

A wide-angle photograph of a field filled with numerous small, bright yellow flowers. In the background, several large, leafy fig trees are scattered across the landscape. The sky is overcast with grey clouds. The overall scene is a natural, agricultural setting.

# Fig botany, biology, production

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# Figs – an ancient fruit

- Species has been domesticated since the bronze age
  - Extremely easy to propagate – roots readily from cuttings
  - Can be consumed fresh and stored in dried form
- Domestication resulted in:
  - Increased fruit size
  - The development of “artificial” pollination
  - Selection of cultivars that exhibit fruit persistence



# Botany

- Latin binomial is *Ficus carica*
- *Ficus* genus is huge - over 700 species with species-specific pollinators
- Part of the Moraceae family
  - Other notable food species in this family: breadfruit, jackfruit, mulberry
  - Family traits:
    - production of latex
    - Compound, inconspicuous fruit

# Figs – an ancient fruit

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- Figs were traded all over the Mediterranean and beyond
- Many regional varieties?
  - No extensive genetic mapping
  - But most likely a much smaller number of varieties were given local names as they were traded and cultivated over the centuries



# Figs – local history and horticulture

- Figs are a traditional crop for the Fresno-Madera-Merced area
- Fresno was founded on fig production as well as raisins
- Acreage has shrunk due to competition and changing tastes
- Traditionally production has focused on dried and canned fruit
  - Calimyrna (Sarilop) is the traditional dried variety
  - Kadota (Datatto) was the canned variety



# There are two crops of edible figs

## **Breba / first crop**

- Ripens in June (ish)
- Formed from reproductive buds (immature fruit) that did not complete development in the previous season

## **Main crop**

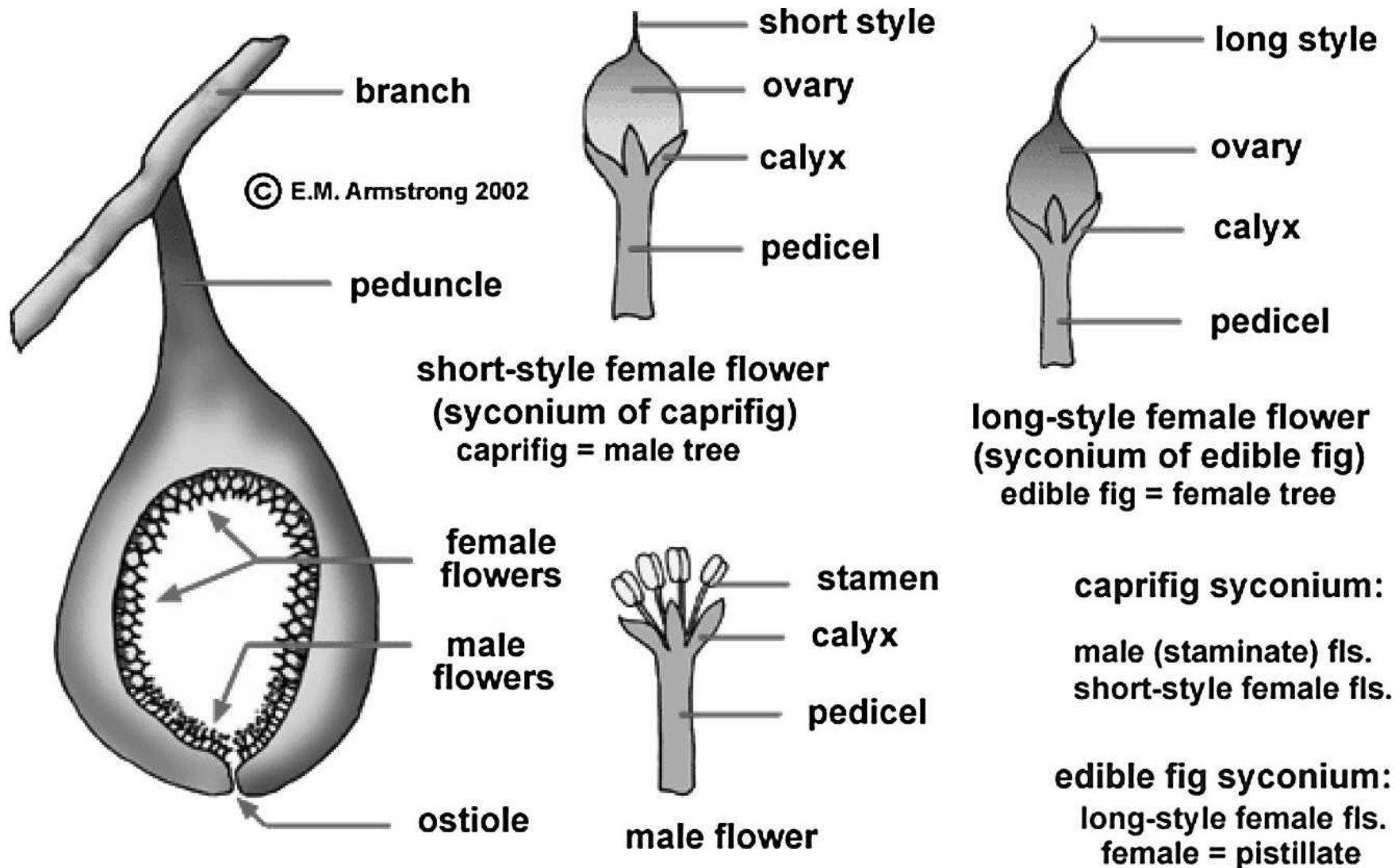
- Ripens from August through October
- Formed from reproductive buds produced in season

# Figs are borne on current season's wood

- Syconium (the fig "fruit") are produced at leaf axils as the branch grows
- Trees can have fruit at all stages of maturity at a single point in time
- Requires multiple harvests
  - Fruit is picked as frequently as every day for fresh harvests
  - Dried fruit is picked up approximately weekly from August – October



# The fig "fruit" is a syconium



Armstrong, W.P. 2006. Sex determination & life cycle of *Ficus carica*.



# Figs are pollinated by wasps

- Wasps survive on ‘caprifigs’ which allow them to successfully reproduce
  - Caprifigs have three crops, which allow multiple generations of fig wasps
- The second crop of the caprifig (profichi) coincides with when the main crop needs to be pollinated
  - There is a short time frame when profichi are ready to go, so harvest-season in wasp-pollinated figs tends to be shorter
- Hard “seeds” in figs are actually the fruit – drupelets!

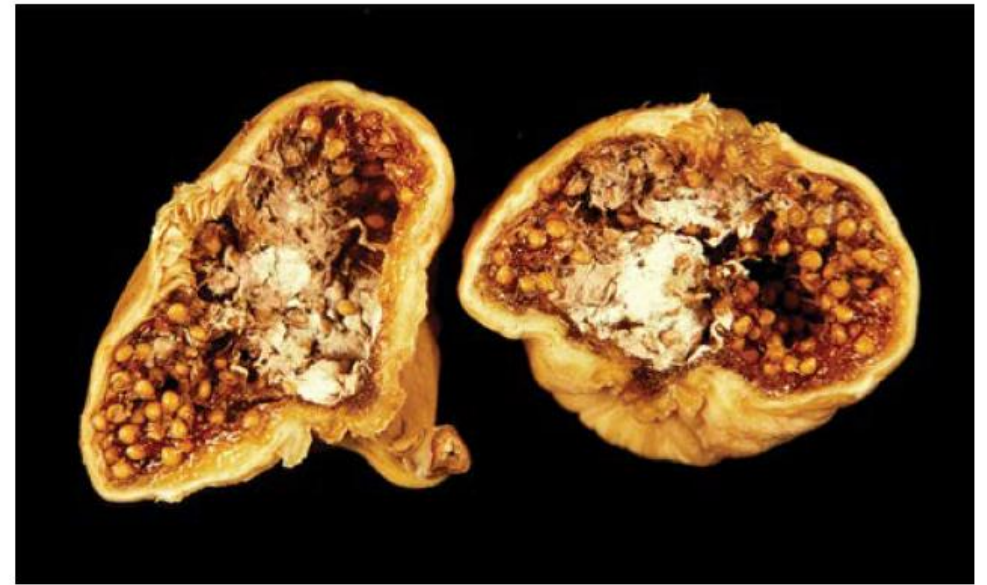


# There are four 'types' of fig trees

- Smyrna
  - Requires pollination to set any fruit; bears no breba/first crop
- San Pedro
  - Does not require pollination for the breba, requires pollination for the main crop
- Common / Persistent
  - Does not require pollination for either crop, does not always produce breba
- Genrifig
  - Mostly inedible. Functionally male, and where the fig wasp completes its life cycle

# Wasp pollination is obsolete in California production systems

- Calimyrna (Sarilop) doesn't yield as well as other cultivars
- The fig wasp introduces endosepsis into fruit – formerly a serious disease of fruit
  - Weedy figs used to be culled to reduce the chance of wild fig wasps introducing the disease into orchards



**Fig. 12.6.** Endosepsis disease or pink rot of fig fruit caused by *Fusarium* spp. (Figure courtesy of T.J. Michailides.)

Image from: [The Fig: Botany, Production, and Uses](#)

Figs soften as they age, and drop from the tree



# Dried figs are machine harvested

- Once fruit have partially dried out, they fall to the ground
- Fruit is harvested much like almonds:
  - Blown to row middles
  - Windrowed
  - Picked up and binned and then transported to a processor
  - Processor sorts good fruit from damaged and cleans and changes the moisture content of the fruit
  - Premium dried fruit may be hand picked and tray dried, may or may not be sulfured



# Fresh fig harvest

- Figs are climacteric (ripen via ethylene) but do not continue to ripen off of the tree
- Harvested at commercial maturity – when the entire fruit has developed color but the final color development is not complete
  - Consumer preference research shows that fruit picked at commercial ripeness has much less acceptability than tree ripe fruits –
    - 56% of consumers accepted commercial ripe fruits
    - 86% accepted tree ripe fruits – similar acceptance numbers to cherries!
  - However, consumers being what they are, will buy fruit that are commercial ripe, not tree ripe
  - Potential market for tree ripe fruit? If you can get acceptance and sell fruit before it goes bad

# Fresh fig harvest

- Fruit should still be firm, and latex free
- Harvest early in the morning, and pickers need to be trained to harvest fruit without damaging it
- Stem should be left on the fruit to preserve shelf life
- Provide hand protection for workers – fig latex **STINGS** after a while



**Fig. 15.13.** Incorrect (left, stalk removal) and correct harvest (right, included stalk). (Figure courtesy of A. Yavari.)

Image from: [The Fig: Botany, Production, and Uses](#)

# Fresh fig sales are limited by the fruit's short shelf life

- Cool the fruit and sell it as soon as possible
- Figs have a shelf life of 1-2 weeks
- Ensure storage containers are clean and smooth to reduce fruit damage
- Some work done to expand the shelf life of fresh figs
  - Sulfur dioxide emitting pads
  - Ozone gas treatment
  - Both work by killing fungal pathogens
  - I know the engineer who developed the ozone treatments – if interested, email me

# Fig production

Caveat – there hasn't been much production research in CA orchard systems for a very long time

# Site selection and orchard design

# Site selection

- Figs are weedy in riparian areas – will grow with abandon given the right conditions
- Very low chilling requirement
- Fairly frost tolerant (frost damage is rare)
- Do best in areas with hot, dry summers
  - Canned figs do better with higher humidity
- Like most orchard crops, select sites with abundant, high quality water
  - Irrigation requirements discussed later

# Site selection – soils and water

- Tolerant of many soil types
  - Generally don't thrive in soils with high levels of free lime
  - Do not do well in acidic soils (pH < 6.0)
- Like most tree crops, figs require well-drained soils
  - Rooting zone is fairly shallow for trees – likely 3-4 feet deep
- Salinity tolerance not well understood, but regarded to begin losing yields between soil salinities of 3-6 dS/m
  - Reference: almonds/walnuts begin losing yield around 1.5 dS/m
  - Pistachios: begin losing yields around 8 dS/m
- Figs are likely not tolerant to high boron levels

# Orchard design

- Orchard design will follow other fruit orchards
  - Old plantings maximized fruit production per tree, with wide spacings
  - Spacing has shrunk as it has been recognized that close spacing reduces fruit borne per tree but maximizes fruit production per acre
  - Between tree spacing can be as close as 8 feet
  - Between-row spacing should depend on your farm equipment – often limited by tractor needs



# Site preparation

- Know site history
- Soil sample, dig backhoe pits to assess soil condition
  - Land previously used for farming likely compacted, pattern depends on crop
  - Good way to understand drainage issues
  - Assess soil chemistry
- Ripping or tillage may be beneficial to alleviate soil compaction
  - Especially beneficial if new orchard row spacing differs from old production system
- Deep ripping to eliminate soil pans?
  - May be beneficial if an area has a drainage issue during heavy rains

# Figs are sensitive to pathogenic nematodes

- No rootstocks available to provide nematode tolerance/resistance
- Ring, root knot, and lesion nematodes have all been reported to reduce tree establishment
- Potential solutions:
  - Fumigation? expensive – unclear if economics work out and not organic friendly (though could regain organic status by the time the trees begin to produce)
  - Soil solarization? labor intensive, only works on top foot of soil, unclear if economically effective at large scale and not been tested in figs
  - Fallowing with cover crops ('Piper' sudangrass) likely the best option for small scale production

# Planting

- Fig planting is no different from other fruit trees
- Don't dig a hole deeper than the root ball
- Plant in the fall-spring – summer planted trees will struggle
- Make sure the irrigation system gets water *in the root zone of the potted tree*
- Monitor newly planted trees closely if planting in the spring – use the proctology test to make sure water is landing in the root zone

# Pruning trees

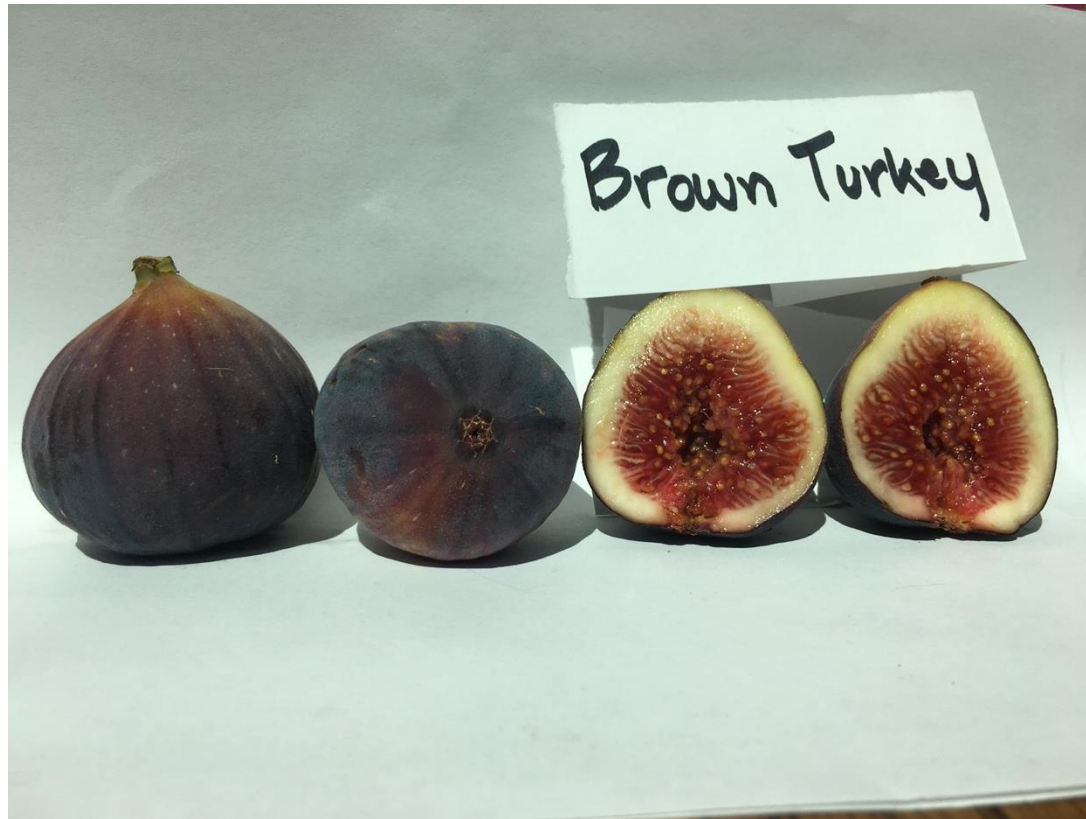
- Little to no modern research on best pruning methods in figs – use “old fashioned” fruit tree pruning
- Head the first dormant season, picking a height that works for your production system
  - Trend is to keep fresh-picked orchards SHORT to eliminate the need for ladders
  - Dried fig orchards have space between the canopy and the ground to accommodate fruit pickup
- Select scaffolds to form a vase-shaped structure in the second season
- Annual pruning is needed to keep fruiting wood at hand-height; prune branches back to 3-4 basal buds that will grow the next season
- May periodically need to do “rejuvenation pruning” to pull tree height back, particularly an old orchard that has a lot of diseased or damaged wood

# Cultivars



- A lot of market familiarity
- Good in the fresh and dried market

# Cultivars



- Exclusively for fresh consumption – inferior dried product
- Larger than black mission, more color variation

# Cultivars



- UC-bred replacement for Calimyrna in the dried market, some use for the fresh market

# Cultivars



- UC-bred for the fresh market

# Cultivars



- Requires wasp pollination; no longer planted
- Large fruit, honey like flavor

# Cultivars



- Panache/tiger/stripped fig
- Fresh market only

Photo from Four Winds Growers

# Abiotic disorders

# Fig sunburn

- Both green-skinned fruit and wood can be damaged by sunburn
- Ensure canopy coverage to protect fruit, bark from sun exposure
- When rejuvenating tree canopies, use whitewash to protect exposed branches



# Fig splitting and cracking

- Fig splitting (skin deep) and cracking (splitting of fruit typically by the ostiole) most serious issue for fresh market fruit
  - Decreased storage life
  - Unappealing to consumers
- Research done in the US and in Türkiye has shed some light on management of cracking and splitting



# Timed deficit irrigation can reduce fruit cracking

- Kong et al. (2013) showed that reducing irrigation during stage II of fruit development significantly reduced fruit cracking and splitting
  - Significant problems with study: no actual amount of applied water reported
  - Initiated in the first week of August when 25% of the fruit were in stage II
  - Took the trees down to a midday stem water potential (SWP) level of -12 bars, though no baseline SWP established so it's unclear how stressed this is
- Bottom line: if you have a lot of cracking, examine water applications during August

# Plant nutrients and fruit cracking

- Calcium applications, either to the soil or as a foliar spray, have been reported to reduce fruit cracking – even if leaf Ca levels are high
  - Calcium chloride for foliar sprays
  - Calcium nitrate, calcium thiosulfate for soil applications
- Somewhat conflicting reports in the literature on the role of potassium
  - One study looked at K and Ca ratios in fruit and found higher ratios of K to Ca resulted in cracking, but problems with study:
    - Cultivars with differing levels of susceptibility were used; cultivar is a confounding effect
    - No leaf nutrient status reported

# Plant nutrients and fruit cracking

- Plenty of published literature that shows that applied potassium reduces fruit cracking
  - US-based study used a combo of potassium and calcium thiosulfate – yields were increased due to reduced cracking/splitting, and fruit quality improved
  - Other studies outside of the US have shown reduced fruit cracking; these are in more limited input systems, so take with a small grain of salt

Irrigation

# Little to no modern irrigation research

- 2 ac-ft/year has been cited as fig irrigation requirements (and still found in modern publications), but this amount was developed for dried fig orchards
  - Flood irrigation and dried fig production are antagonistic
  - Previous irrigation practices were to severely curtail irrigation once harvesting season started, trees may have been underirrigated from August onward
- Every fresh fig grower I have talked to thinks that fresh figs require more water
  - Reduction in water stress = bigger fruit
  - 3 ac-feet? 4? Unknown
  - One study I found used a  $K_c$  of 0.75, but in reality  $K_c$  will change throughout the year
- No  $K_c$ s, no stem water potential guidelines have been established

Fertilization

# Little to no modern fertilization research

- No July leaf tissue standards, though some suggestions
  - Literature is also extremely inconsistent on what leaves are selected for analysis
- No nitrogen/potassium uptake curves
- No nitrogen/potassium export rates
- Last California-based nitrogen research I've seen was from the 1950s, when the researchers applied all their nitrogen in the fall before the growing season
  - Yikes

# N suggestions

- Modern orchard nitrogen management is based on:
  - Calculating yield potential
  - Then using export rates to estimate tree demand
  - Subtracting other N inputs (N in irrigation water, cover crops??)
  - And splitting applications based on uptake patterns
  - Results in applying what the trees need when they need it, reduces N losses from the field
- One big problem is a lot of research comes out of countries where low-input systems dominate

# Nitrogen application rates

- 50-70 lbs of nitrogen/acre reported in the literature
  - 50 lbs/ac used in The Fig: Botany, Production, and Uses
- Fig growth habit *suggests* nitrogen applications should be split evenly between April and (?)August(?)
  - Fruit is borne on current seasons wood
  - High vigor should in theory = high yields
- Excess nitrogen may increase splitting and has been associated with a reduction in fruit quality
- Wide range in leaf N levels depending on the source – no common sampling method
- Survey of well-producing California orchards suggests levels above 2%
- A study out of Brazil suggested levels of 2.6%, selected from mid-shoot from branches actively growing

# Potassium and fig quality

- Potassium generally known to be important for *fruit* quality
  - Sweetness and size negatively impacted by K deficiency
- Many studies report the importance of adequate K levels for fig fruit quality
  - Same issues apply – not much research in high input, high yield systems
- Suggested leaf tissue value of 2% potassium in one study on fig fertilization in CA
- One other study surveying orchards via leaf values found that K was the only nutrient that explained a difference in vigor
  - i.e. orchards with higher leaf K values were better off
- How much potassium to apply?
  - One study reported 44 lbs K<sub>2</sub>O/ac exported with 10 tons of fresh fruit
  - Another study reported that figs are 1.5% potassium by dry weight
  - My suggestion: equal amounts of N and K<sub>2</sub>O

Other nutritional needs?



# Fig pests, diseases



# Figs are naturally vulnerable to insect infestation

- The ostiole is a natural opening that allows insect and disease entry
- Insects can directly cause damage...
- As well as carry in fungi and molds

# Many animals will feed on figs

- Nitidulids, e.g. dried fruit beetle (*Carpophylus* spp.)
- Fig Beetle (*Cotinis texana*)
- Darkling Ground Beetle (*Blapstinus fuliginosus*)
- Navel Orangeworm (*Amyelois transitella*)
- Vinegar flies (*Drosophila* spp.)
- Ants (various species)
- Black Fig Fly (*Silba adipata*)
- Birds





Photo Credits: top row, middle right, middle: H. Wilson

# Fig diseases

- Many fig diseases are also more of a concern for the dried market
- Alternaria rot a potential issue – can be caused by high humidity or dew
- Botrytis limb blight can enter shoots via frost damage
- Some Botryosphaeria cankers can enter fresh pruning cuts
- Prune off damaged and dead wood
- Prune when the risk of rain is low
  - Feb/March in the Central Valley

# Fig mosaic virus

- Probably vectored by the fig mite
- Mottled leaves in the spring, symptoms typically disappear in the summer
- Likely reduces yield
- No management recommendations aside from not propagating from infected tissue



A wide-angle photograph of a large field of young trees, likely a nursery or orchard. The trees are arranged in rows and are relatively small, with green foliage. The ground is dry and brownish, suggesting a hot or arid environment. The sky is a clear, bright blue with a few wispy clouds. The text "Thank you!" is overlaid in the center of the image in a large, white, sans-serif font.

# Thank you!

Questions?

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