Biology and control of Neofabraea leaf and twig lesions of oil olives in California

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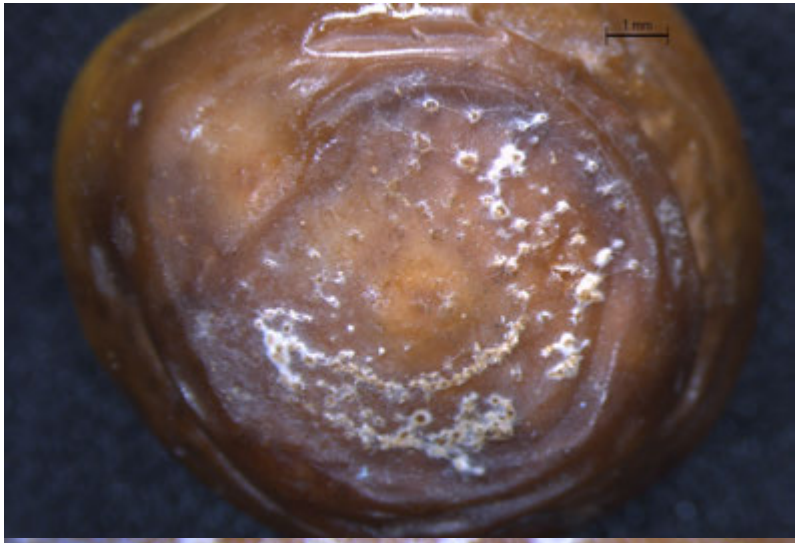
Symptoms: severe defoliation (2016)

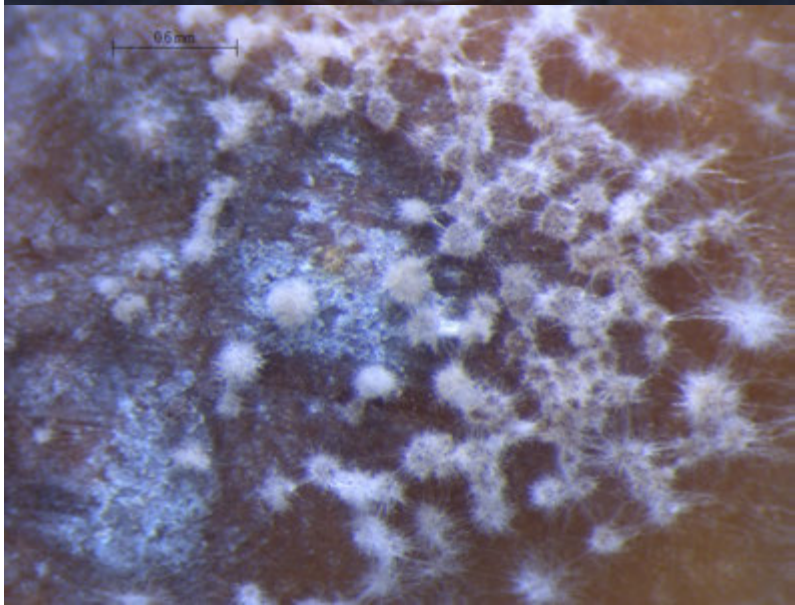
Symptoms: Arbosana

Symptoms: Branch cankers (Arbosana)

Neofabraea diseases in olive:

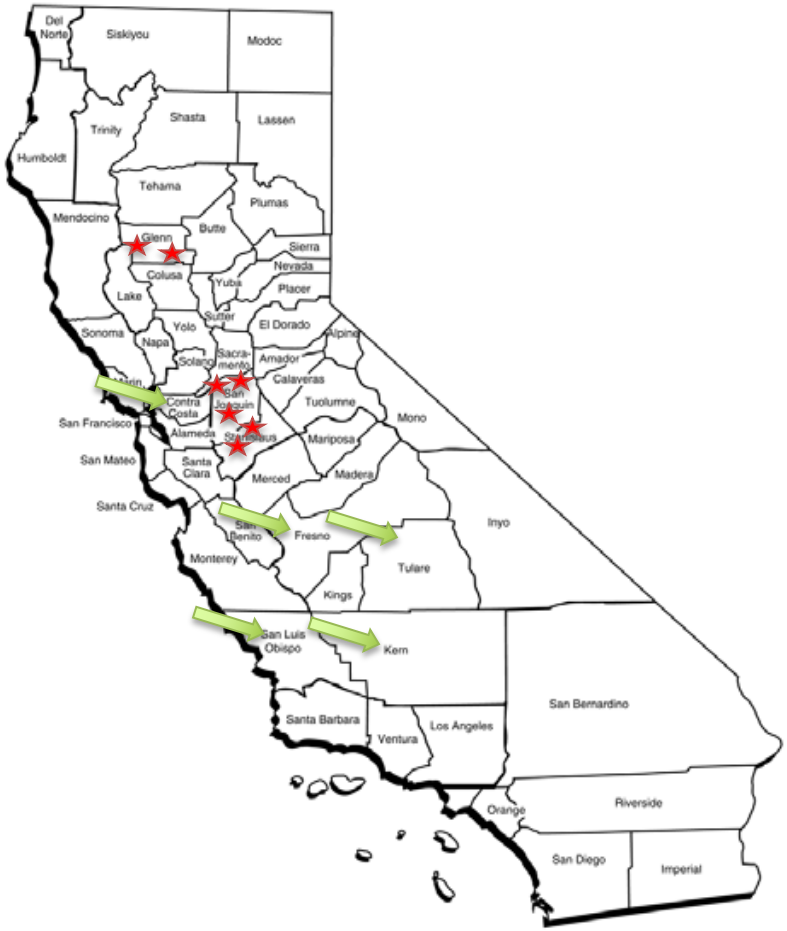
- Fruits can also get infected in CA (**Arbequina**)



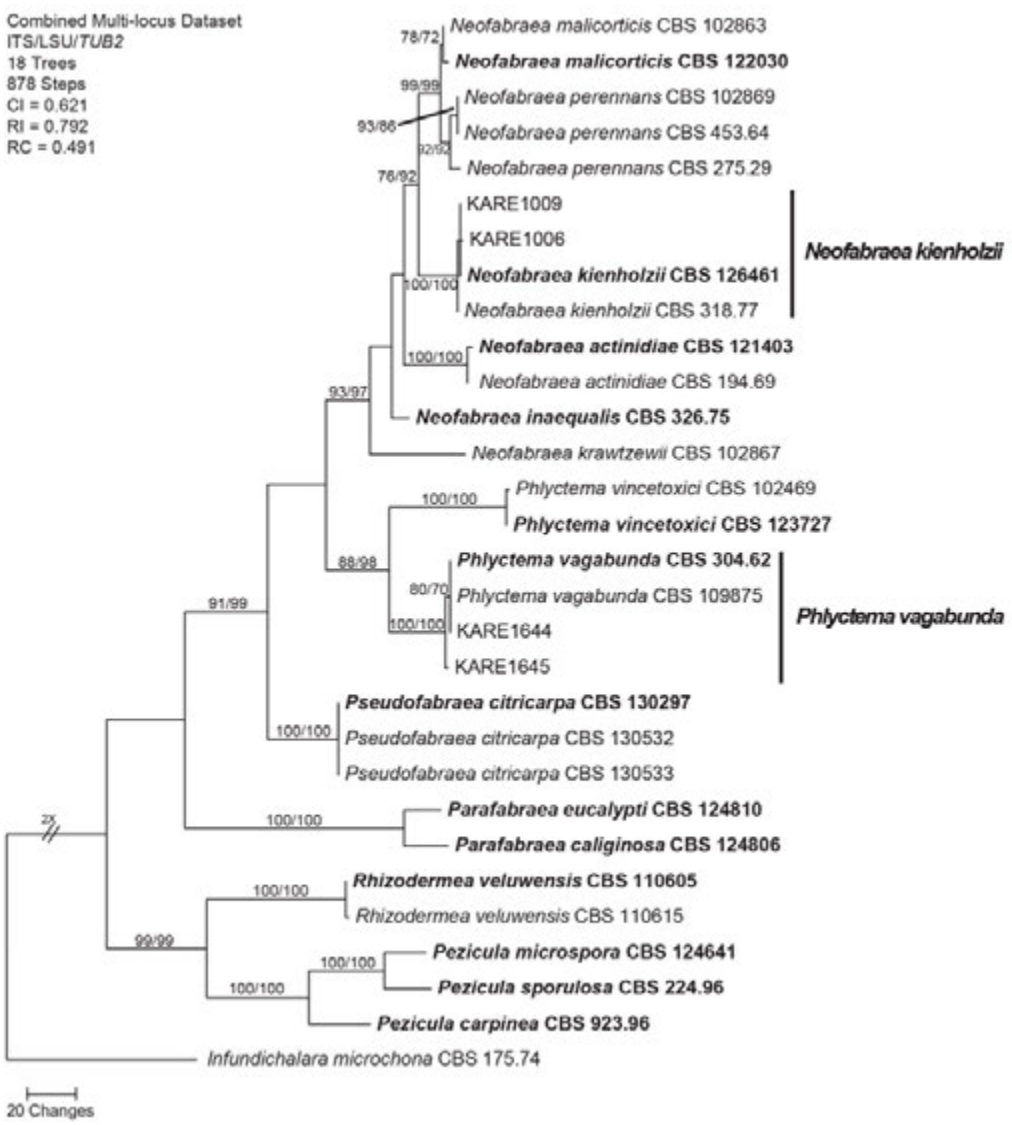


Surveys for Neofabraea diseases of olive:

In Super-High-Density orchards



Pathogen identification: morphological and molecular studies



Neofabraea diseases in olive:

- Lepra Fruit Rot/Leprosis
  - Tuscany Italy in 1907 (Petri, 1915)
  - Spain (Roca et. al., 2007)

- First report of *Neofabraea alba* causing fruit spot on olive in North America. (Rooney-Latham et al., 2013). Found in coratina and picholine cultivars in two commercial orchards in Sonoma County. Pathogenic in frantoio.

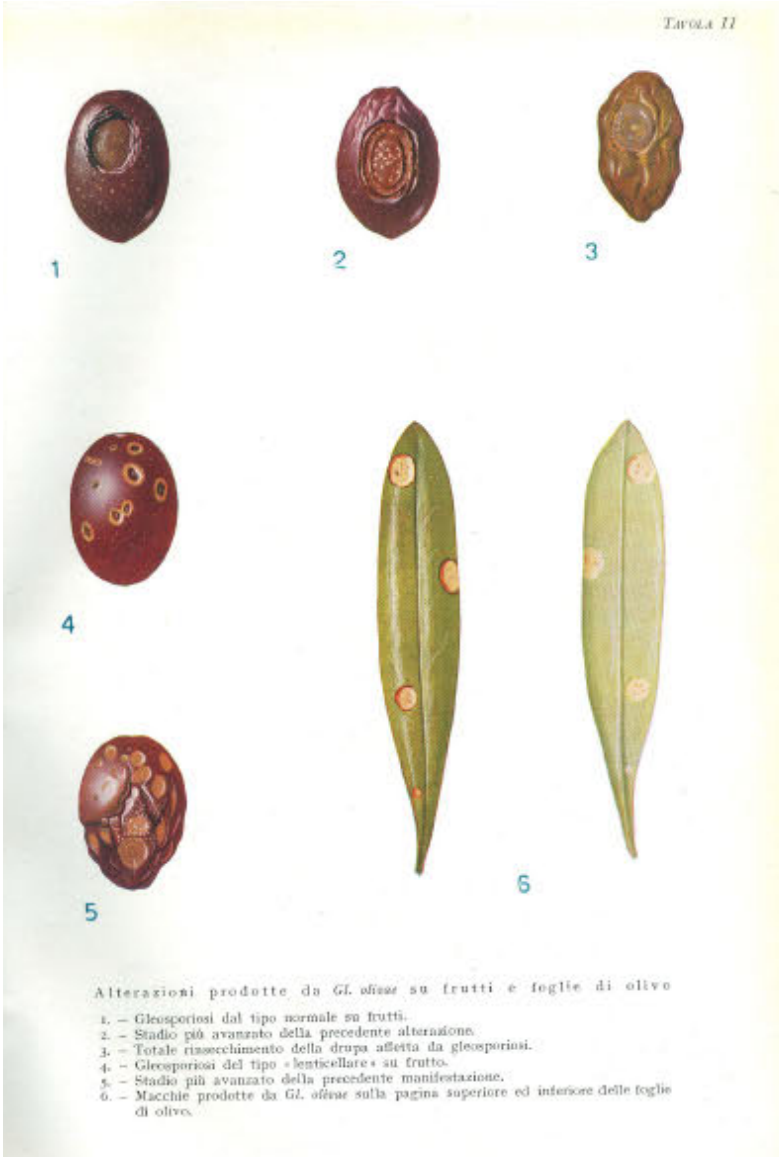
Photo credits: S. Rooney-Latham and Doug Gubler

Neofabraea diseases in olive:

- A problem increasing problem in Spain and Portugal
- 2016. First report of *Neofabraea vagabunda* causing branch cankers on olives in Spain. Found in Arbequina and Picual. (Romero et al. 2016).

Photo credits: J. Romero

Disease diagnosis: An old disease, “Lepra”



Neofabraea diseases in apple and pear:

- ***Bull's eye rot and canker***
- "Bull's-eye rot" occurs on fruit at open lenticels or at breaks in the skin
- The rot spots may be only specks, but most of them are 0.5 to 1 inch
- Spots may occur singly or be numerous
- The fungus overwinters in cankers and infected fruits
- Oregon, Washington, and California

Neofabraea in apple orchards in CA:

- Not found, but likely to occur

Pathogenicity in apple:

- CA olive isolates are pathogenic to apple: source of inoculum?

Disease emergence: super-high-density oil olive

- Intensification of agricultural practices
- Mechanical harvest
- Changing weather conditions

Disease emergence: Infection occurs at wounds caused by mechanical harvesters

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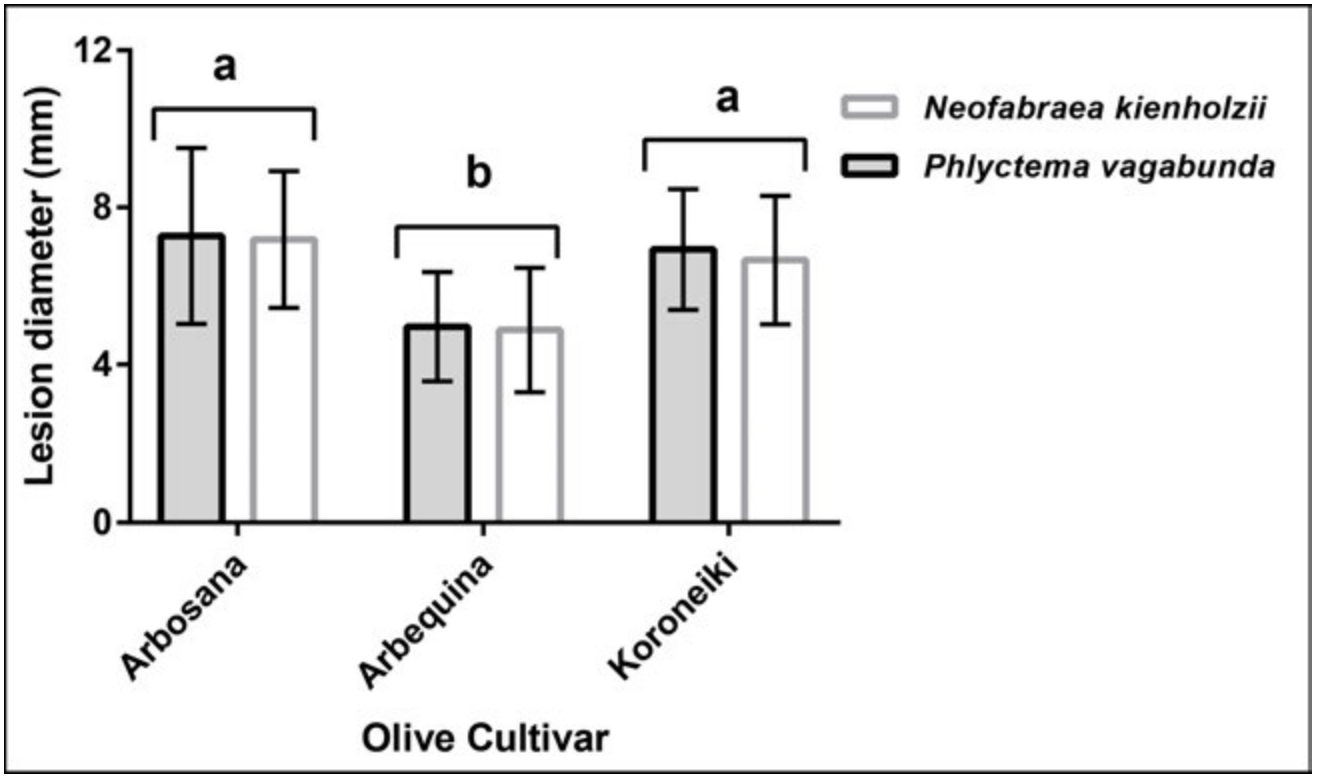
Disease emergence: Infection occurs at wounds caused by mechanical harvesters

Disease emergence: super-high-density oil olive

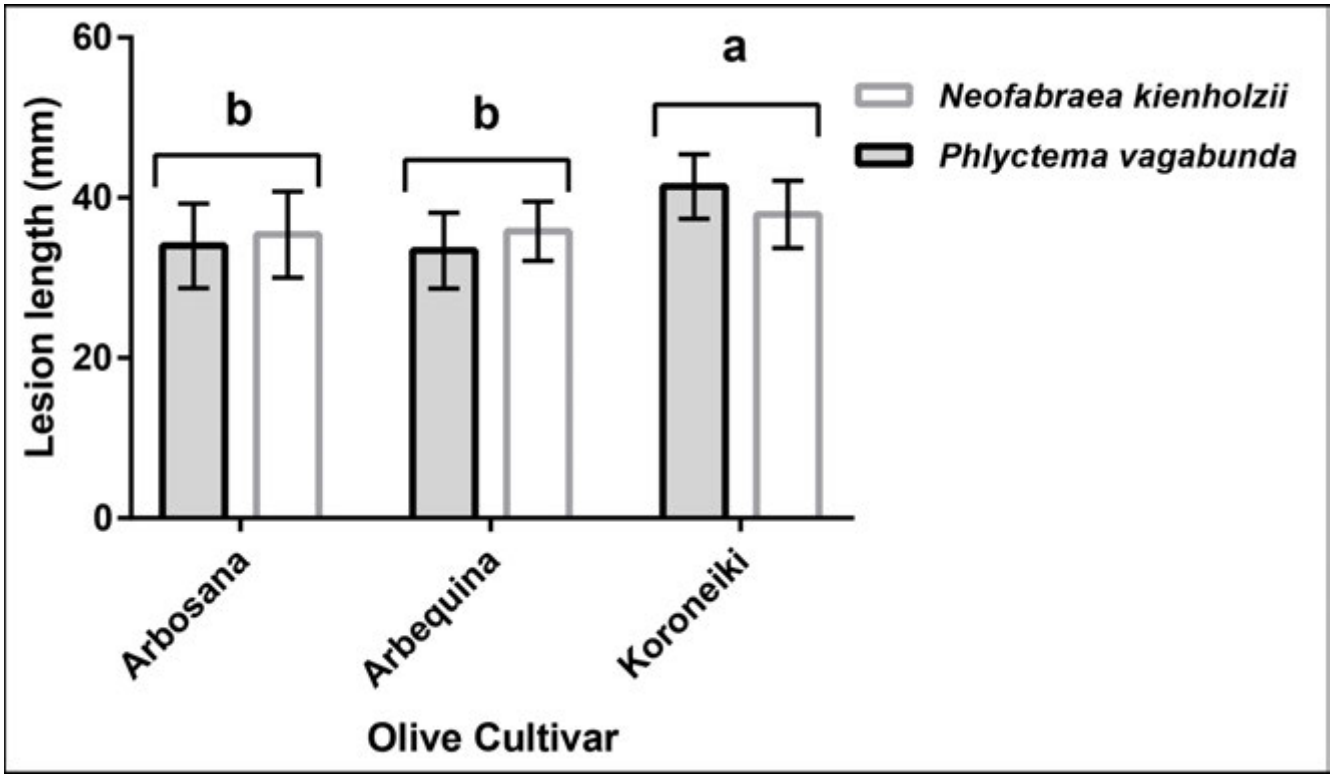
- Pathogens not detected from harvester pads: not a source for disease spread

Pathogenicity in leaves:



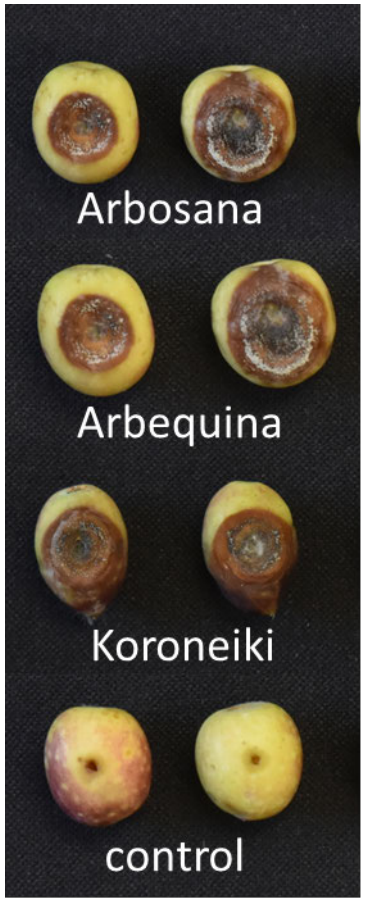
Wounds are required for infection!

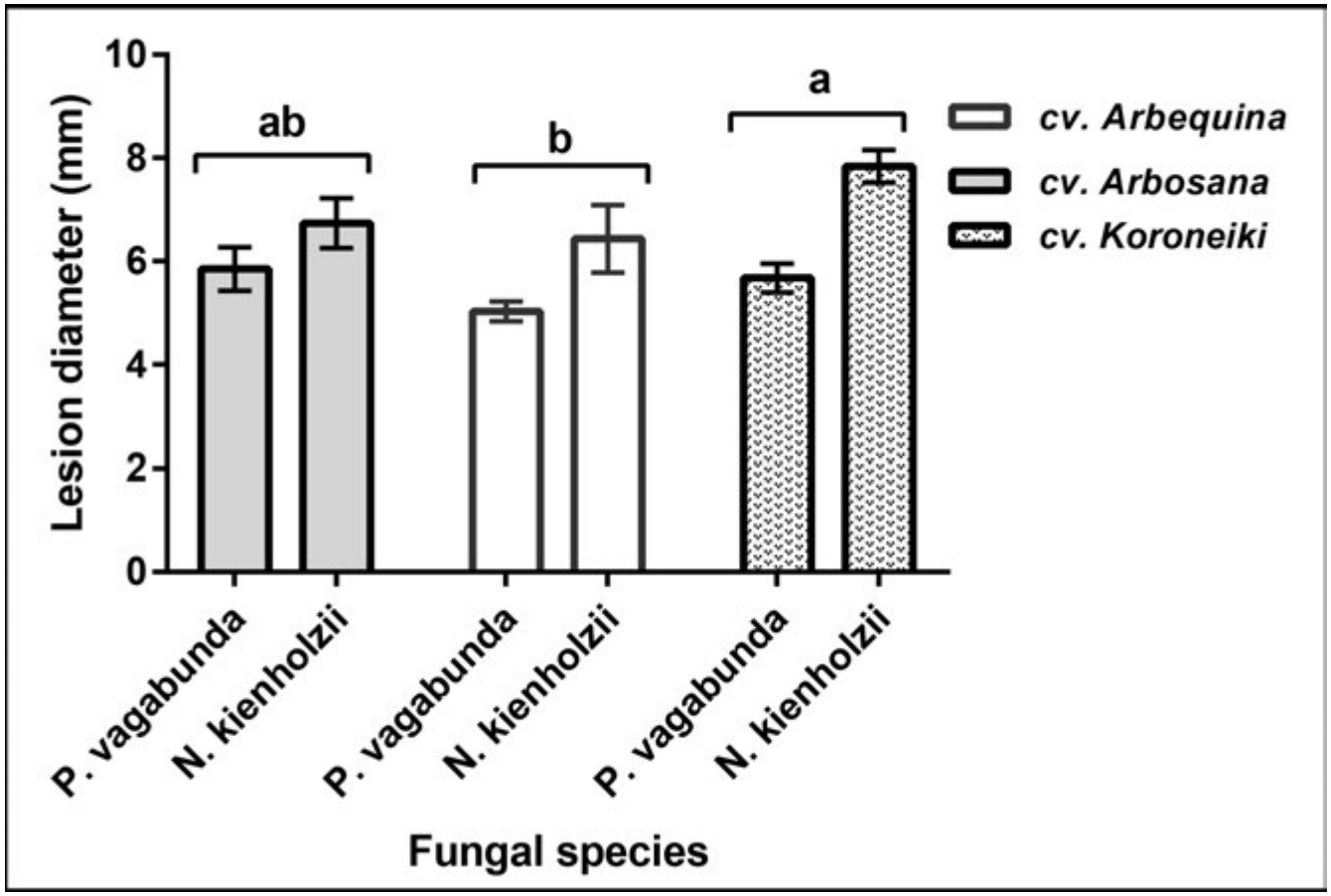
Pathogenicity in shoots:



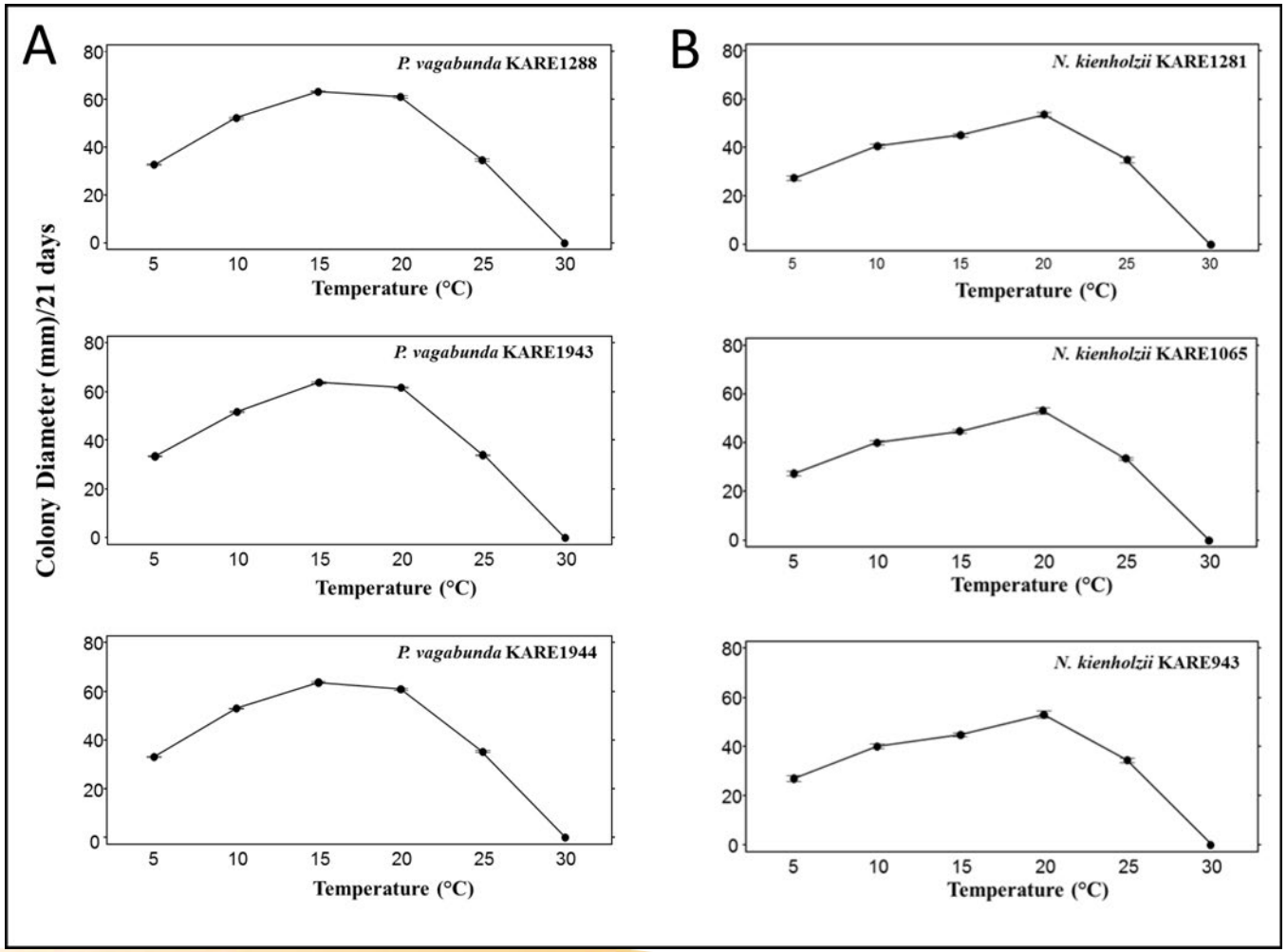
Wounds are required for infection!

Pathogenicity in olive fruits:





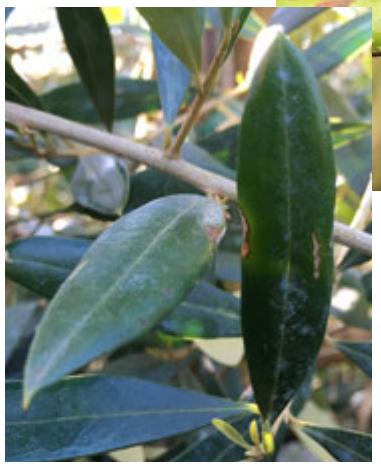
Temperature study:

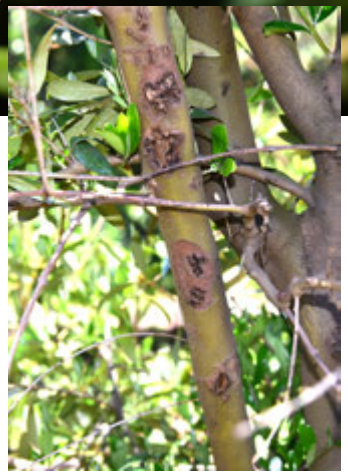


Disease cycle:

Rain

Fall: Mechanical harvest

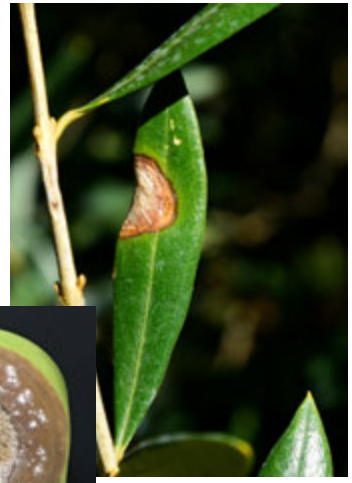


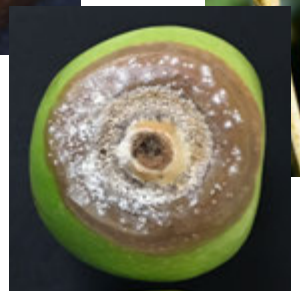


Fall: Infection of fresh wounds

Symptoms best visible in March/April

May-June: Defoliation





Inoculum reservoir: Old olive leaves and fruits, possibly apples (November)

Neofabraea diseases in olive:

- Premature leaf senescence
- Increased leaf drop
- Limited fruit set
- Poor tree and orchard performance
- Reduced yield
- **Reduced profitability**

Table 1. Yield data for two locations where Neofabrae diseases have been documented.

Arbosana Oilve Orchards	Yield* (TPA/Year)						Avg. Yield (2012, -13, -15, and -17)	Avg. Yield (2014 and -16)	Difference in Yield (%)
	2012	2013	2014	2015	2016	2017			
Orchard A - 203 acres	5.78	7.16	3.37	6.93	4.92	6.567	6.61	4.15	37.28
Orchard B - 38 acres	4.1	5.8	2.8	6.1	4.7	5.6	5.40	3.75	30.56

*- TPA = tons per acre.

Disease control: fungicide trials

Copper fungicides?

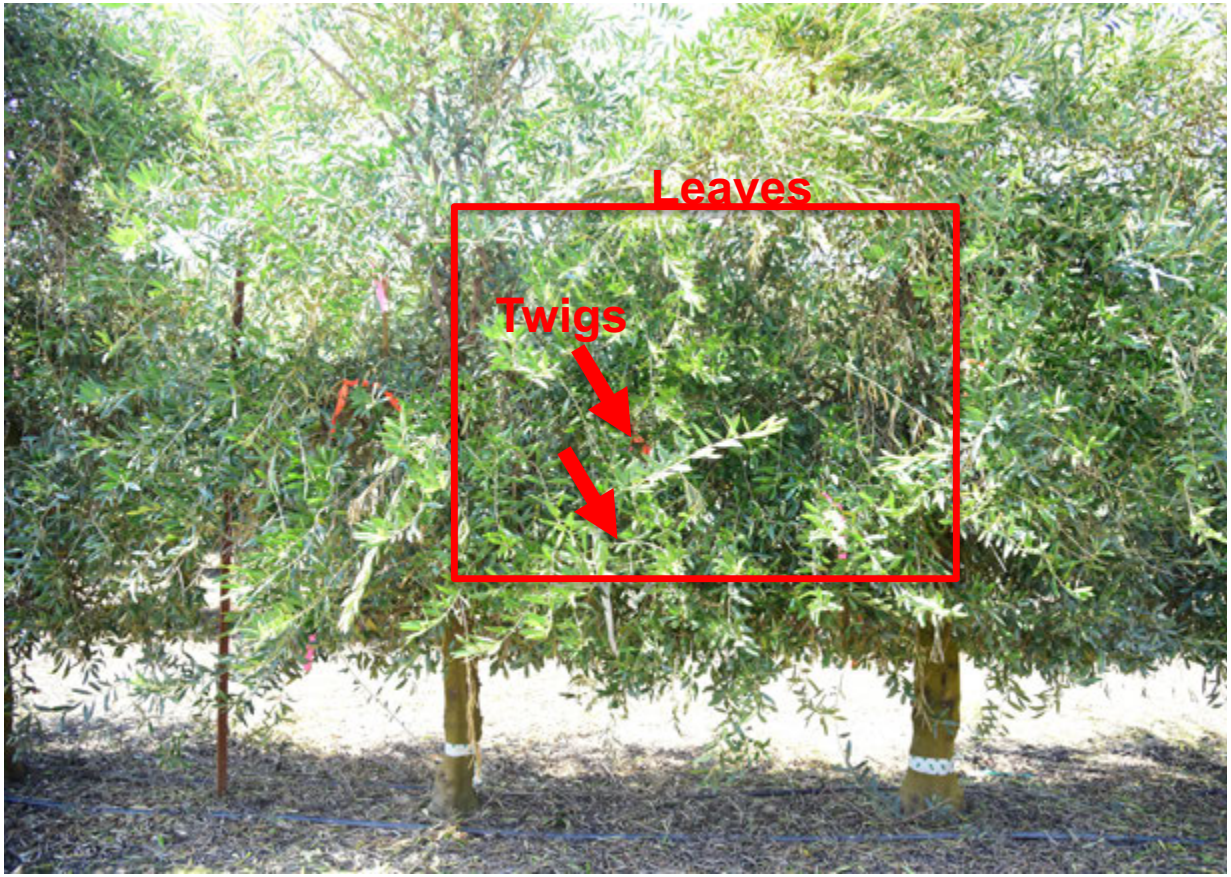
Fungicide trials 2016-2017, 2017-2018, 2018-2019:

- Arbosana trees
- Stihl SR 450 Backpack Sprayers
- Rating on March 8, 2018

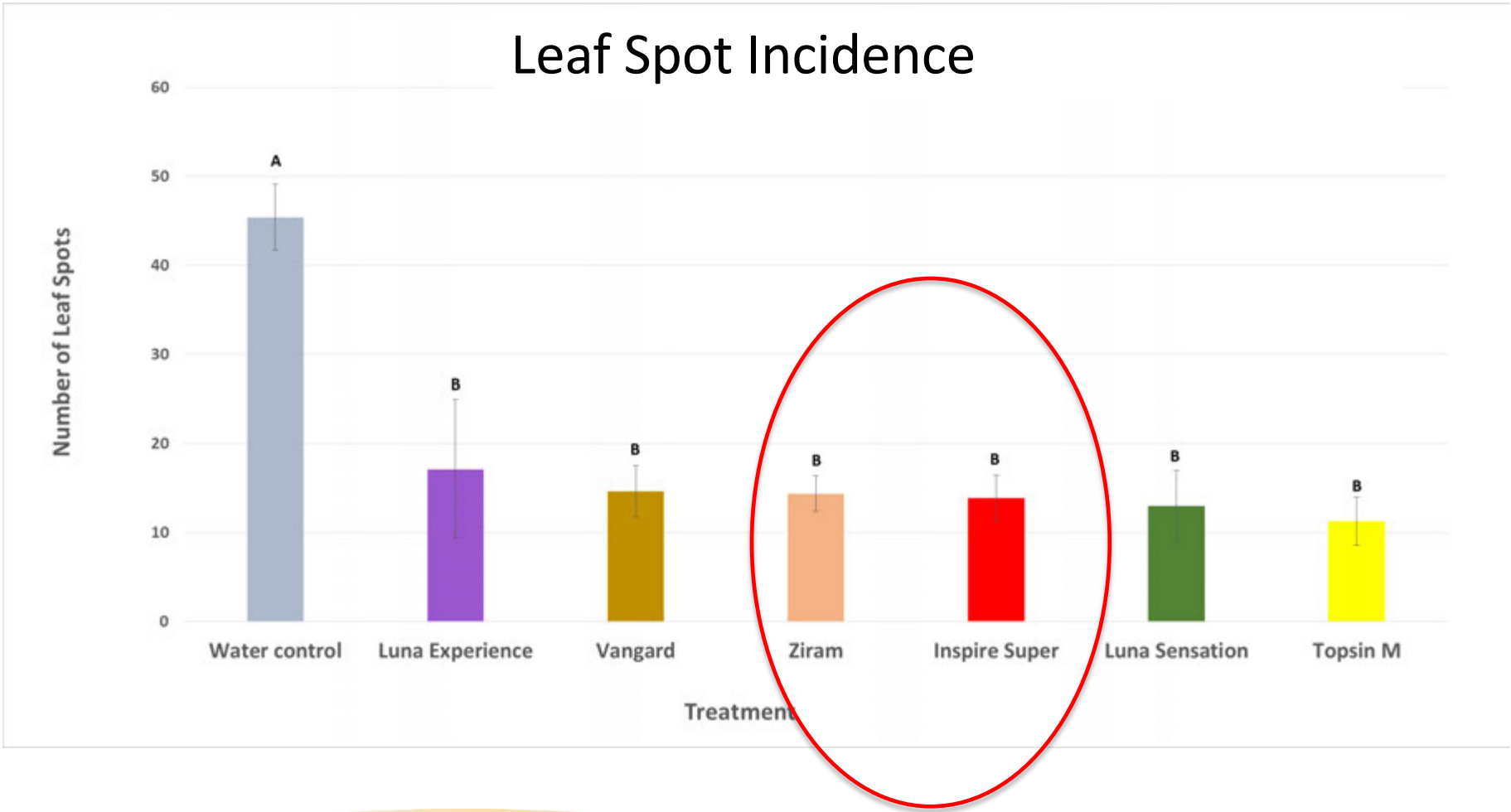
- Single application at harvest
- Two applications, one at harvest, and a second 2 to 3 weeks after harvest

- Topsin M (thiophanate-methyl – group 1)
- Inspire Super (difenoconazole/cyprodinil – group 3+9)
- Luna Experience (fluopyram/tebuconazole – group 3+7)
- Luna Sensation (fluopyram/trifloxystrobin – group 7+11)
- Mertect (thiabendazole – group 1)
- Kocide 3000 (Copper Hydroxide)
- Rhyme (flutriafol – group M3)
- Vangard WG (Cyprodinil 75% – group 9)
- Ziram (ziram – group M3)
- Bravo (Chlorothalonil – group M5)

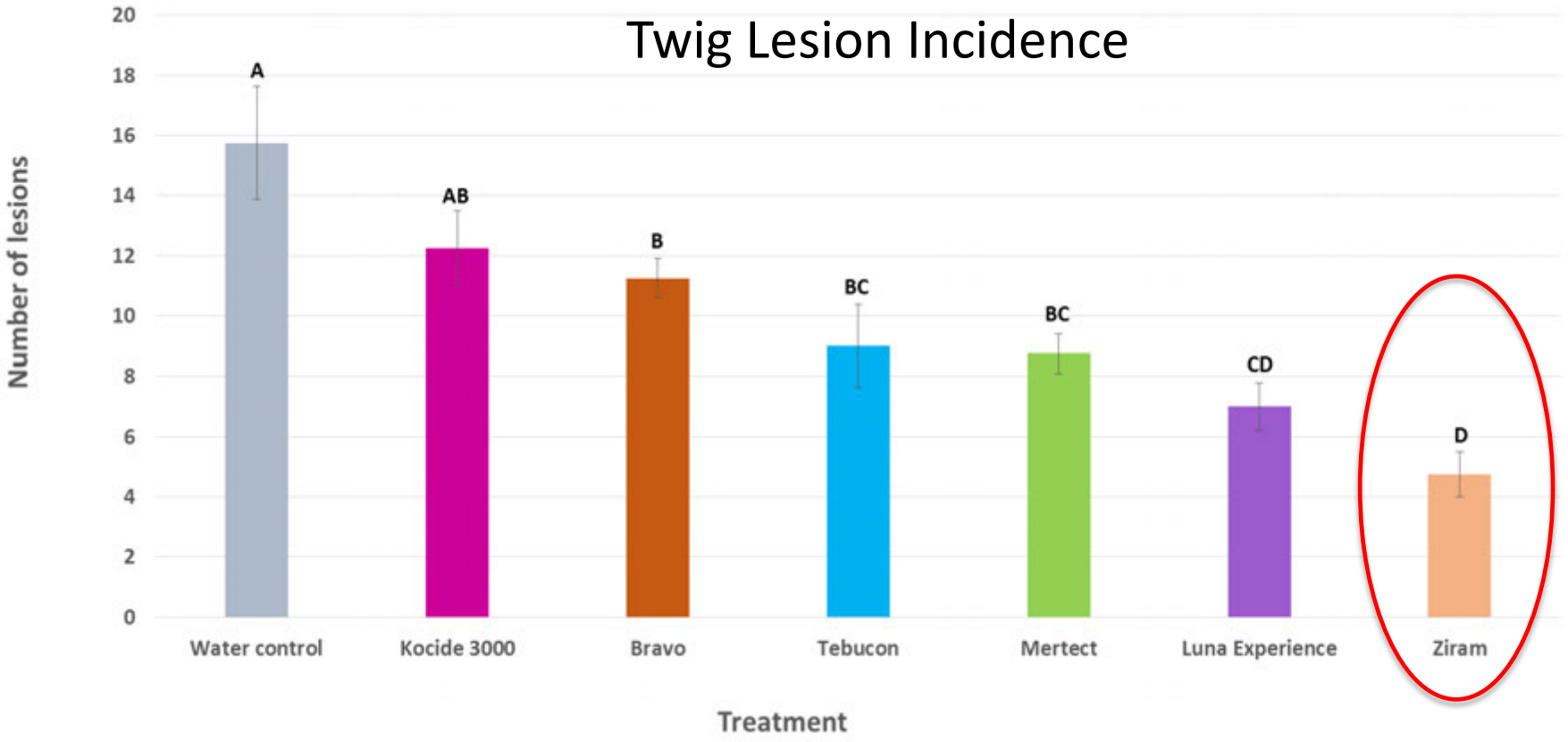
Fungicide trials: Experimental unit = 2 Trees, 4 repetitions



Fungicide trials 2016-2017:



Fungicide trials 2016-2017:

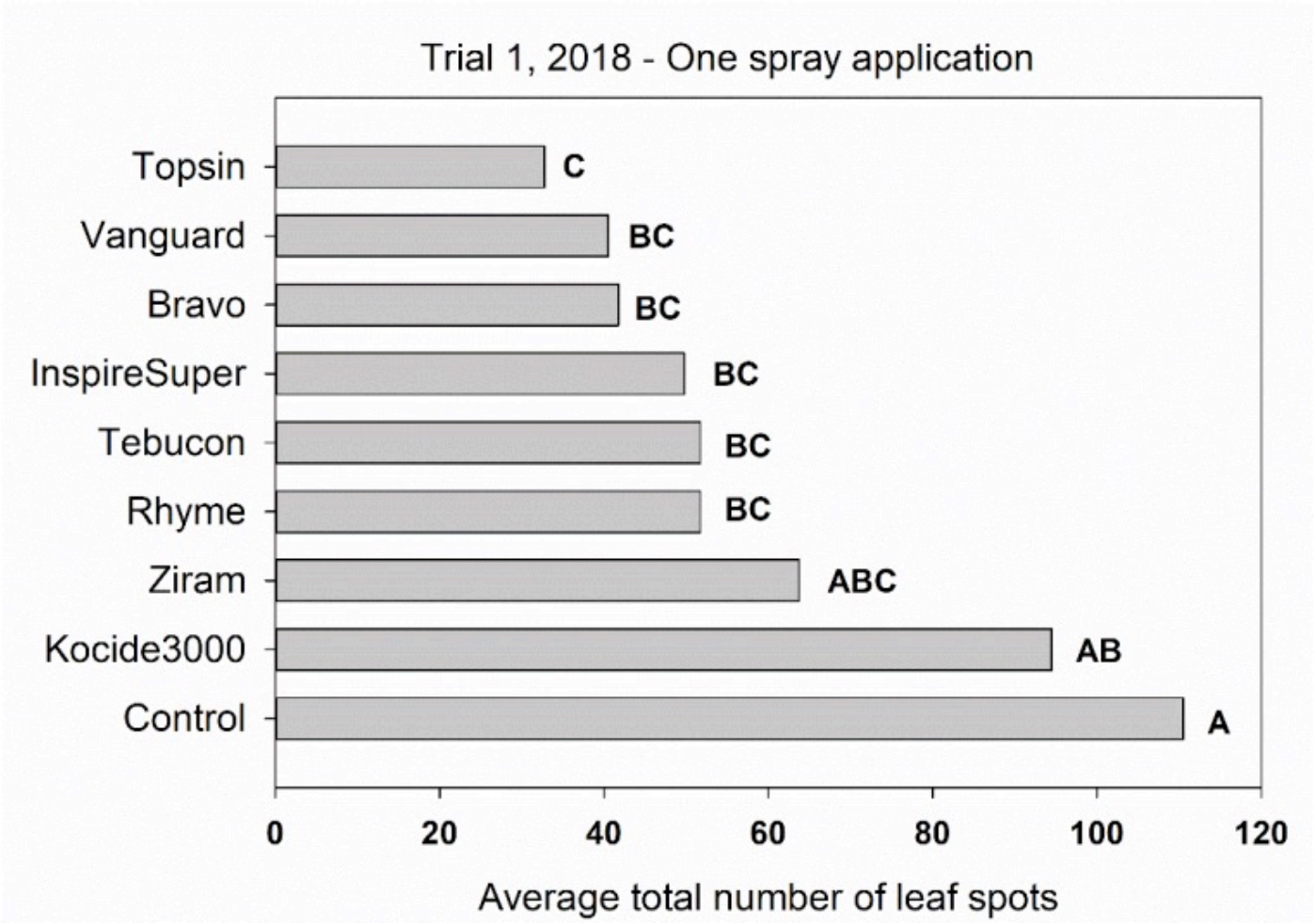


Fungicide trials 2017-2018:

Eight products were tested in the field during the fall and winter 2017-2018:

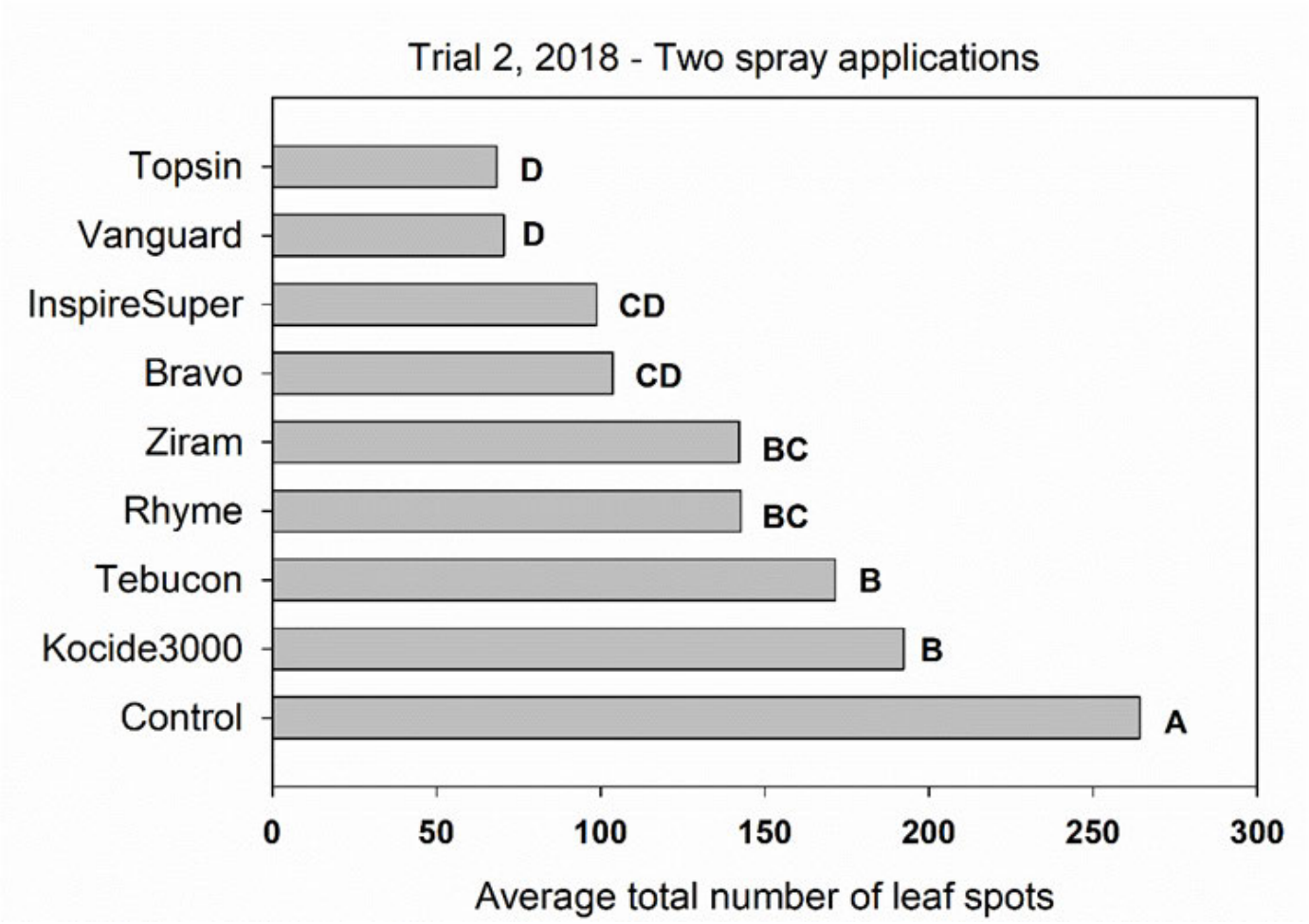
- Topsin M (thiophanate-methyl – group 1)
- Inspire Super (difenoconazole/cyprodinil – group 3+9)
- Kocide 3000 (copper hydroxide)
- Tebucon (tebuconazole – group 3)
- Rhyme (flutriafol – group M3)
- Vanguard WG (cyprodinil – group 9)
- Ziram (ziram – group M3)
- Bravo (chlorothalonil – group M5)

Fungicide trials 2017-2018: Trial 1



Trial 1, single spray application: Average number of leaf lesions per olive tree according to various fungicide treatments and compared to the water treatment a copper treatment (Kocide 3000).

Fungicide trials 2017-2018: Trial 2



Trial 2, two spray applications: Average number of leaf lesions per olive tree according to various fungicide treatments and compared to the water treatment a copper treatment (Kocide 3000).

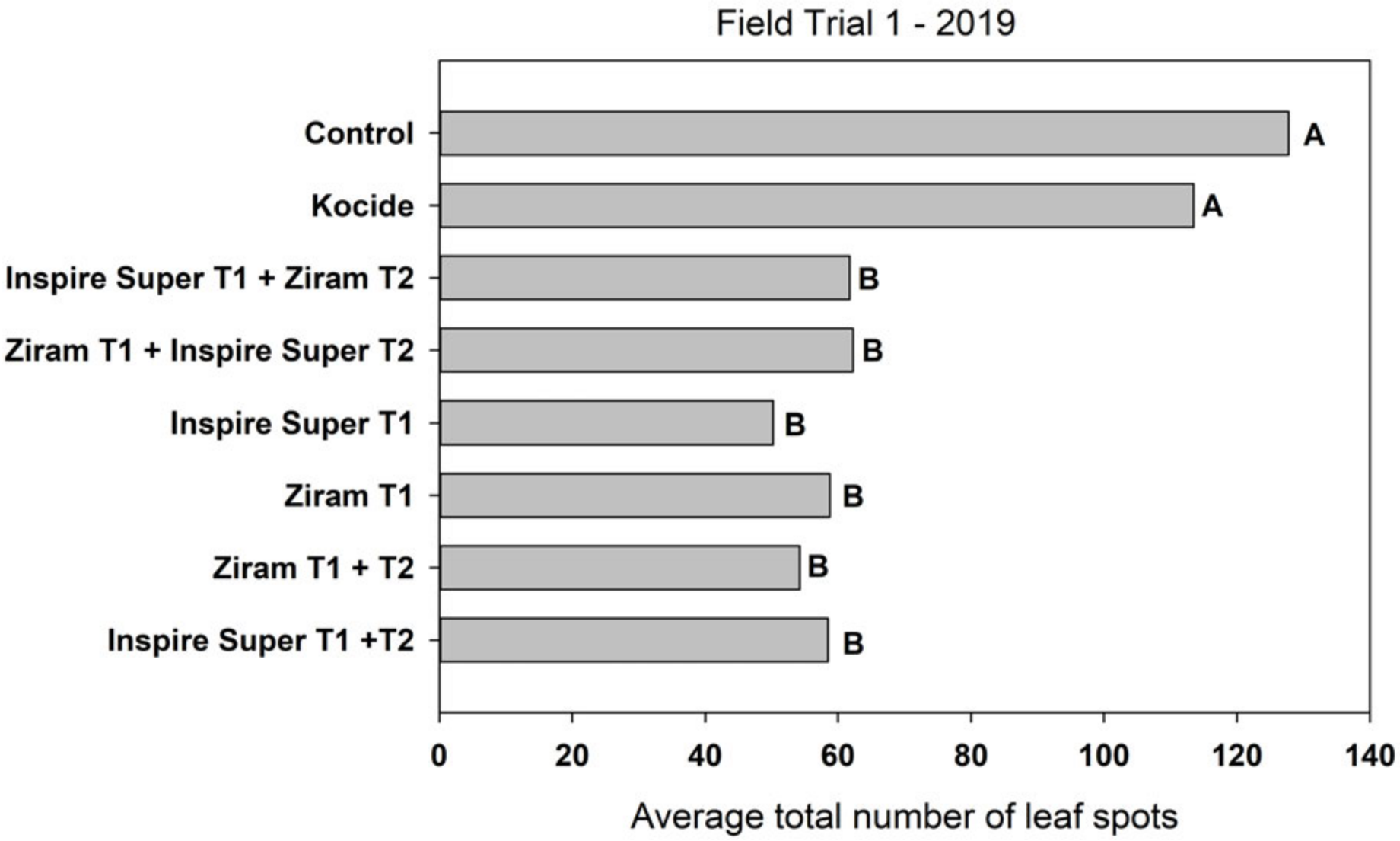
Fungicide trials 2018-2019: Trial 1 & 2

Company	Fungicide	Flag	Rec. Rate/A	My Calc (2.8gal)	Unit
UPI, United Phosphosus Inc	Ziram 76DF		6 pounds / acre	**37.5**	gr
Syngenta	Inspire Super		20 fl oz	**8.2**	mL
Certis	Kocide 3000		7 lb	**43.7**	gr
	Control	W			

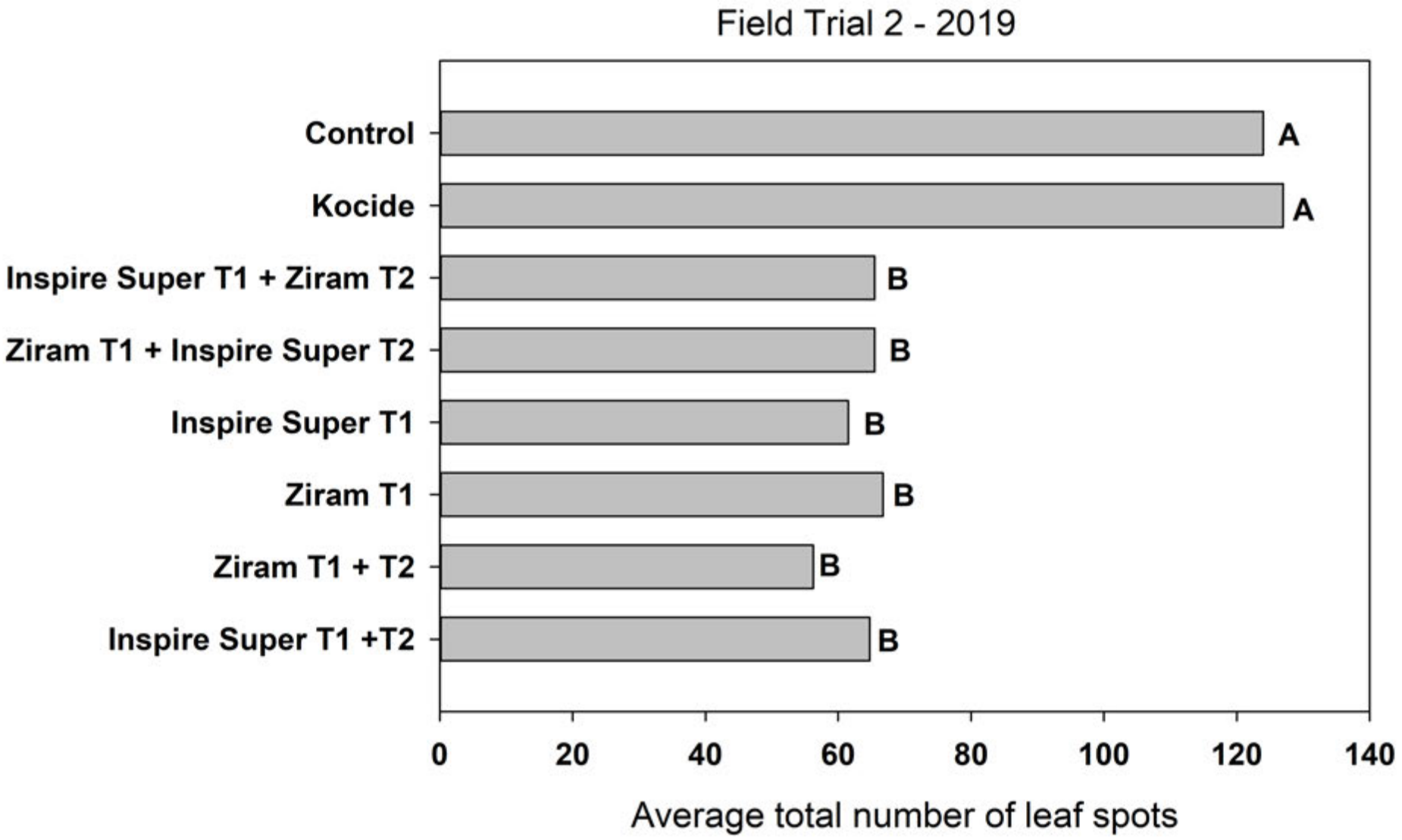
Trt. #	Treatment	Assigned Flag
1	Ziram T1	Black (B)
2	Inspire Super T1	Pink (P)
3	Kocide 3000 T1	Yellow (Y)
4	Inspire Super T1 + T2	Orange (O)
5	Ziram T1 + T2	White Red Dots (RD)
6	Inspire Super T1 + Ziram T2	White Blue Stripe (BS)
7	Ziram T1 + Inspire Super T2	Green (G)
8	Control	White (W)

First spray was on **11/20/2018** (T1) and the second spray on **12/3/2018**. Olive harvest was on 11/13/2018. Trial rating of leaf spots was on **4/24/2019**.

Fungicide trials 2018-2019: Trial 1



Fungicide trials 2018-2019: Trial 2



Fungicide registration: IR4

- Two new fungicides for olive (Inspires Super and Ziram)
- Neofabraea, Phlyctema, Peacock, Cercosporiose foliar diseases
- Improve health, yield and profitability of orchards
- No residues in fruits or oil

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P. O. No: OOCCRESIDUE2018 Project: Neofabraea Olive

Client Sample	EMA Sample No	Sample	Date Analyzed	Method	Chemical	Amount	RL	Units
T1-Pu	18071821-01	Olive Fruits	07/26/18	LC/MS/MS Extended	Cyprodinil	ND	0.01	ppm
			07/26/18	LC/MS/MS Extended	Difenoconazole	ND	0.01	ppm
T2-Pu	18071821-02	Olive Fruits	07/26/18	LC/MS/MS Extended	Cyprodinil	ND	0.01	ppm
			07/26/18	LC/MS/MS Extended	Difenoconazole	ND	0.01	ppm
T1-O	18071821-03	Olive Fruits	07/24/18	EBDC Screen	Ziram	ND	0.05	ppm
T1-P	18071821-04	Olive Fruits	07/27/18	LC/MS/MS Extended	Thiophanate Methyl	ND	0.01	ppm

P. O. No: Project: Neofabraea Olive

Client Sample	EMA Sample No	Sample	Date Analyzed	Method	Chemical	Amount	RL	Units
T2-O	18071822-01	Olive Fruits	07/24/18	EBDC Screen	Ziram	ND	0.05	ppm
T2-P	18071822-02	Olive Fruits	07/27/18	LC/MS/MS Extended	Thiophanate Methyl	ND	0.01	ppm

ND = None Detected at the Reporting Limit (RL)
RL = Reporting Limit.
Excess sample and extracts are stored for a minimum 30 of days from the date of analytical report. Special storage arrangements possible.
Results relate only to items tested.
Samples are analyzed as received.

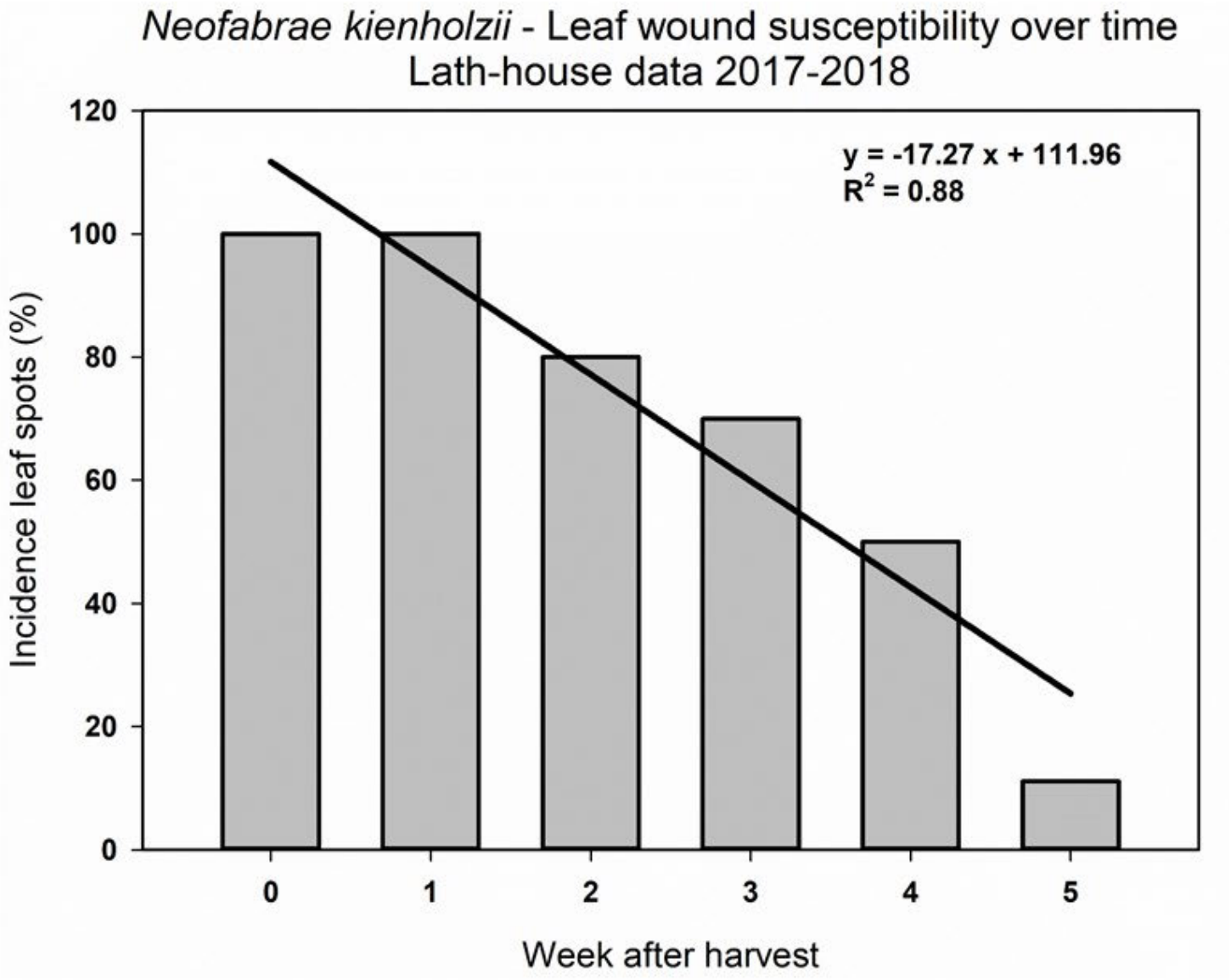
To see the scope of our ISO 17025 accreditation go to http://emalab.com/ISO17025.pdf

Duration of wound susceptibility: Leaves

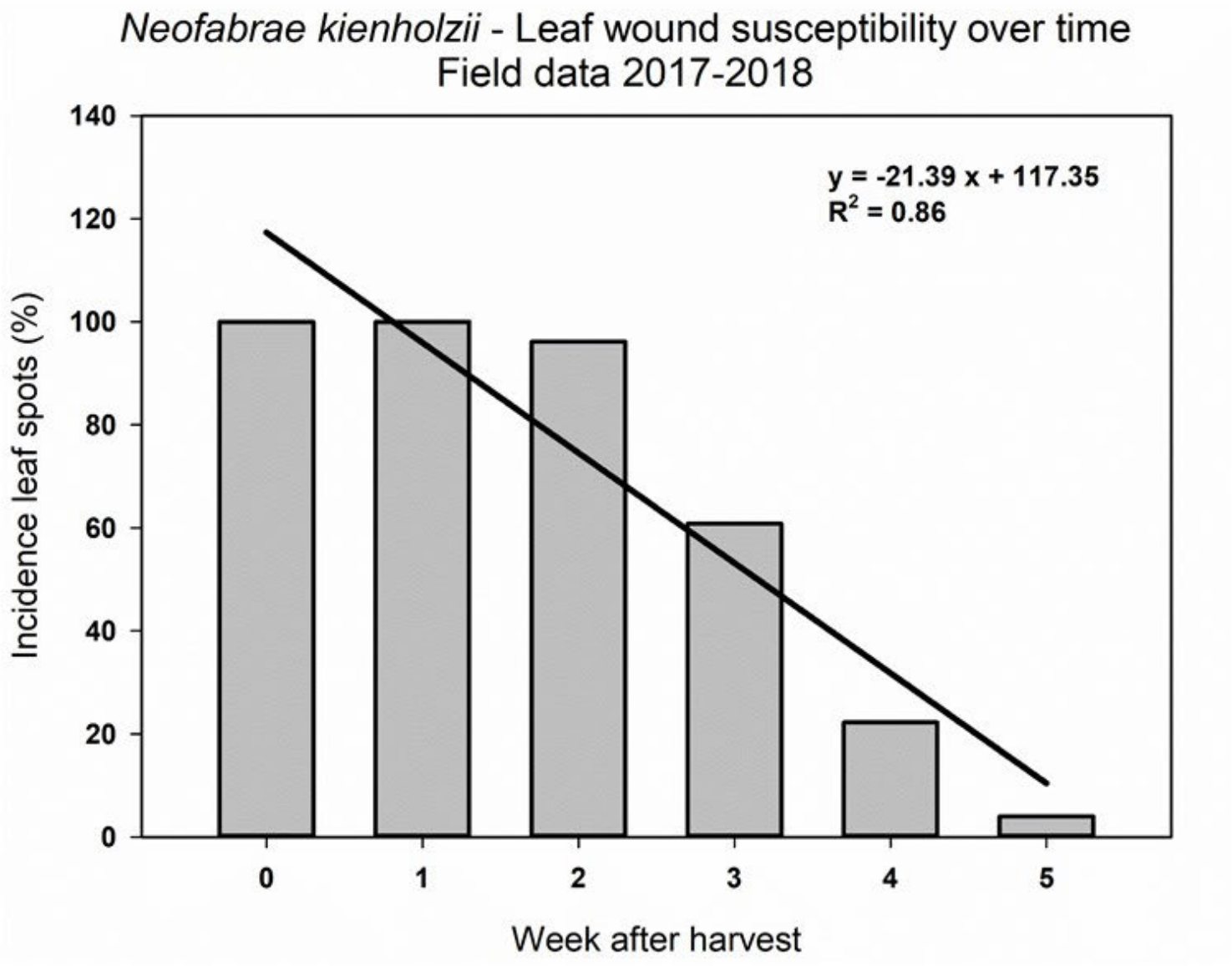
- Optimizing the number and timing of fungicide applications
- Limit costs while improving performance of orchards

Week	Flag color	Inoculation
W 0	Orange	22-Nov
W 1	Blue	29-Nov
W 2	Green	6-Dec
W 3	Purple	13-Dec
W 4	Red	20-Dec
W 5	Yellow	27-Dec

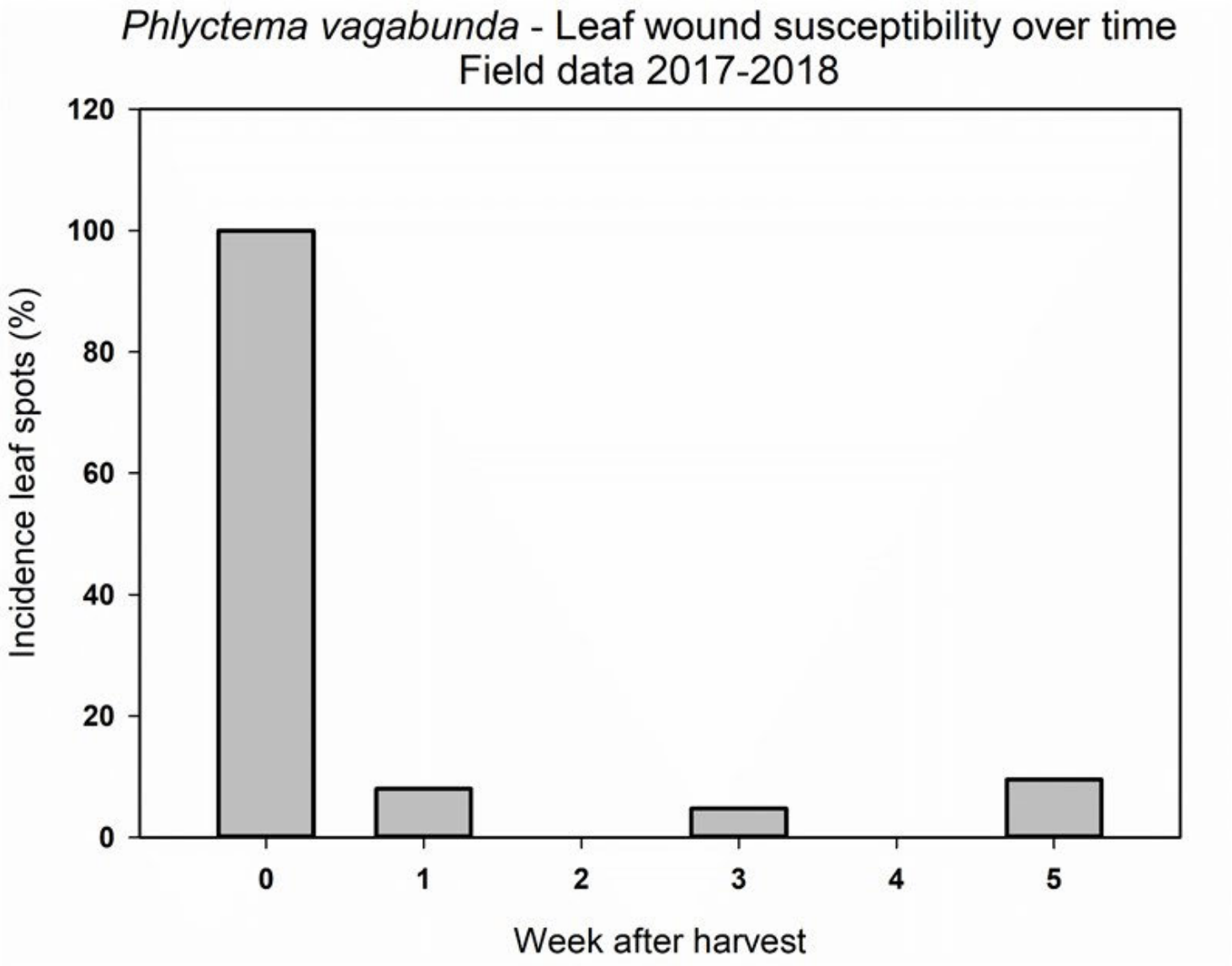
Duration of wound susceptibility: Leaves



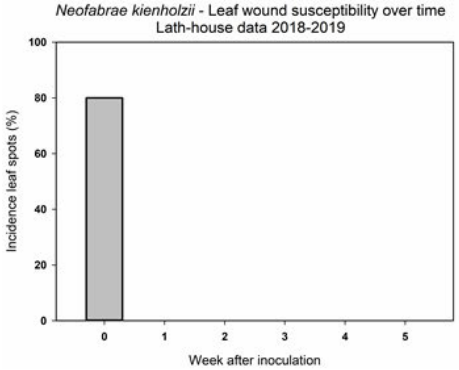
Duration of wound susceptibility: Leaves

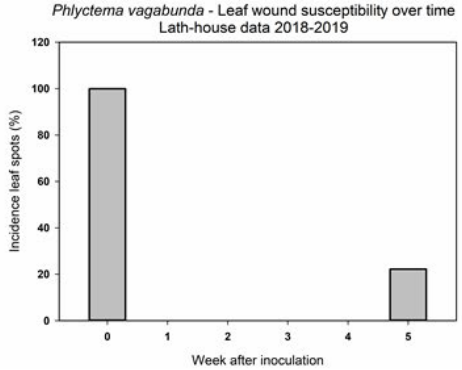


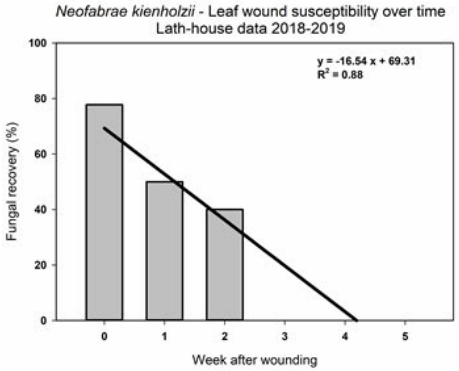
Duration of wound susceptibility: Leaves

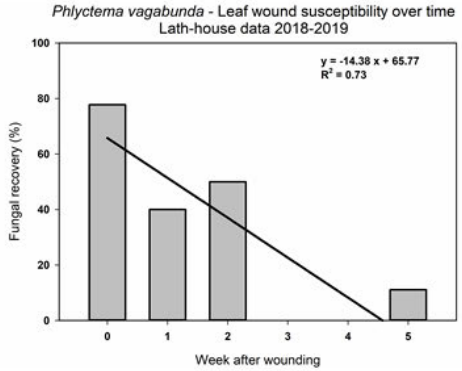


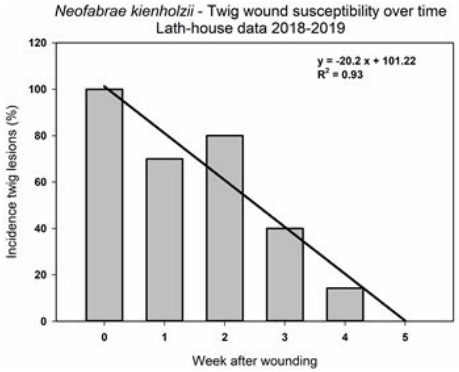
Duration of wound susceptibility 2018-2019:

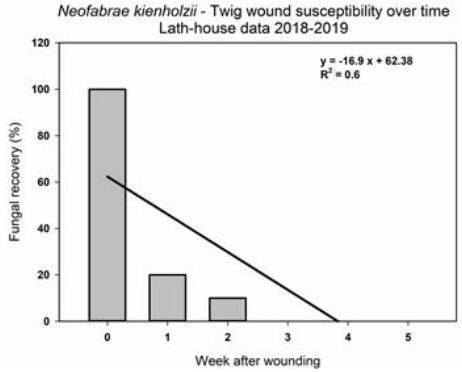




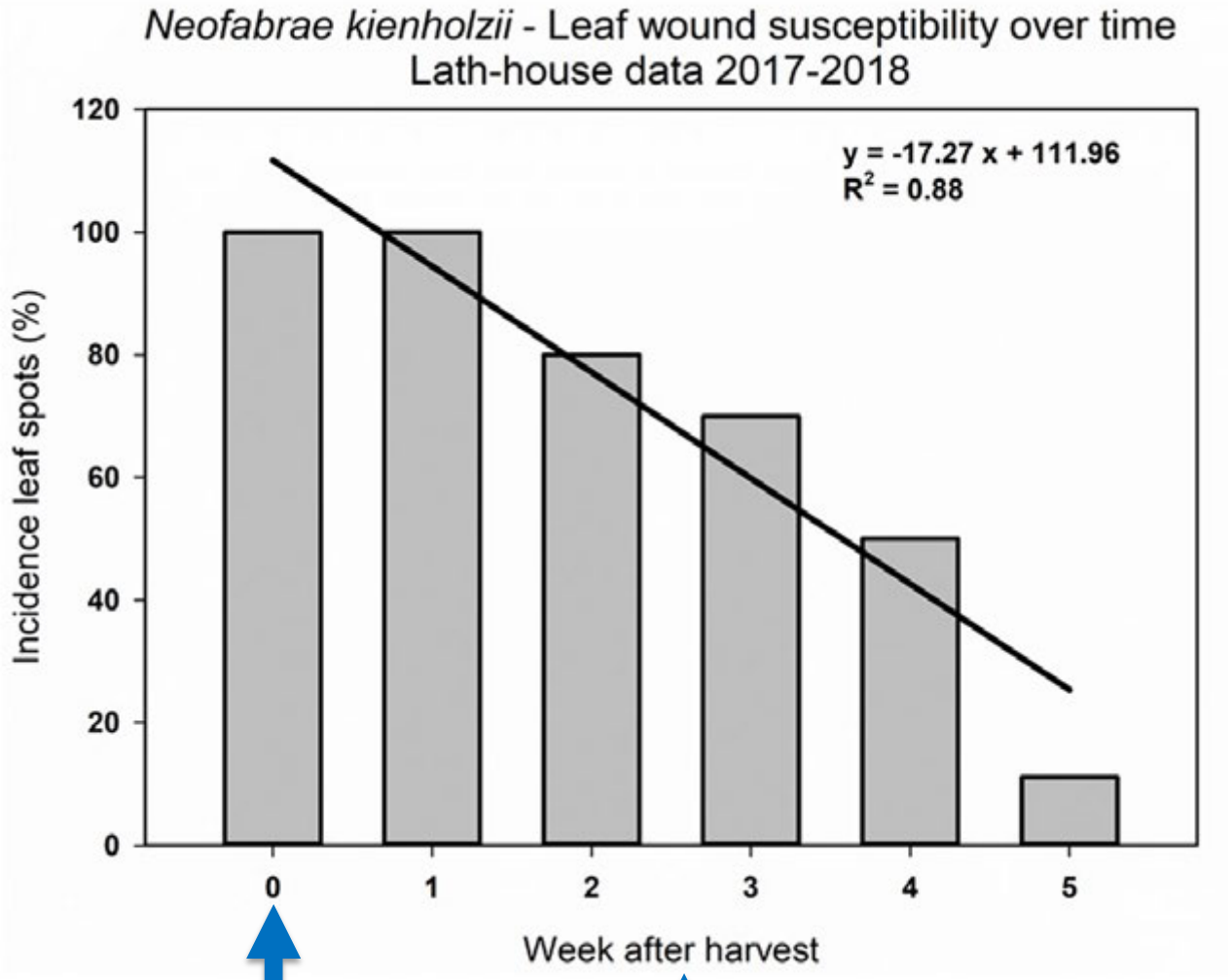






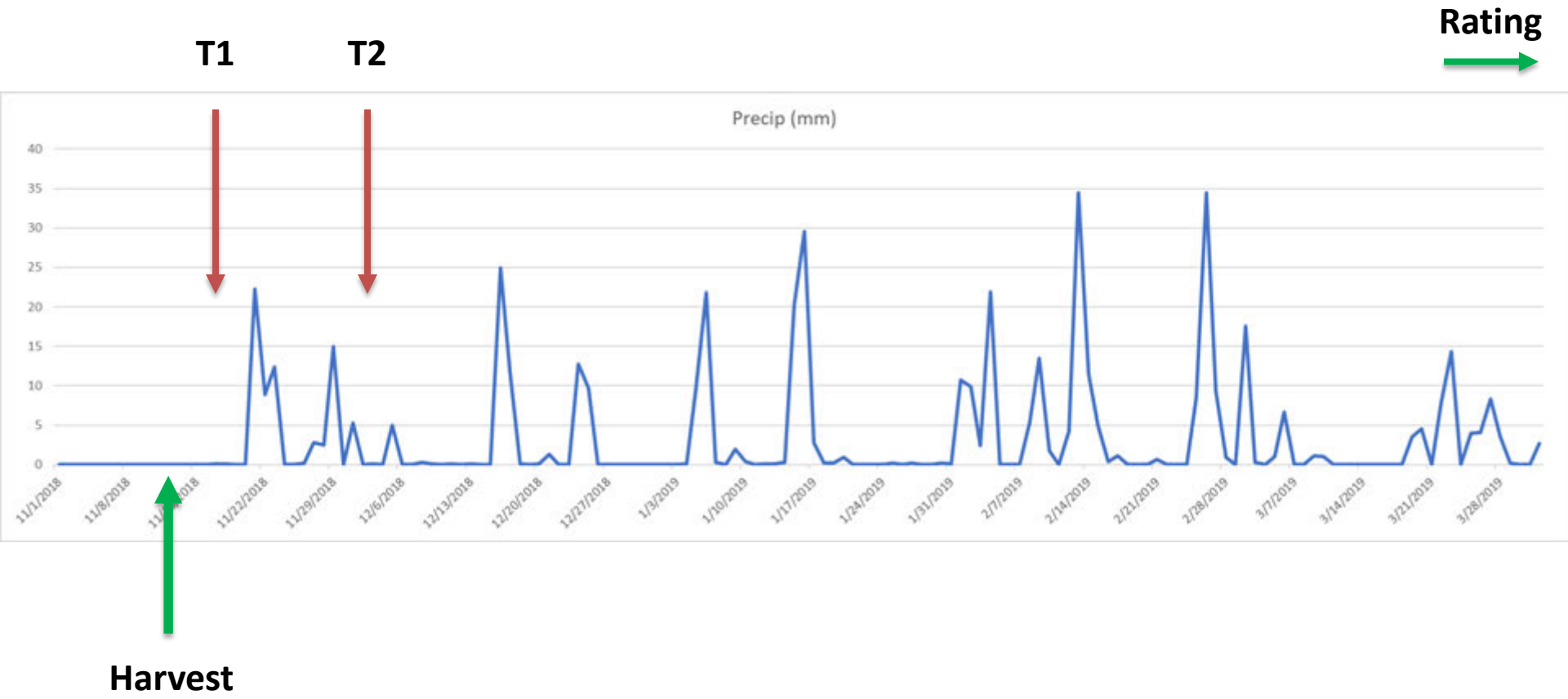


Timing of fungicide applications:



Fungicide trials 2018-2019: Trial 1 & 2

- **Our research helped minimize the number of spray applications without increasing risks of disease incidence – IPM practices**



First spray was on **11/20/2018** (T1) and the second spray on **12/3/2018** (T2). Olive harvest was on **11/13/2018.** Trial rating of leaf spots was on **4/24/2019**.

Conclusion:

- Neofabraea leaf spot is an emerging disease of oil olives in CA
- Limited to Super-High-Density orchards
- Two Neofabraea species are involved
- Aggressive pathogens of increasing concern in Spain, Italy and Portugal
- Associated with mechanical harvest
- Requires wounds (leafs and twigs) for infection
- Mainly Arbosana cultivar is susceptible
- We understand the disease cycle
- Duration of wound susceptibility: 4 weeks
- Ziram and Inspirer Super after harvest + 2-3 weeks after
- **IR4 projects for product registration**

Olive Anthracnose:

Olive Anthracnose:

Olive Oil Commission of California

RESEARCH GRANT PROPOSAL

Project Year: 2020 **Anticipated Duration of Project:** 2 years

Principal Investigator: Florent Trouillas, University of California, Davis, Department of Plant Pathology and Kearney Agricultural Research and Extension (KARE) Center, flotrouillas@ucanr.edu

Cooperating Personnel:
Mohamed Nouri, Farm advisor, UCCE San Joaquin County, mnouri@ucanr.edu
Rosa Jaime Frias, Laboratory Assistant, KARE, rejaimefrias@ucdavis.edu

Project Title: INVESTIGATING THE OCCURRENCE AND DISTRIBUTION OF OLIVE ANTHRACNOSE IN CALIFORNIA

Commodity: Oil Olive

Objectives:

1- Determine the occurrence and distribution of olive Anthracnose in California.
2- Determine what *Colletotrichum* species are associated with olive Anthracnose in California.
3- Determine the pathogenicity of the identified *Colletotrichum* species to main oil olive cultivars in California.

Olive Anthracnose:

Photo credits: Juan Moral

Olive Anthracnose:

Cacciola et al. 2012, Journal of Plant Pathology 94: 29-44

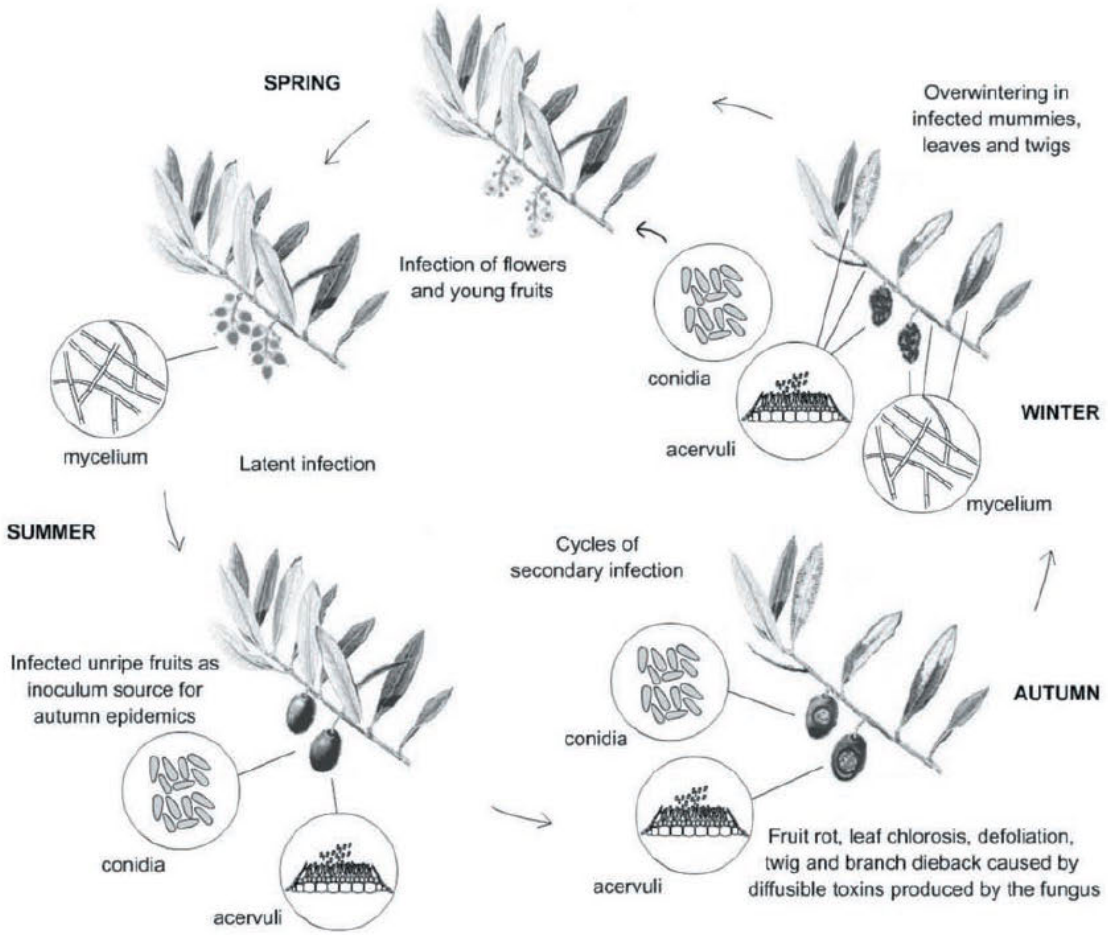
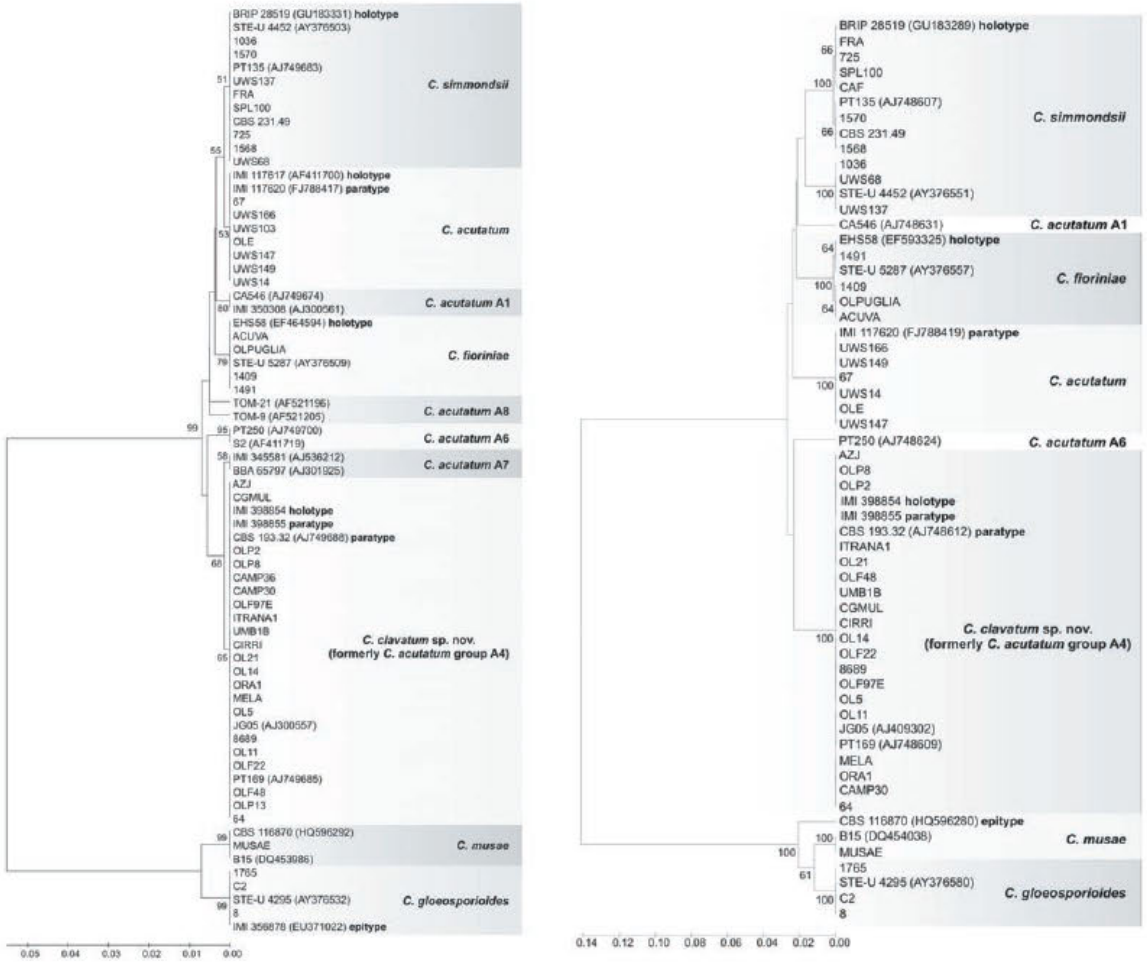


Fig. 8. Diagramatic representation of the disease cycle of olive anthracnose in the Mediterranean region.

Olive Anthracnose:

Cacciola et al. 2012, Journal of Plant Pathology 94: 29-44

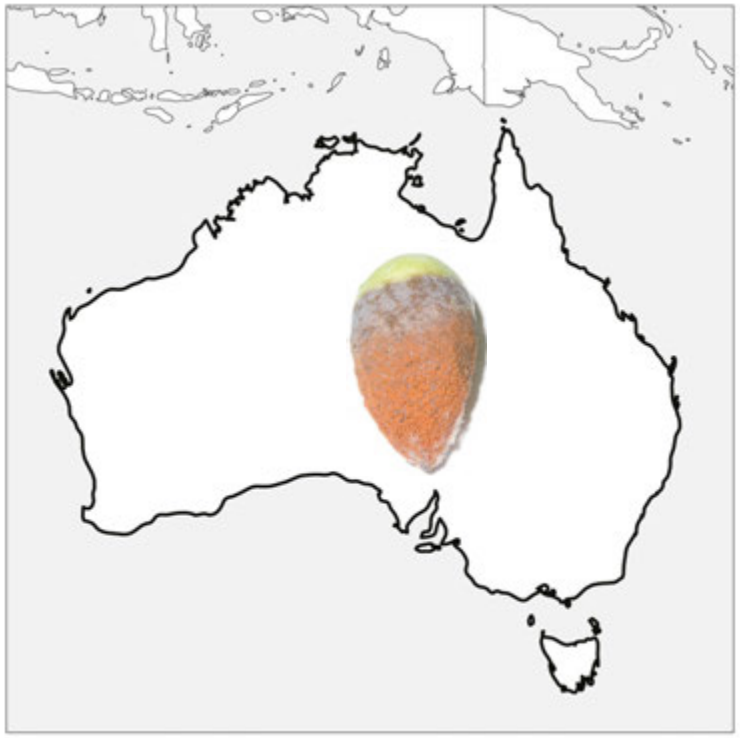


Olive Anthracnose worldwide:

Cacciola et al. 2012, Journal of Plant Pathology 94: 29-44

Fig. 5. Supposed route of the olive anthracnose epidemics caused by *Colletotrichum clavatum* in Italy. The years of first records of olive anthracnose epidemics in different regions are indicated. Epidemic outbreaks of olive anthracnose reported in Portugal in 1890s and in Spain in 1930s were probably caused by *C. simmondsii* while based on circumstantial evidences it can be supposed that *C. clavatum* is the prevalent causal agent of severe epidemics reported in Andalusia (southern Spain) since the late 1990s.

Dr Vera Sergeeva
www.olivediseases.com

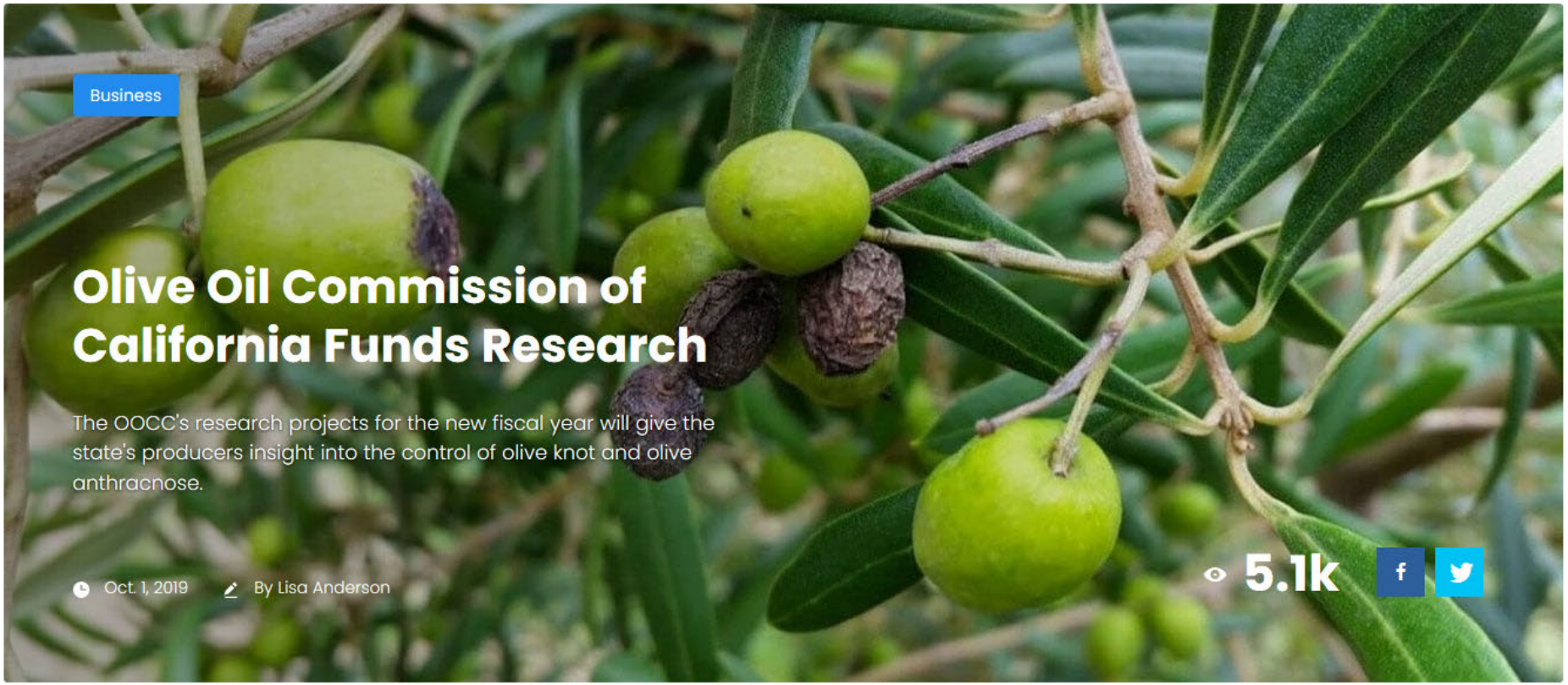


2019-20 Surveys for olive Anthracnose:

- ✓ **November 2019**
- ✓ **December 2019**
- ✓ **January 2020**

Field observation and disease diagnosis:

- Working with OOCC members



The OOCC will provide nearly $15,000 of funding to research olive anthracnose. Photo courtesy of Valmir Duarte

Survey for olive Anthracnose:

- Olive trees near almond and walnut orchards

Survey for olive Anthracnose:

- Olive trees near orange and mandarin orchards

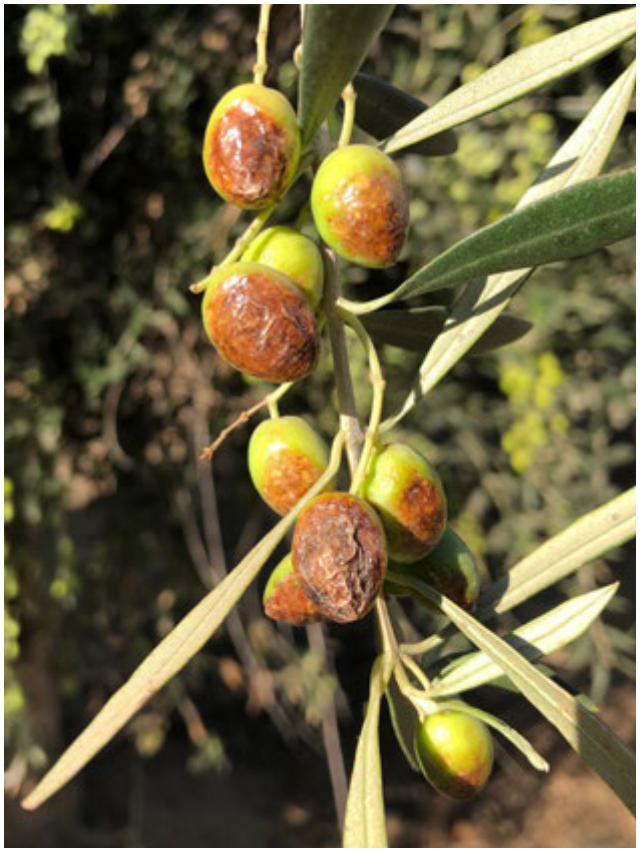
Survey for olive Anthracnose:

- Ornamental olive trees near commercial olive orchards

Field observation and disease diagnosis:

- Testing symptomatic fruits





Field observation and disease diagnosis:

- Testing mummies from commercial olive orchards

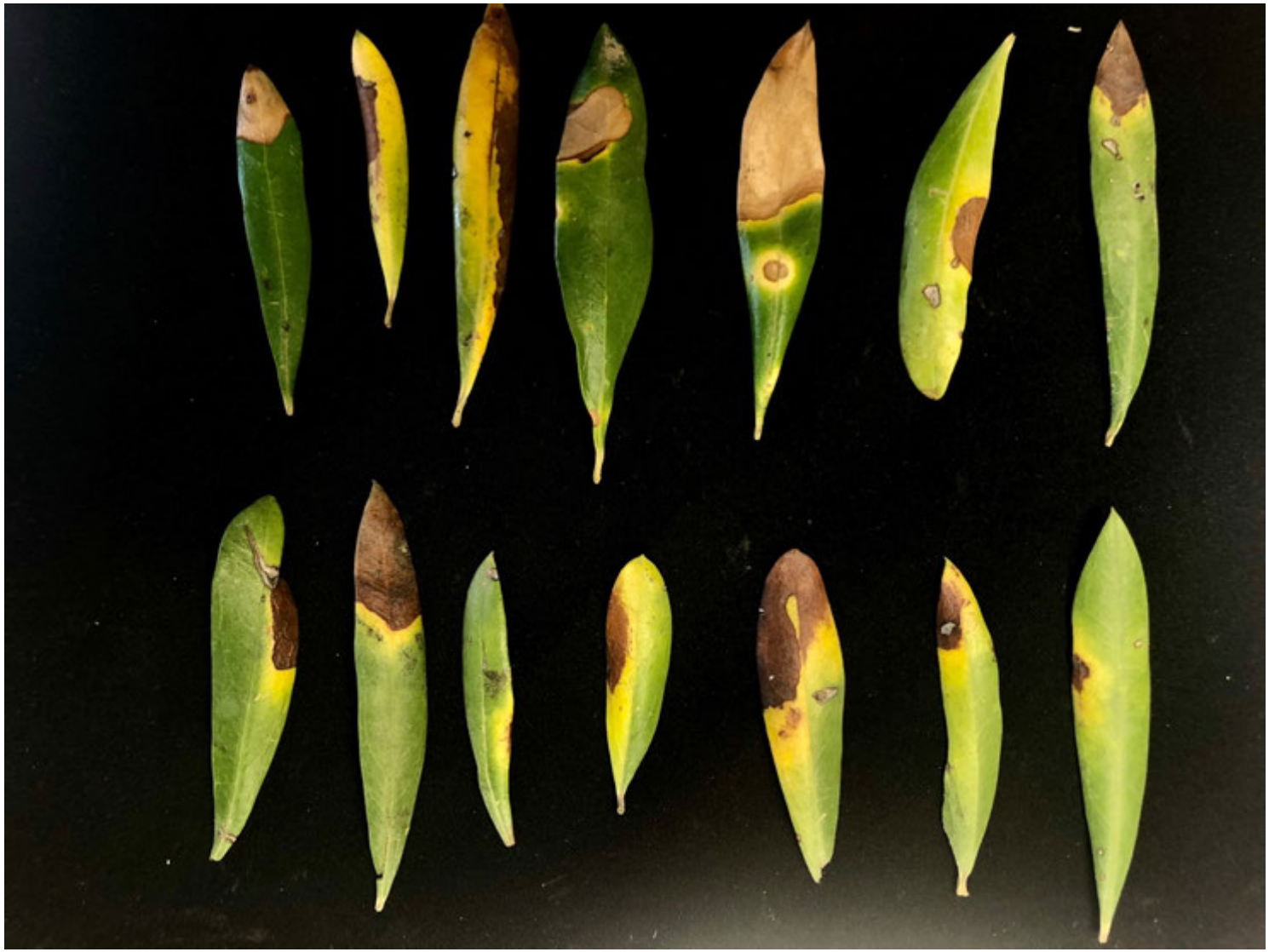


Field observation and disease diagnosis:

- Testing symptomatic leaves

Field observation and disease diagnosis:

- Testing symptomatic leaves

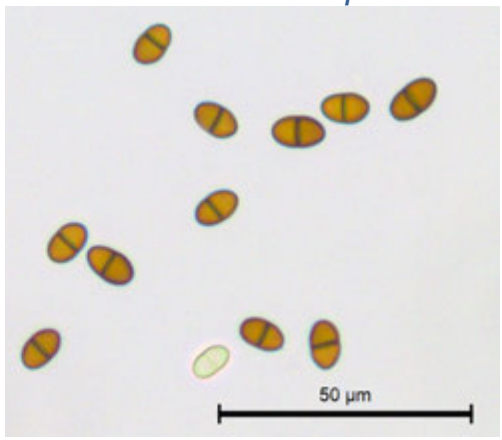


Field observation and disease diagnosis:

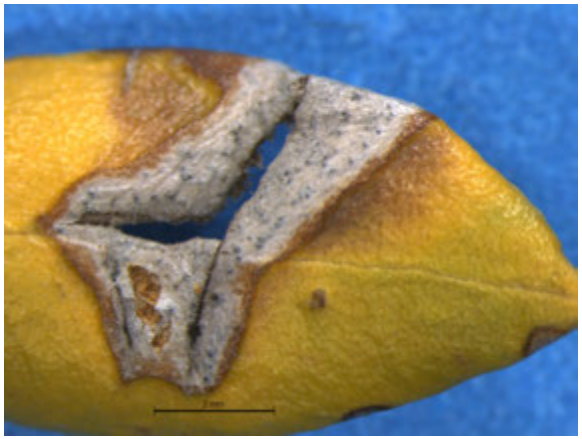
- Botryosphaeria

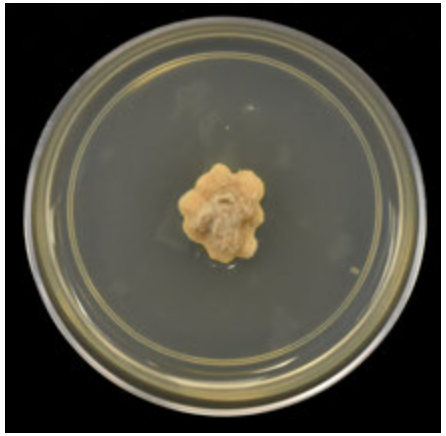
Disease diagnosis: morphological studies

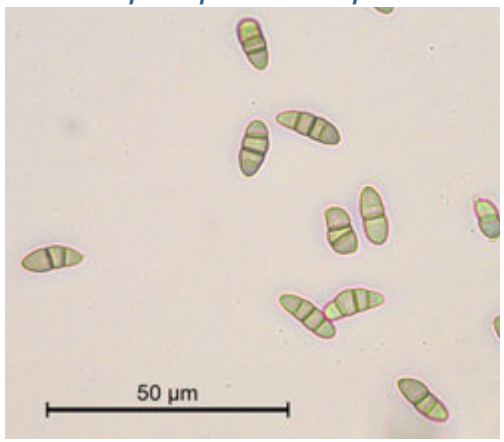
Undescribed species…



Leptosphaeria species…







Leaf senescence and leaf drop:

Leaf senescence and leaf drop:

- General neglect of the normal inputs
- Water stress
- Nitrogen on other nutrient deficiency

Photo credits: E . Fichtner

Field observation and disease diagnosis:

- Nitrogen or Potassium deficiency, water problem

Field observation and disease diagnosis:

- Nitrogen or Potassium deficiency, water problem

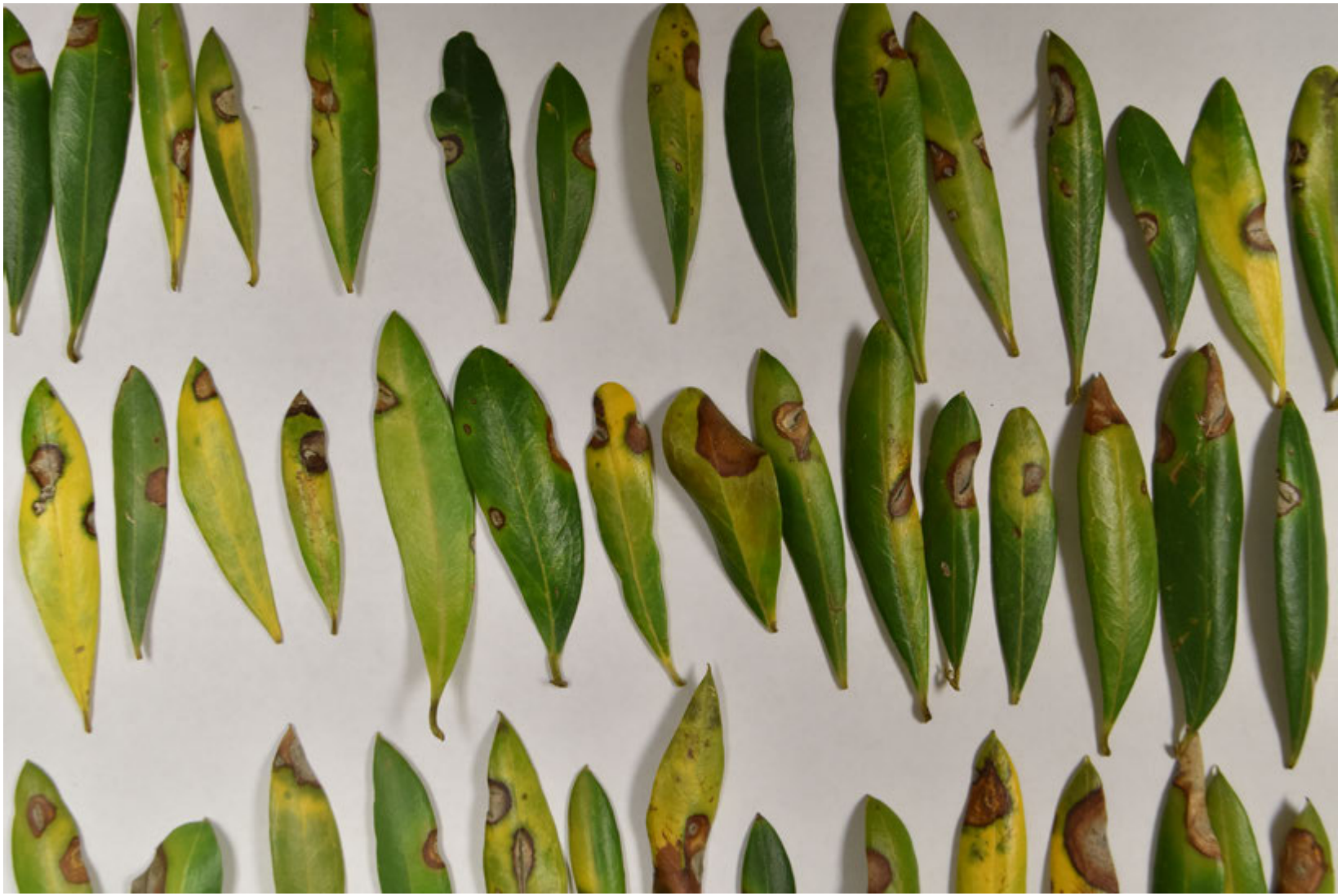


Field observation and disease diagnosis:

- Neofabraea?

Field observation and disease diagnosis:

- Neofabraea



Field observation and disease diagnosis:

- Herbicide drift

Field observation and disease diagnosis:

- Lygus or Stink bug

Field observation and disease diagnosis:

- Weevil damages

Field observation and disease diagnosis:

- Freeze injury

Field observation and disease diagnosis:

- Olive anthracnose was not found in commercial olive orchards in California!

Kearney Ag Center:

Kearney Ag Center:

Kearney Ag Center:

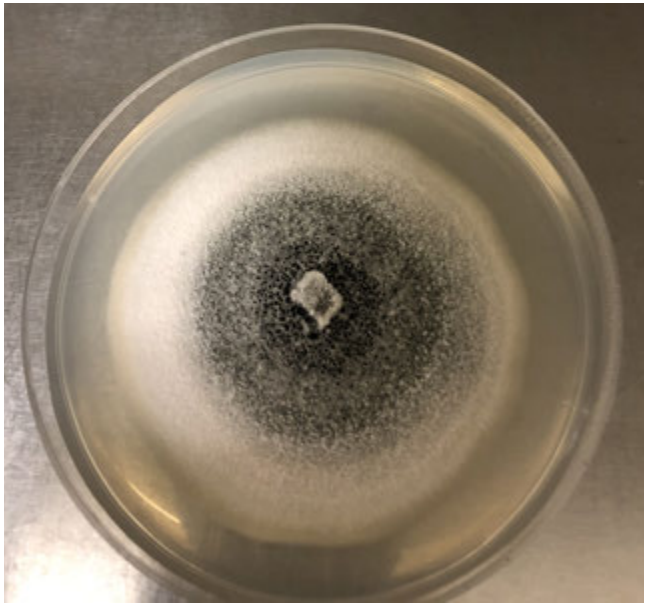
Olive Anthracnose:

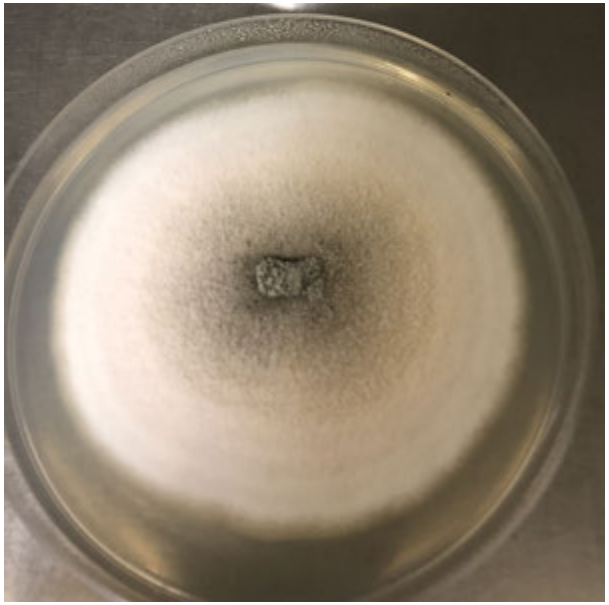
Gordal Sevillana olives

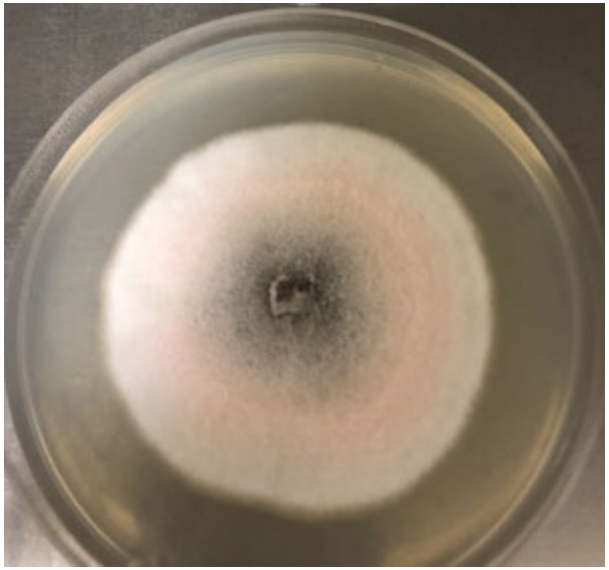
Olive Anthracnose:

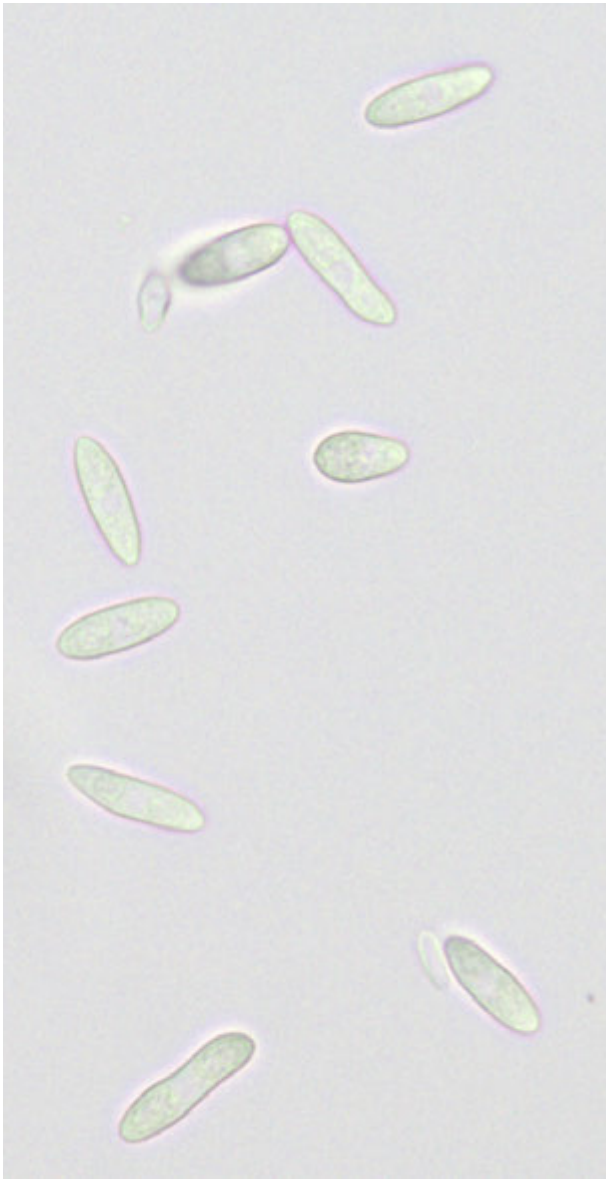
Olive Anthracnose:

Olive Anthracnose: *Colletotrichum fioriniae*



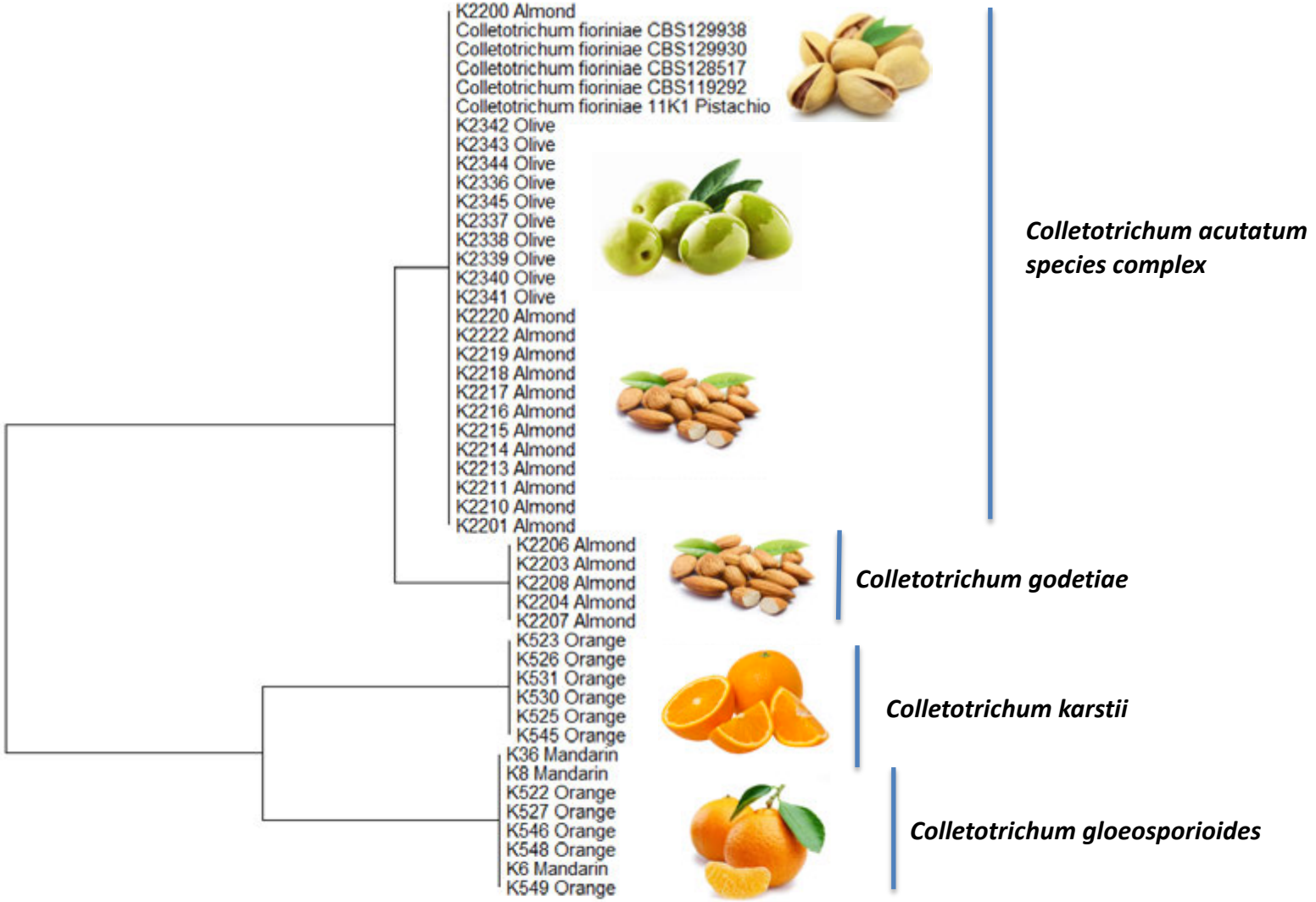






Olive Anthracnose: causal agent

- ***Colletotrichum fioriniae*** *(Colletotrichum acutatum species complex)*



Is Anthracnose a threat to California oil olives?

Anthracnose; Is it a Threat to California Pistachios?

BY THEMIS J. MICHAILIDES, PAULO LICHTEMBERG, ROBERT SANDERS, AND JUAN MORAL

Anthracnose of pistachio: In July 2016, putative diseased samples were collected from two pistachio (*Pistacia vera*) orchards in northern California (Glenn County) with black and sunken lesions on leaves and rachises. Samples were of the Red Aleppo, Joley, and Kerman cultivars. Eventually, individual fruit were totally blighted. These

genus infects a large number of plant species, causing a plant disease generally known as "anthracnose" and can be very devastating because under the conducive environmental conditions can cause epidemics on various annual and perennial crops.

Isolations from spore masses of pistachio fruit and the margins of leaf lesions from multiple diseased samples revealed 100 percent Colletotrichum species recovery from samples the cultivar (cv.) Red Aleppo and 18 percent from samples of the cv. Kerman in the first orchard. In the second orchard, 9 percent of the isolations from fruit lesions of cv. Red Aleppo and 100 percent of isolations from small spots in panicles were *Colletotrichum* species. Also, 40 percent of the fruit lesions produced *B. dothidea*, an indication that the conditions were conducive to both of these diseases in the summer of 2016. By early August lesions showed on fruit and leaves of cv. Joly, which was also planted in the first orchard, and isolations from fruit and leaf lesions of this cultivar also produced *Colletotrichum* species at in the majority of isolations.

In Australia and China, the anthracnose of pistachio has been reported to cause significant yield losses, ranging from 25 percent to up 50 percent in years with wet spring and summer (Yang et al., 2012; Hall et al., 2014). In California, it is considered a new discovery. Specifically, a 50 percent destruction of the Australian pistachios was reported following the very wet summer of 2010. The occurrence of this severe disease in a couple of orchards in Butte County reminds us of how the devastating Botryosphaeria panicle and shoot blight started in a pistachio orchard in northern California, and in about 12 years the disease became a devastating epidemic on pistachio throughout the state.

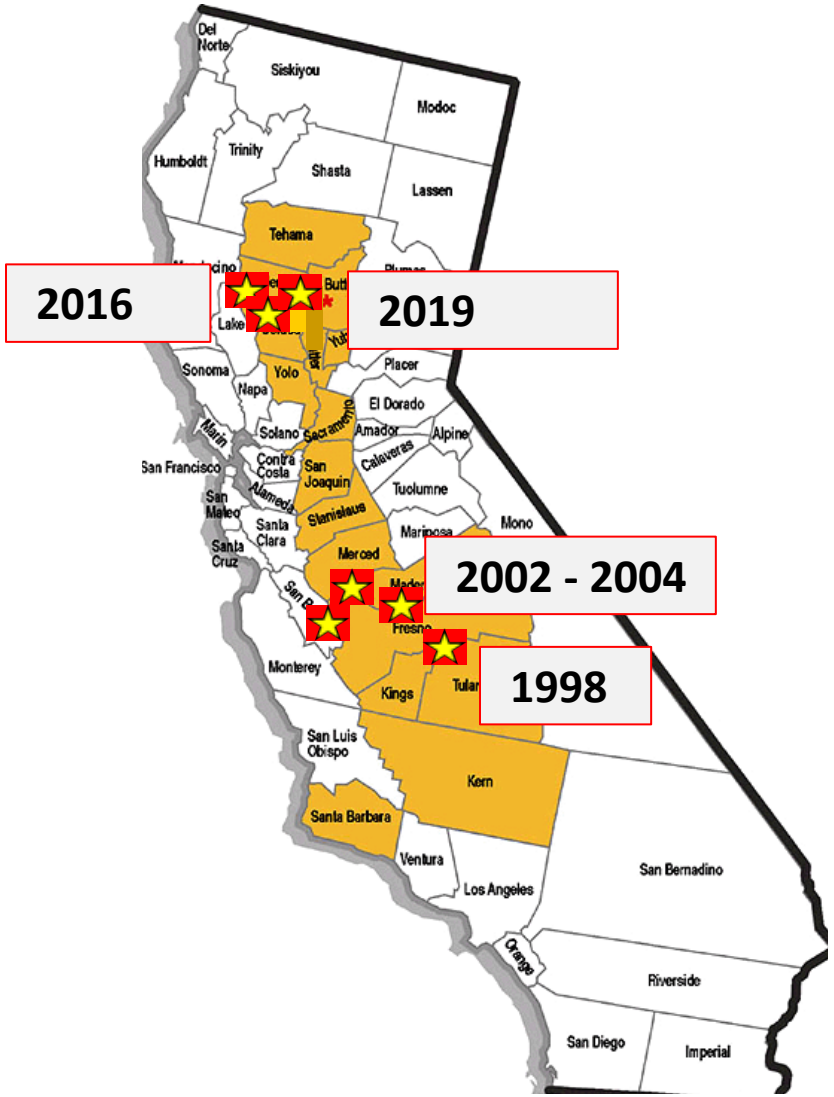
Photo 1

fruit blight symptoms looked different from the Botryosphaeria (Bot) panicle and shoot blight and did not bear any characteristic pycnidia of Botryosphaeriaceae fungi. Instead some of the fruit lesions developed slimy, pink ooze by harvest time. Lesions on the leaves were black and angular and also some developed the same slimy, pink ooze on the surface (**Photo 1**). Examination of the ooze under a compound microscope revealed masses of elliptical, one-cell conidia, characteristic of the fungal pathogen Colletotrichum. This fungal

Colletotrichum

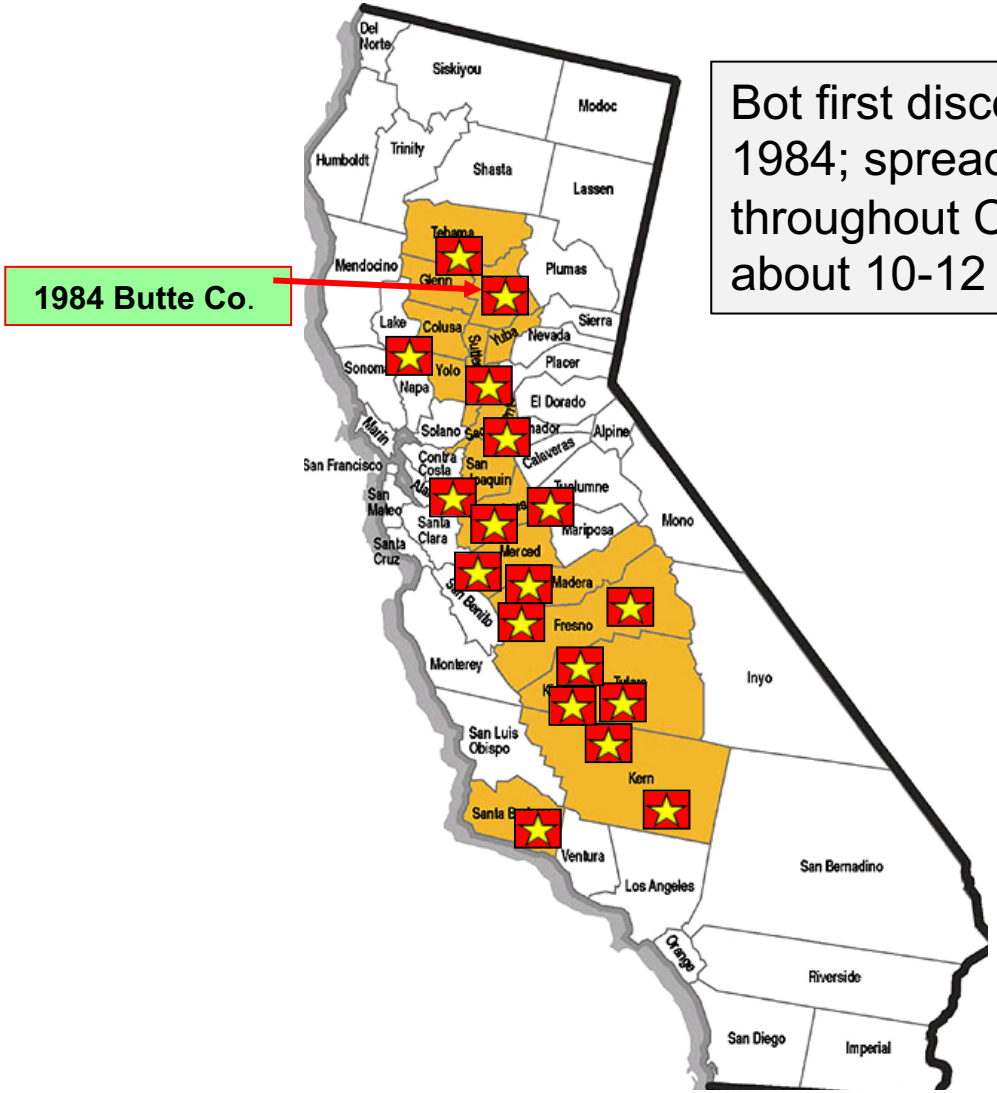
Anthracnose blight in pistachio

Dr Themis Michailides



Botryosphaeria panicle and shoot blight in pistachio

Dr Themis Michailides



Bot first discovery in 1984; spread throughout CA in about 10-12 years.

Is Anthracnose a threat to California oil olives?

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La Antracnosis del olivo y su efecto en la calidad del aceite

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Assessing the Susceptibility of Olive Cultivars to Anthracnose Caused by *Colletotrichum acutatum*

J. Moral and **A. Trapero,** Departamento de Agronomía, ETSIAM, Universidad de Córdoba, Campus de Rabanales, 14071 Córdoba, Spain

ABSTRACT

Moral, J., and Trapero, A. 2009. Assessing the susceptibility of olive cultivars to anthracnose caused by *Colletotrichum acutatum*. Plant Dis. 93:1028-1036.

Selected olive (*Olea europaea*) cultivars were tested in the field and laboratory for their relative susceptibility to anthracnose caused by *Colletotrichum acutatum*. A rating scale to assess fruit-rot incidence in naturally infected trees was validated by comparing ratings with direct counts of affected fruit. Fruit-rot incidence varied greatly among 20 cultivars and was correlated with the severity of branch dieback symptoms that developed after fruit-rot epidemics. For determining whether artificial inoculation can be used to predict anthracnose susceptibility in the orchard, detached fruit of 12 cultivars were inoculated with *C. acutatum* and fruit-rot severity was assessed periodically. Progress of disease severity over time fit the logistic function for all cultivars. The best correlation between fruit-rot incidence in the field and disease severity on inoculated fruit was obtained using a disease susceptibility index that integrated the maximum disease progress rate and the estimated time to reach 50% disease severity. Based on field observations and laboratory data on susceptibility to anthracnose, 21 cultivars were classified into three groups: highly susceptible (Cornicabra, Hojiblanca, Lechín de Sevilla, Manzanilla de Sevilla, Morona, Ocal, Picudo, and Verdial de Huévar); moderately susceptible (Arbequina, Arbosana, Morrut, Pajarero, and Villalonga); and resistant (Blanqueta, Empeltre, Frantoio, Koroneiki, Leccino, Morona-D, Picual, and Razzola). The assessment method may be useful to screen olive cultivars for anthracnose resistance.

Source: http://oliviculturadeprecision.com

Is Anthracnose a threat to California oil olives?

- "Olive fruit usually becomes susceptible to the fungus under warm, humid conditions during summer as the fruit begins to develop and ripen." ***Dr Vera Sergeeva - Australia***

- "Anthracnose is a latent disease. The fungus infect the fruit when the environmental conditions are suitable but will remain dormant until the fruit begins to ripen." ***Dr Vera Sergeeva - Australia***

- "The disease incidence is not recognized until the symptoms appear on mature fruit. Early harvesting before ripening can avoid the disease." ***Romero et al. 2017 - Spain***

- **CA environmental conditions are not too favorable for olive anthracnose**

- **New fungicides to be registered in CA**

- **Conclusion:** Risks of anthracnose epidemic in CA oil olives are (very) low

Thank you!

Dr. Mohamed T. Nouri, UCD
Dr. Renaud Travadon, UCD
Dr. Juan Moral, UCD
Dr. Daniel Lawrence, UCD
Dr. Jim Adaskaveg, UCR
Dr. Brenna Aegerter, UCCE
Dr. Dani Lightle, UCCE