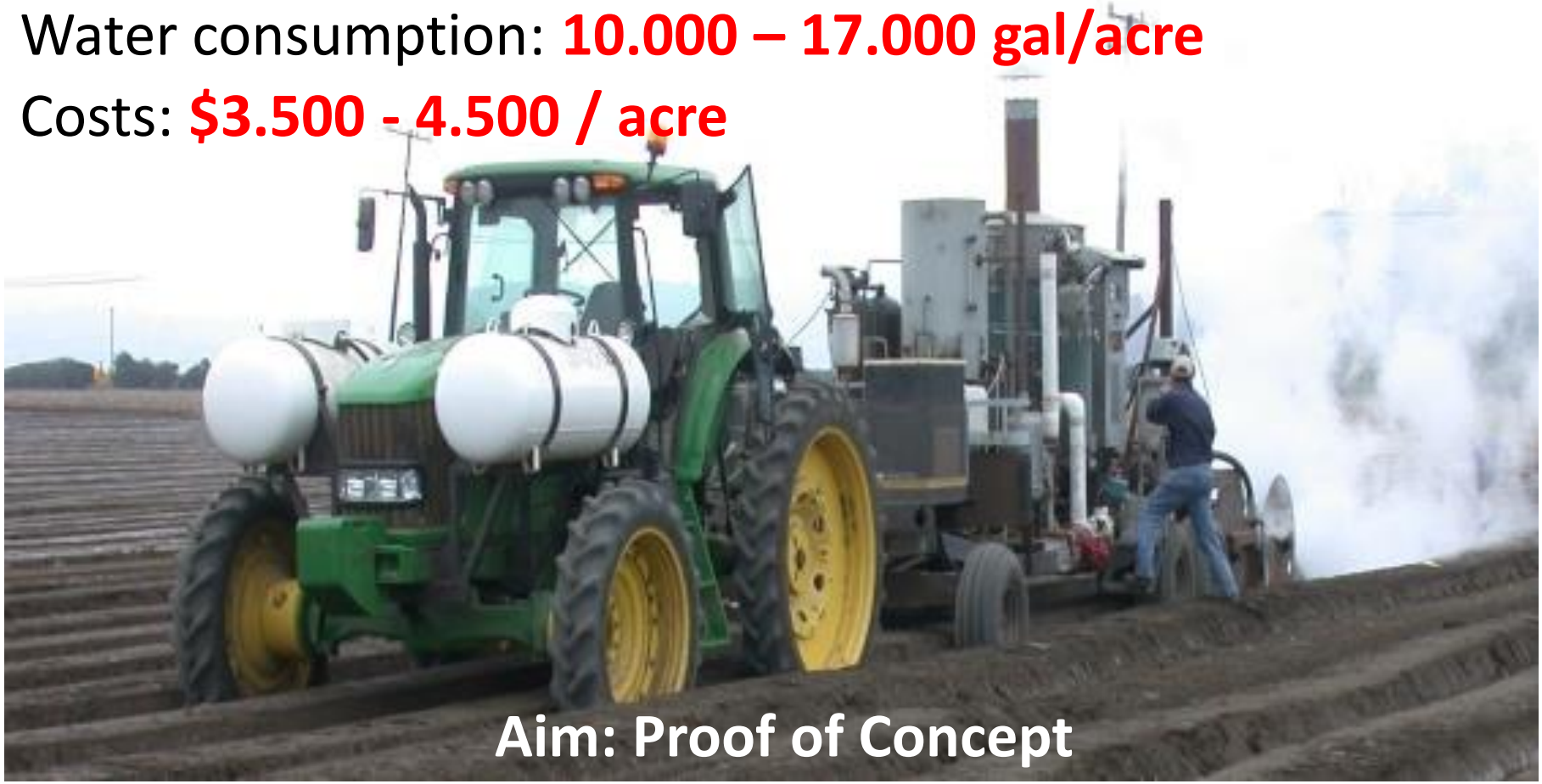
Research – Prototype I (2011-2015)

Speed: **31 – 51 hours/acre**

Propane consumption: **1500 – 2500 gal/acre**

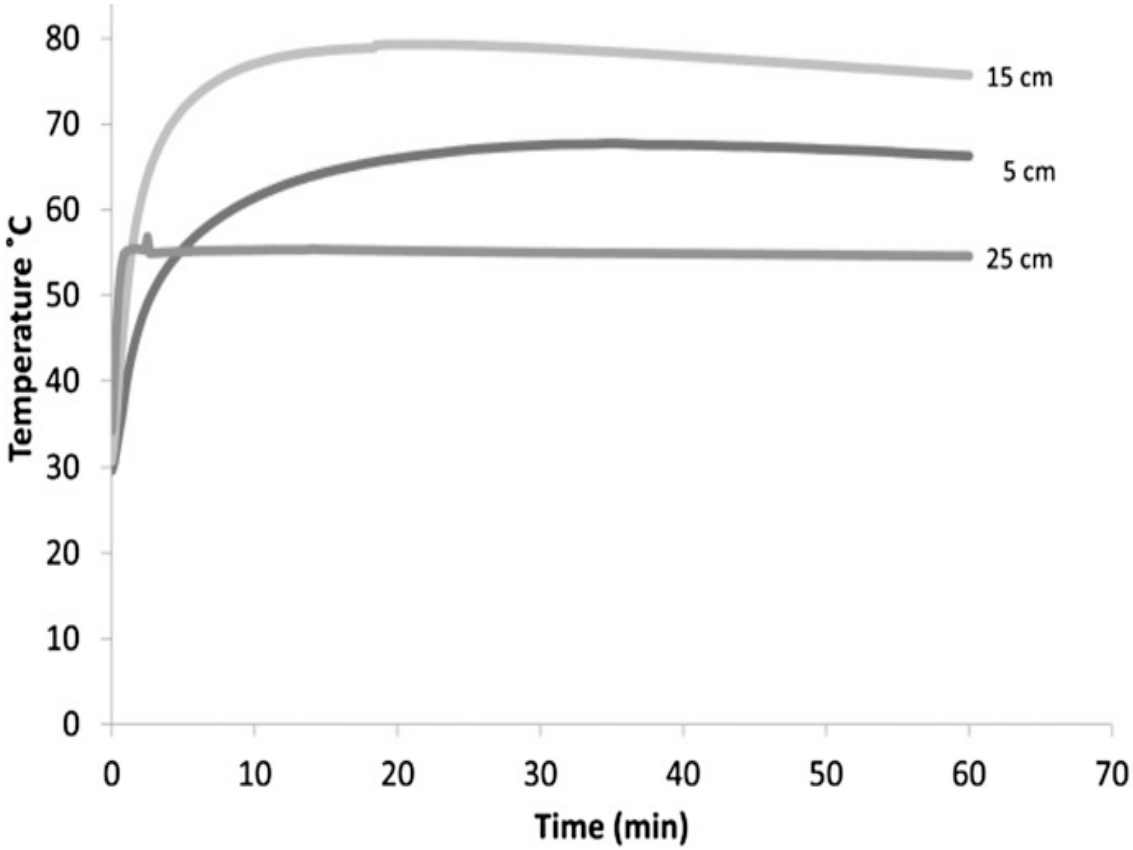
Water consumption: **10.000 – 17.000 gal/acre**

Costs: **$3.500 - 4.500 / acre**



Research – Prototype I (2011-2015)

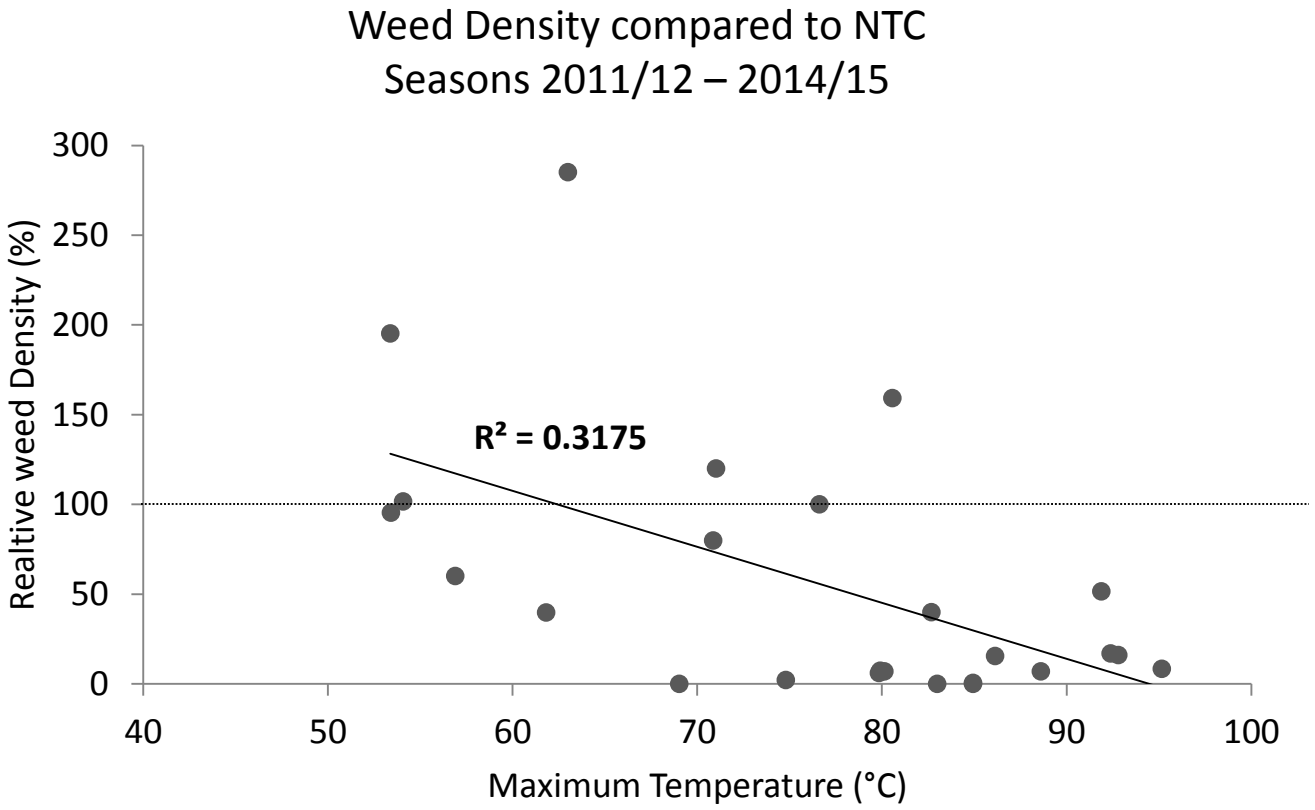
Temperatures



Fennimore et al. 2014

Research – Prototype I (2011-2015)

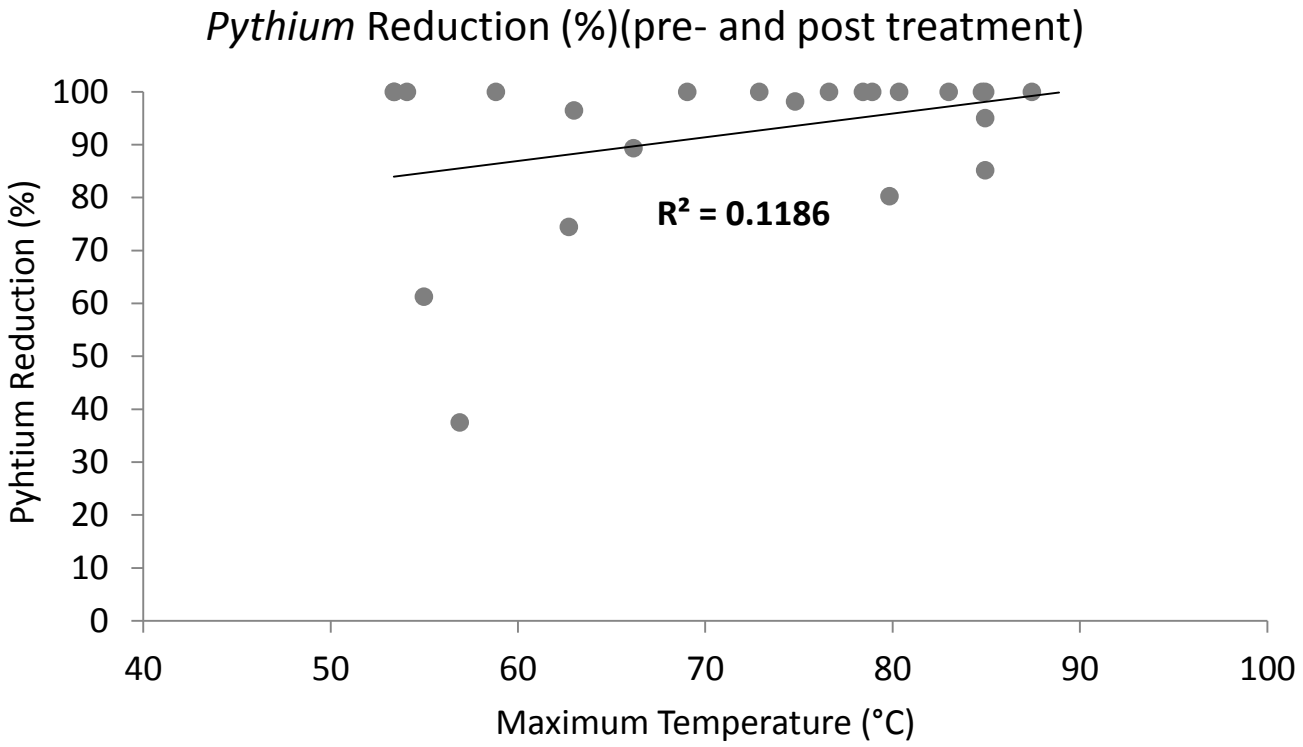
Weed Control



Hoffmann et al. *(in prep)*

Research – Prototype I (2011-2015)

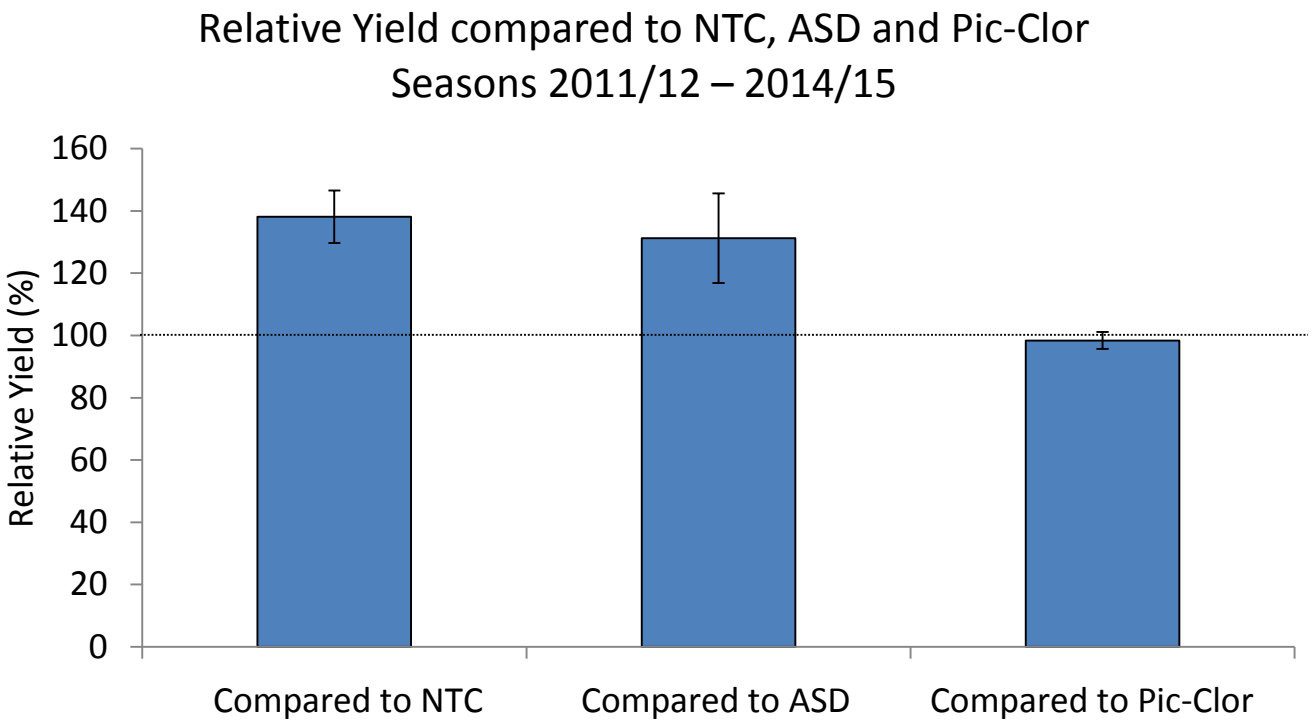
Pathogen Control



Hoffmann et al. *(in prep)*

Research – Prototype I (2011-2015)

Yields



Hoffmann et al. *(in prep)*

Research – Prototype I (2011-2015)

Conclusions

Proof of Concept:

Weed Control, Pathogen Control, Yield Improvement with Steam in CA Strawberry

Make the application more efficient!

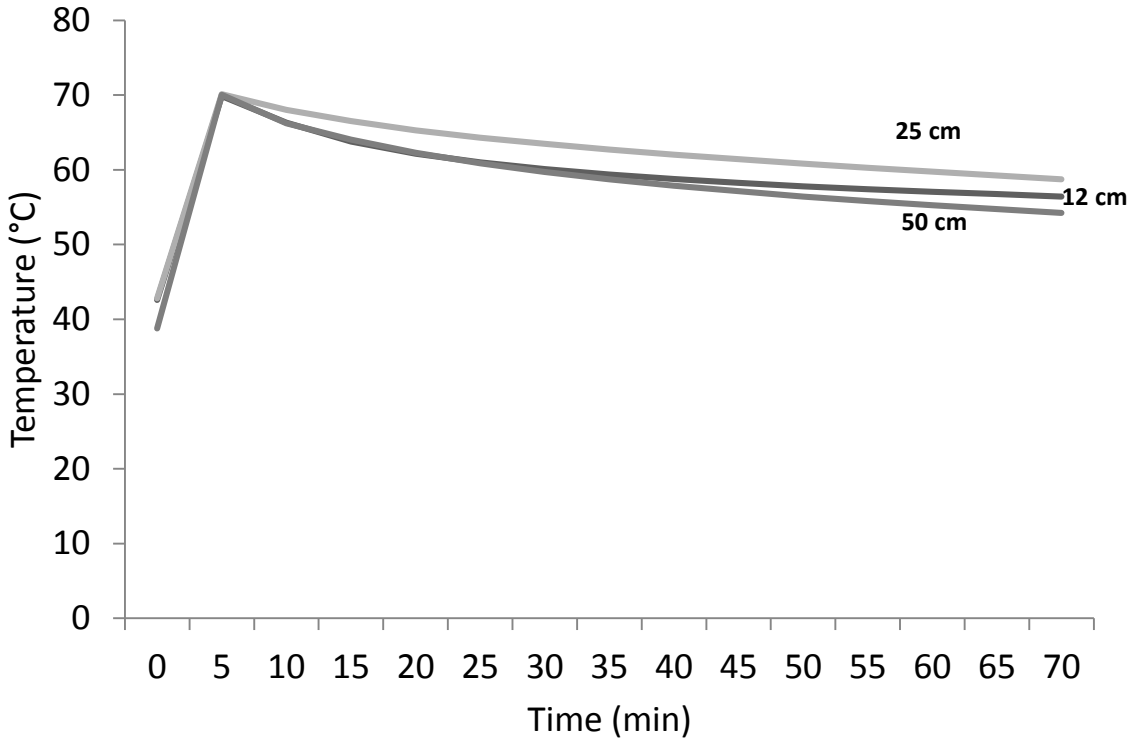
Research – Prototype II (2015-2016)

Research – Prototype II (2015-2016)

Prototype II v.1.0 (October 2015)

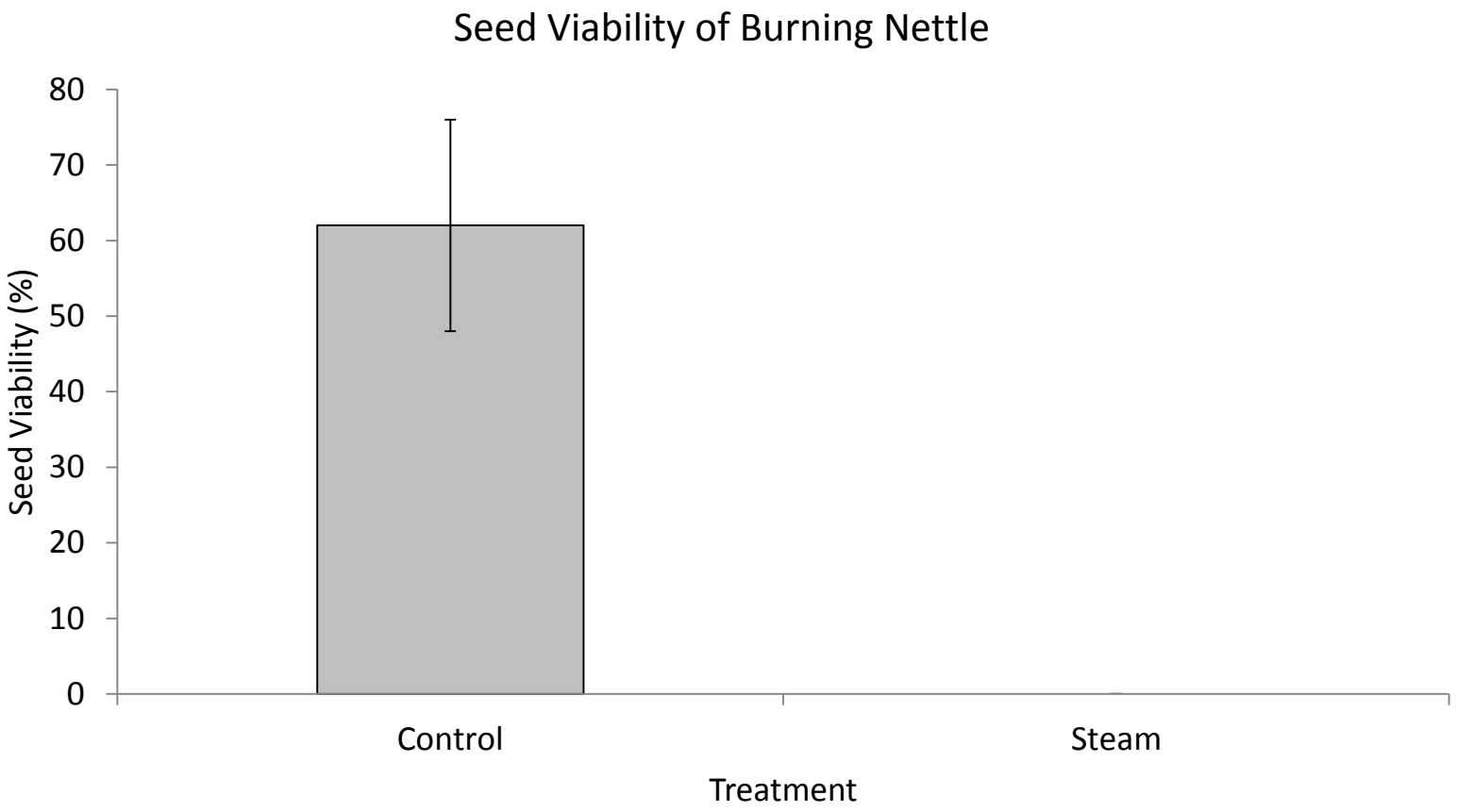
Research – Prototype II (2015-2016)

Temperatures



Research – Prototype II (2015-2016)

Weed Control



Research – Prototype II (2015-2016)

Prototype Development (October 2015 – current)

Fuel efficacy: 855 gal/a ($ 440 per acre)

Improvement:

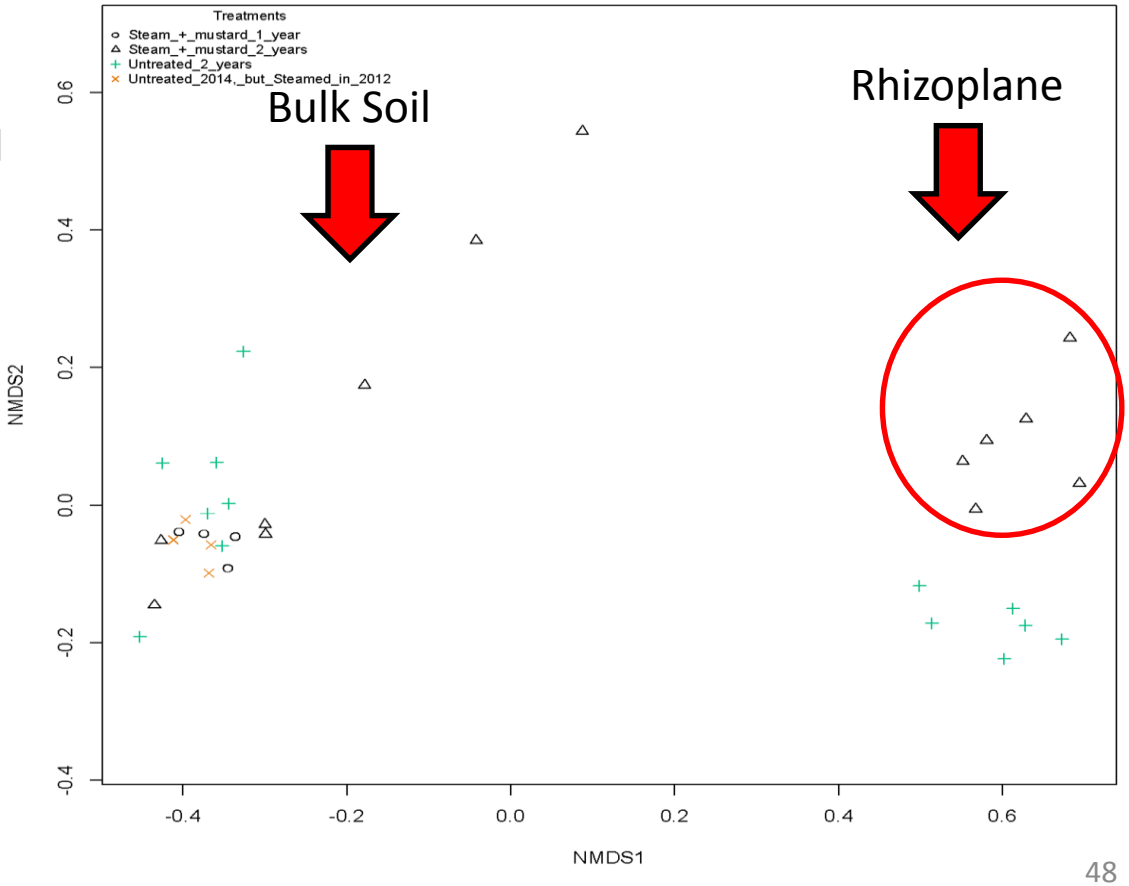
- Energy distribution
- Heat trapping
- Speed
- Water amount and field preparation

Research

Steam + Mustard Seed Meal (MSM) – Microbial Community – 16S Deep Sequencing

Rhizoplane associated included
Novosphingobium,
Sphingomonas,
Phenylbacterium

Bulk soil associated included
Kaistobacter,
Arthrobacter,
Thermomonas



Hoffmann et al. *(in prep)*

Strawberry – Summary

- Proof of concept over four seasons of steam applications with Prototype I
- Improvement of application efficacy by engineering Prototype II
- Differences in plant development and bacterial community due to soil treatments with steam + MSM

Research

Strawberry – Conclusions

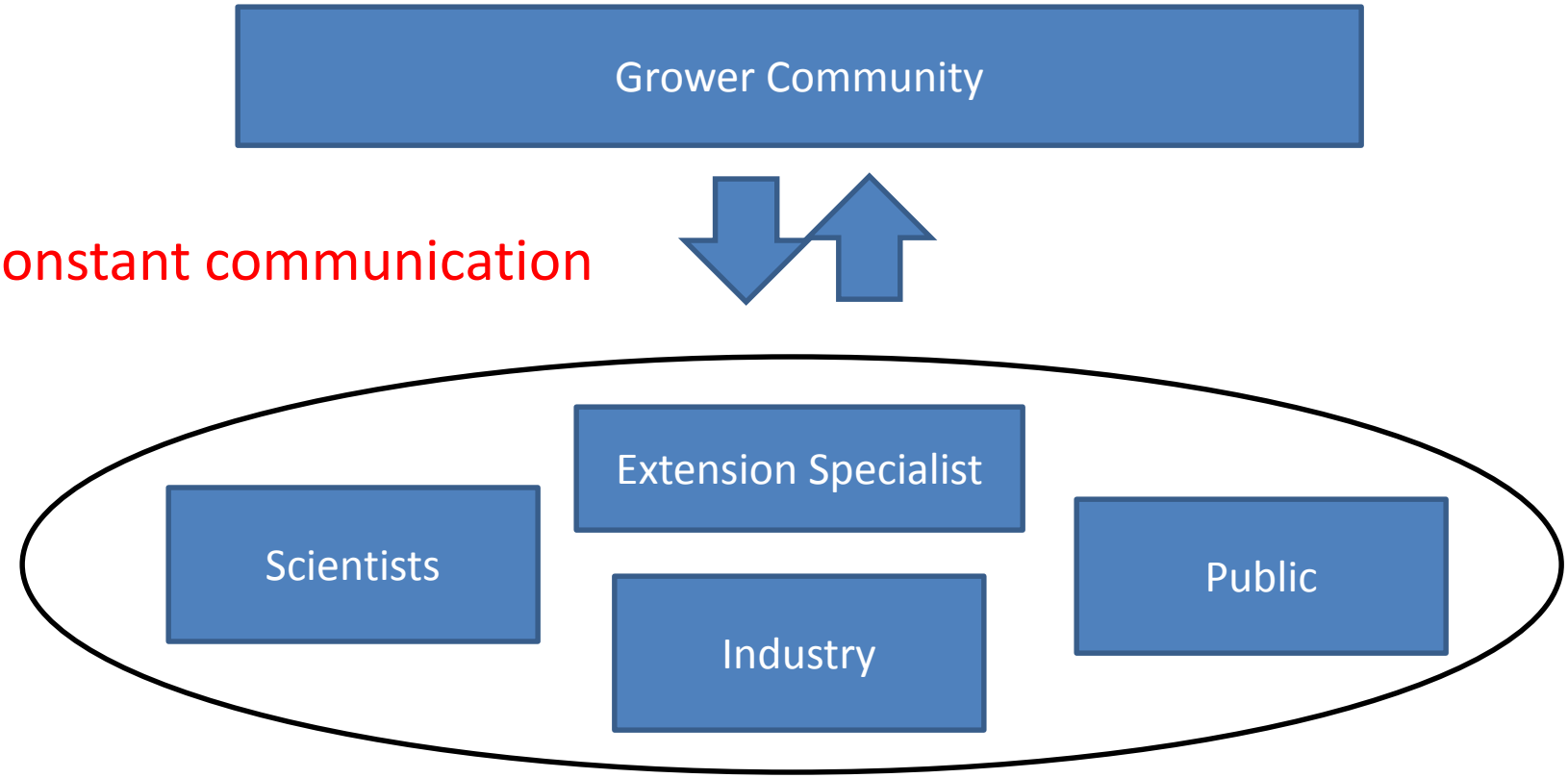
Steam: a valuable addition to the California soil management toolbox

Outlook

Outlook

Viticulture in NM

Where I see myself



Outlook

Viticulture in NM

Personal Guidelines

- Build trust and value in community
- Serve to the needs as part of a team
- Contribute with dedication and innovation
- Get things done

Outlook

Viticulture in NM

Visions – Team Work

Precise sustainable management systems	Weeds, diseases and pests with focus on plant health, yield quality and water usage
Statewide seminar and outreach system	Vineyard establishment, management and wine-making
Media based disease management decision tool	Help to make decisions on sprays, pruning, new establishment of vineyards etc.

Outlook

Precise Sustainable Management

Short-Term Goals

- Establish grower and science collaborations
- Integrate into a team and explore needs!
- Establish laboratory and research program with focus on horticulture and disease detection/management
- Variety selection trials

Potential future threats: GWSS and Pierce Disease, SWD screening, *Armillaria* root rot

SOM Management for young and mature vineyards (amendments, cover crops)

Collaboration with Geisenheim

Outlook

Precise Sustainable Management

Long-Term Goals

- Establishing a functional and quick early disease detection and warning system for viticulture in NM
- Developing precise and simple management systems, using robotic and engineering skills
- International variety selection program

Early detection and warning: Web based, GIS, Data-Analysis, Modeling, Grower input.

Precise Management: Developing robotic techniques for e.g. detection of nutrient deficiency pruning, picking etc.

Outlook

Statewide Seminar and Outreach Program

Short-Term Goals

- Discussion forums with growers, scientists and other stakeholders: needs, feedback, etc.
- Establishment of frequent seminars, field days and an interactive web based education and discussion forums

How? Advertisement, Collaboration with Tech at Universities.

Outcome: Constant exchange with grower community.

Outlook

Statewide Seminar and Outreach Program

Long-Term Goals

- State wide outreach and seminar program with participating of national and international specialists

Brings constant information and value to community.

Outlook

Media based Disease Management Decision Tool

Short-Term Goals

- ❖ Establishing regional grape pest and pathogen data base
- ❖ Collaborating with data-analysts to establish short-term prediction models
- ❖ Collaborating with specialists to include diseases and pests

Outlook

Media based Disease Management Decision Tool

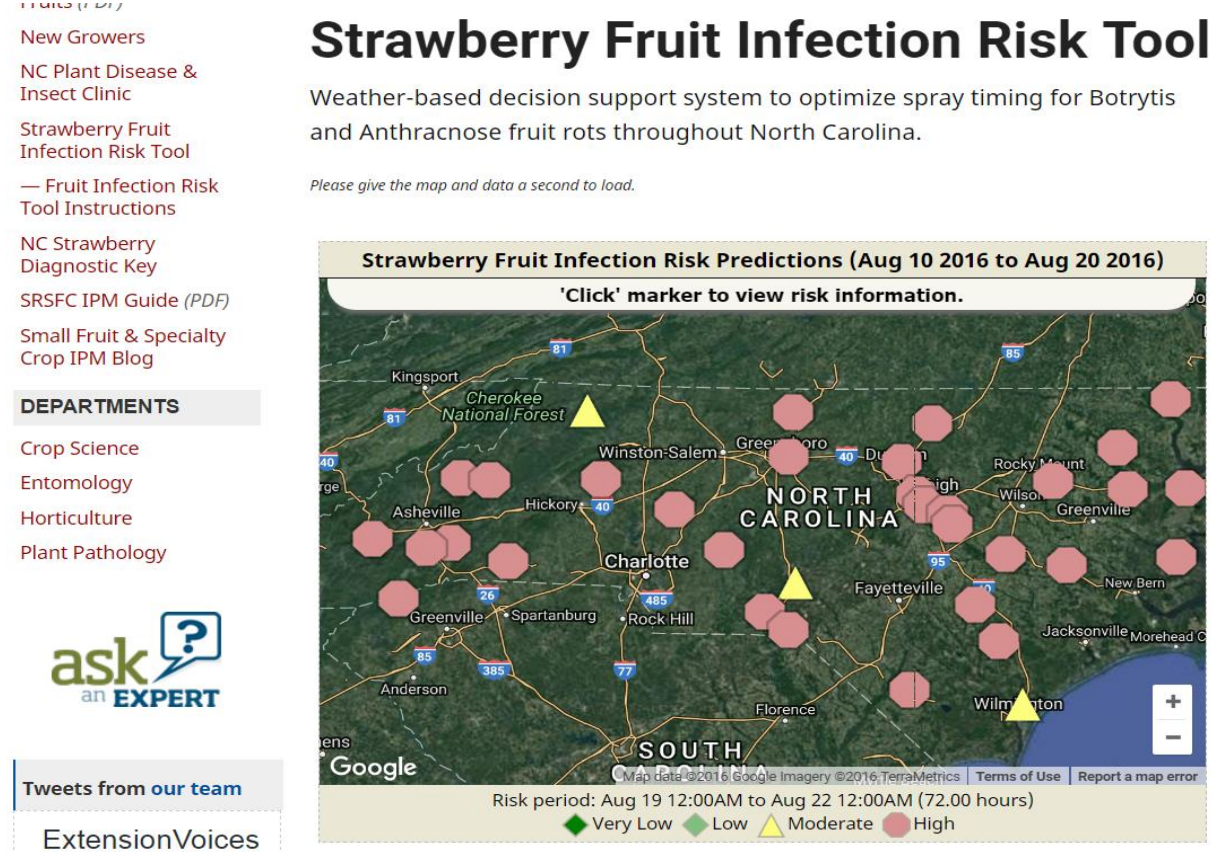
Long-Term Goals

- State-wide web and app based prediction tool to help grower community decide on spray, management and replanting

Outlook

Media based Disease Management Decision Tool

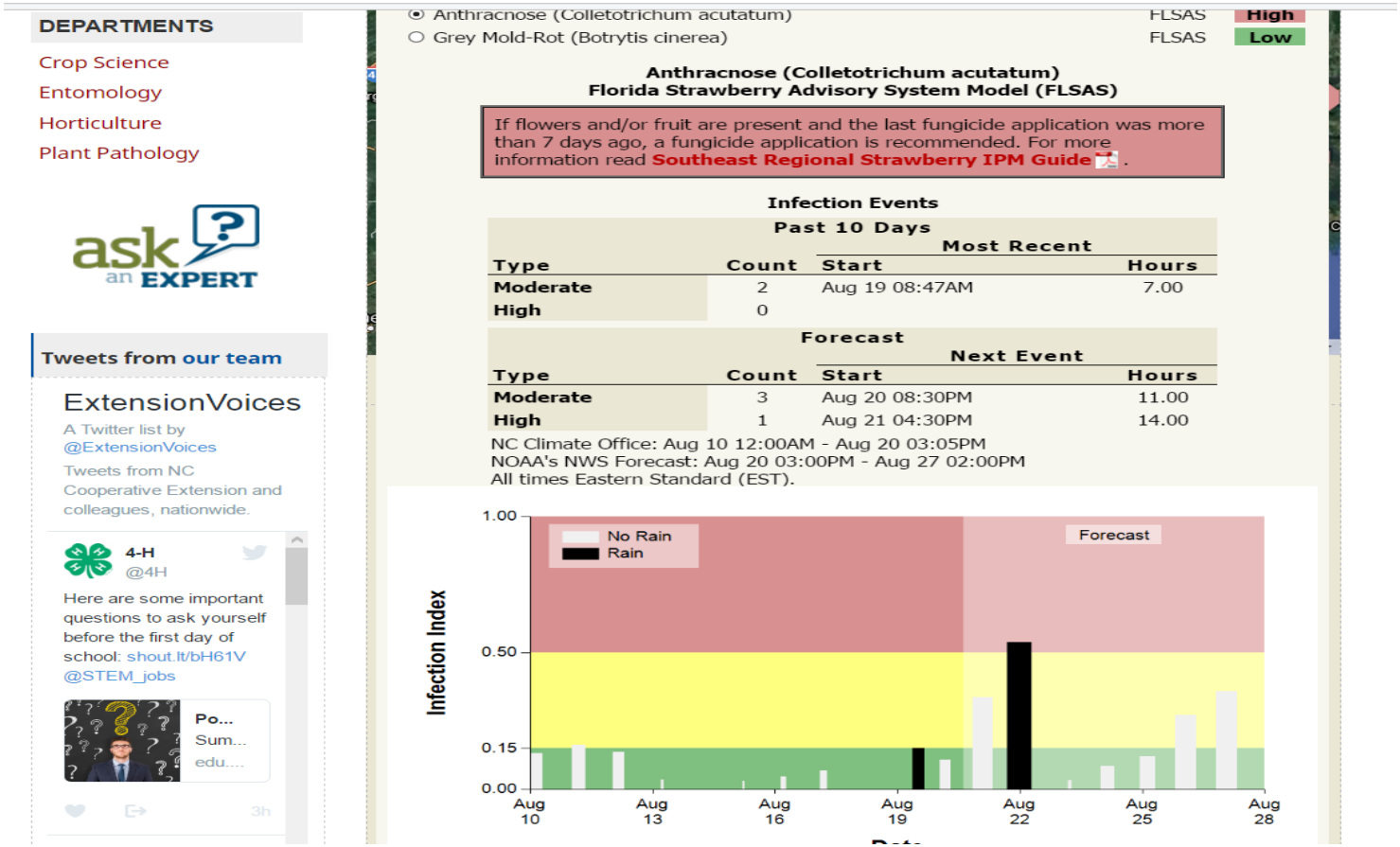
Example from North Carolina



Outlook

Media based Disease Management Decision Tool

Example from North Carolina



Outlook

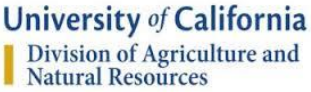
Viticulture in NM

Conclusions

Dreamstime.com

- Personal values and team effort
- Creating positive, creative and productive work environment
- Grower serving systems
- Inclusion rather than exclusion

Funding & Collaborations



Acknowledgments

Growers:
Johan Josef Pruemm, Wiltingen, Germany;
Johannes Boehm, Geisenheim, Germany;
Christian Porten, Mehring, Germany;
Uncle Matt's Farm, Clermont, FL;
Southwest Florida Research & Education Center Research Plot, Immokalee, FL;
Jose Garcia, Salinas, CA;
Roy Fuentes Berries, Salinas, CA;
Mike Mellano, Mellano-Flowers, Oceanside, CA;
Marcos van Wingerten, Pyramid Flowers, Ventura, CA;

Researchers and collaborators:
Dr. Lars Huber, SCC GmbH, Bad Kreuznach, Germany
Dipl.-Oenol. Matthias Porten, DLR Bernkastel-Kues, Germany
Prof. Dr. Ernst Ruehl, Geisenheim University, Germany
Prof. Dr. Gerhard Eisenbeis, Mainz University, Germany
Dr. P.D. Martin Kirchmair, Innsbruck University, Austria
Dr. Mag. Sigrid Neuhauser, Innsbruck University, Austria
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Prof. Dr. Kirsten Pelz-Stelinski, University of Florida, FL
Dr. Monique Coy, Du Pont, DEL
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Dan Hodel, Johnson Gas, IA
Dr. Frank Martin, UDSA-ARS, CA
John Rachuy, University of California, Davis

Thank you for your attention

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