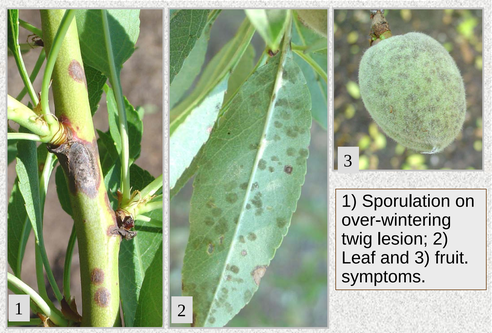
Epidemiology and Control of Almond Scab and Alternaria Leaf Spot

J.E. Adaskaveg, University of California, Riverside

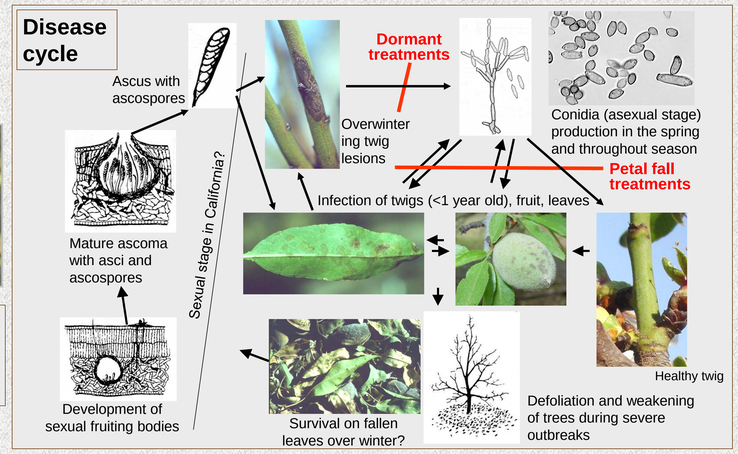
H. Förster (UC Davis), D. Felts and J. Enns (UC Riverside), J. Connell (UCCE Butte Co.), R. Buchner (UCCE Tehama Co.), and B. Krueger (UCCE, Glenn Co.)

Management of Scab (*Venturia carpophila, Cladosporium carpophilum*)



1) Sporulation on over-wintering twig lesion; 2) Leaf and 3) fruit. symptoms.

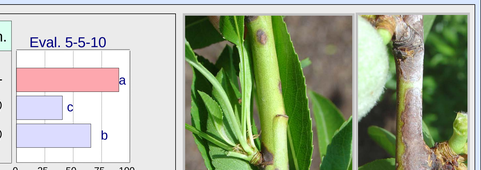
Disease cycle



Field trials on disease management in 2010

1. Dormant applications to reduce inoculum in the spring

2010 Treatments	Jan.
Control	---
Kocide 3000 5 lb - Oil 4 gal	@
Kocide 3000 5 lb - Cohere	@

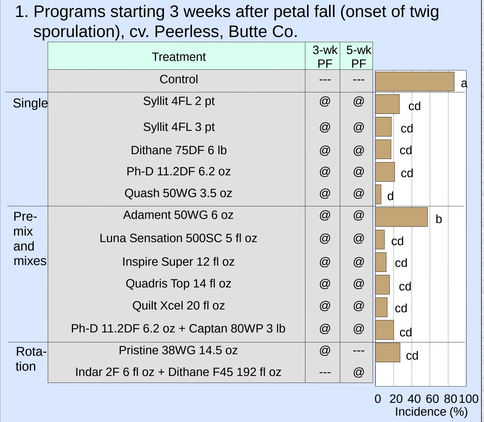


- Dormant treatments with copper-oil are most effective in reducing primary inoculum in spring.
- These treatments are not effective on final disease levels, but they should be included into any scab program because the risk for selection for fungicide resistance is reduced when less inoculum is exposed to in-season fungicides.

2. In-season applications

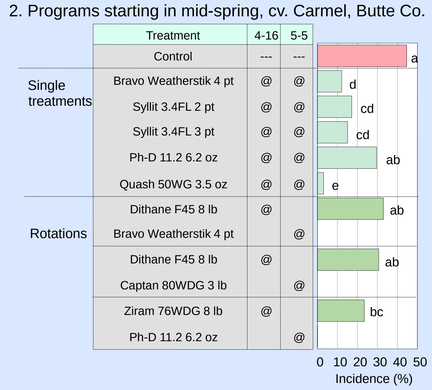
1. Programs starting 3 weeks after petal fall (onset of twig sporulation), cv. Peerless, Butte Co.

	Treatment	3-wk PF	5-wk PF
	Control	---	---
Single	Syllit 4FL 2 pt	@	@
	Syllit 4FL 3 pt	@	@
	Dithane 75DF 6 lb	@	@
	Ph-D 11.2DF 6.2 oz	@	@
	Quash 50WG 3.5 oz	@	@
Pre-mix and mixes	Adament 50WG 6 oz	@	@
	Luna Sensation 500SC 5 fl oz	@	@
	Inspire Super 12 fl oz	@	@
	Quadris Top 14 fl oz	@	@
	Quilt Xcel 20 fl oz	@	@
	Ph-D 11.2DF 6.2 oz + Captan 80WP 3 lb	@	@
Rotation	Pristine 38WG 14.5 oz	@	---
	Indar 2F 6 fl oz + Dithane F45 192 fl oz	---	@



2. Programs starting in mid-spring, cv. Carmel, Butte Co.

	Treatment	4-16	5-5
	Control	---	---
Single treatments	Bravo Weatherstik 4 pt	@	@
	Syllit 3.4FL 2 pt	@	@
	Syllit 3.4FL 3 pt	@	@
	Ph-D 11.2 6.2 oz	@	@
	Quash 50WG 3.5 oz	@	@
Rotations	Dithane F45 8 lb	@	
	Bravo Weatherstik 4 pt		@
	Dithane F45 8 lb	@	
	Captan 80WDG 3 lb		@
	Ziram 76WDG 8 lb	@	
	Ph-D 11.2 6.2 oz		@



- Programs that start at onset of twig sporulation are more effective than those starting later in the spring.

- **New fungicides registered or planned for scab:**
  - Single-site mode of action fungicides: Ph-D, Quash, Inspire, Syllit - *pending*
  - Pre-mixtures: Inspire Super, Quilt Xcel, Luna Sensation - *pending*

Summary: Management of scab

Almond scab can be effectively managed with currently available treatment strategies. The disease history in the orchard will determine the intensity of the program.

- **Fungicide programs:**
  - A highly effective three-spray program should include dormant applications with copper-oil and two after-petal-fall (around twig infection sporulation) applications with chlorothalonil, possibly mancozeb (see below), captan, or ziram (all are multi-site fungicides that have a low potential of resistance development).
  - Because maneb has been voluntarily canceled (2008/2009), mancozeb (e.g., Dithane) fungicides are being tested and are planned for future registrations.
  - Single-site fungicides should not be applied once disease is developing.
- **Cultural practices: IPM and the Disease Triangle**
  - Minimize conducive environments: increase air movement (N-S plantings), reduce humidity (high-delivery irrigation systems), minimize wetting of foliage from sprinklers, etc.
  - Host: plant less susceptible varieties, avoid heavy late-summer/fall fertilization

Update on fungicide resistance in populations of *C. carpophilum*

- A high incidence of QoI resistance (>90%) was confirmed at several additional locations within the state.
- In surveys done in 2009 and 2010 at several locations, a wide range of sensitivities in pathogen populations was found against the DMI fungicides (e.g., Quash, Inspire). EC_{50} values ranged from 0.07 to 1.86 mg/L for difenoconazole and 0.01 to 2.23 mg/L for metconazole.
- To prevent further selection of resistance, DMI fungicides should not be used as stand-alone in-season treatments for scab management, but must be used in a rotation or in mixtures.

Management of Alternaria Leaf Spot (*Alternaria* spp.)

Conidia of *Alternaria* sp.

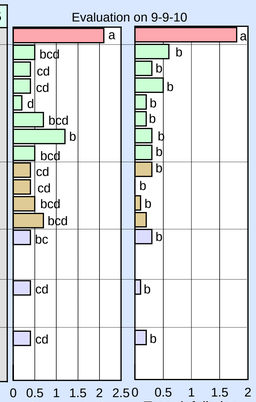
Sporulating lesion

Symptoms with necrotic lesions and sporulating lesions that are black in the center. The new re-growth is already infected.

Severe infections lead to early tree defoliation, new leaf development, and eventual weakening of the tree.

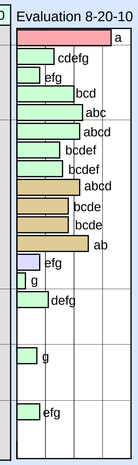
Field trials on disease management in 2010

	Treatments	4-29	5-18	6-15
	Control	---	---	---
Single fungicides	Ph-D 11.2DF 6.2 oz	---	@	@
	Tilt 3.6EC 8 fl oz	---	@	@
	Quash 50WG 3.5 oz	---	@	@
	Inspire EC 7 fl oz	---	@	@
	Abound 2F 12.5 oz	---	@	@
	Gem 500SC 3 fl oz	---	@	@
	Bravo 96 fl oz	---	@	@
Pre-mixtures	Adament 50WG 6 oz	---	@	@
	Quadris Top 20 fl oz	---	@	@
	Quilt Xcel 14 fl oz	---	@	@
	Pristine 38WG 14.5 oz	---	@	@
Rotations	Manzate Pro-Stick 76.8 oz	@	---	---
	Ph-D 11.2DF 6.2 oz	---	@	---
	Adament 50WG 6 oz	---	---	@
	Bravo 96 fl oz	@	---	---
	Quilt Xcel 14 fl oz	---	@	---
	Quadris Top 20 fl oz	---	---	@
	Ph-D 11.2DF 6.2 oz	@	---	---
	Quash 50WG 3.5 oz	---	@	---
	Ph-D 6.2 oz + Quash 2.5 oz	---	---	@



cv. Carmel - Colusa Co.

	Treatments	5-19	6-9	6-30
	Control	---	---	---
Single fungicides	Ph-D 11.2DF 6.2 oz	@	@	@
	Ph-D 11.2DF organic form. 6.2 oz	@	@	@
	Quash 50WG 3.5 oz	@	@	@
	Bravo WS 6 pt	@	@	@
Pre-mixtures and mixtures	Adament 50WG 6 oz	@	@	@
	Luna Sensation 4 oz	@	@	@
	Inspire Super SC 20 fl oz	@	@	@
	Quadris Top 14 fl oz	@	@	@
	Inspire XT/Inspire EC 7 fl oz	XT	XT	I
	Inspire 7 fl oz/Bravo 4 pt	@	@	@
	Pristine 38WG 14.5 oz	@	@	
	Ph-D 6.2 oz + Quash3.5 oz /Inspire 7 fl oz	Q	I	Q
	Ph-D 6.2 oz + Inspire Super 20 fl oz	@	@	@
Rotations	Quash 50WG 3.5 oz Luna Sensation 4 fl oz Ph-D 6.2 oz + Inspire Super 20 fl oz	@	@	@
	Ph-D 11.2DF 6.2 oz Inspire Super SC 20 fl oz Ph-D 6.2 oz + Bravo 6 pt	@	@	@
	Ph-D 11.2DF 6.2 oz Quash 50WG 3.5 oz Ph-D 6.2 oz + Quash 2.5 oz	@	@	@



cv. Monterey - Kern Co., Incidence of QoI resistance 97%, incidence of carboxamide resistance 60%

Evaluation of tree defoliation

Control **Polyoxin-D + Inspire Super**

- Mixtures of the Group 19 Ph-D (polyoxin-D) and the Group 3 fungicides (i.e., Inspire, Quash) were the most effective treatments.
- Other new fungicides with good activity: Luna Sensation, Adament, Quadris Top, Quilt Excel. These all have a QoI component and thus, will exacerbate QoI resistance.

Relative efficacy of selected fungicides for management of Alternaria leaf spot of almond

	Fungicide	Class	Mode of action	Efficacy	Remarks
	Bravo, Echo	Aromatic nitrile	Multiple	+	Label for timing change pending
	Captan	Pthalimide	Mutiple	+	2ee amendment
	Ziram	Dithiocarbamate	Multiple	+	---
	Vangard/Scala	Anilinopyrimidine	Single	+	2ee amendment (Scala)
	Rovral*	Dicarboximide	Multiple	+++	Registered bloom to petal fall
	Abound, Gem	QoI	Single	+++	Resistance
	Pristine	QoI-SDHI	Multiple	++++	Resistance
New	Adament	QoI-DMI	Multiple	++++	Registered, Res. to 1 comp.
New	Inspire	DMI	Single	++++	Registered
New	Quash	DMI	Single	++++	Registered
New	PhD	Biofungicide	Single	++++	Registered
New	Luna Sensation	QoI-SDHI	Multiple	++++	Resistance, Expected 2011

Rating: ++++ = most effective, - = not effective

*- Restricted to applications until 5 weeks after petal fall.

Summary: Management of Alternaria Leaf Spot

- **Fungicide programs:**
  - Field resistance against QoIs is common while resistance against SDHIs occurs at several locations at high levels. Cross resistance among QoIs (e.g., Abound, Gem, etc.) and among SDHIs (boscalid, fluopyram, etc.) is common.
  - Management programs should start with petal fall applications that include Rovral and Bravo (performance is variable and depends on the occurrence of favorable conditions).
  - Late-spring/early-summer applications (based on the DSV model) with other materials.
  - New materials (e.g., Quash, Inspire, Ph-D, Quadris Top, Quilt Xcel, Luna Sensation) will have to be strictly used in rotations and mixtures for resistance management.
  - Other components of an integrated approach in disease management are highly critical for management of Alternaria leaf spot.