Management Ideas for Plant-parasitic Nematodes in Juice and Wine Grapes

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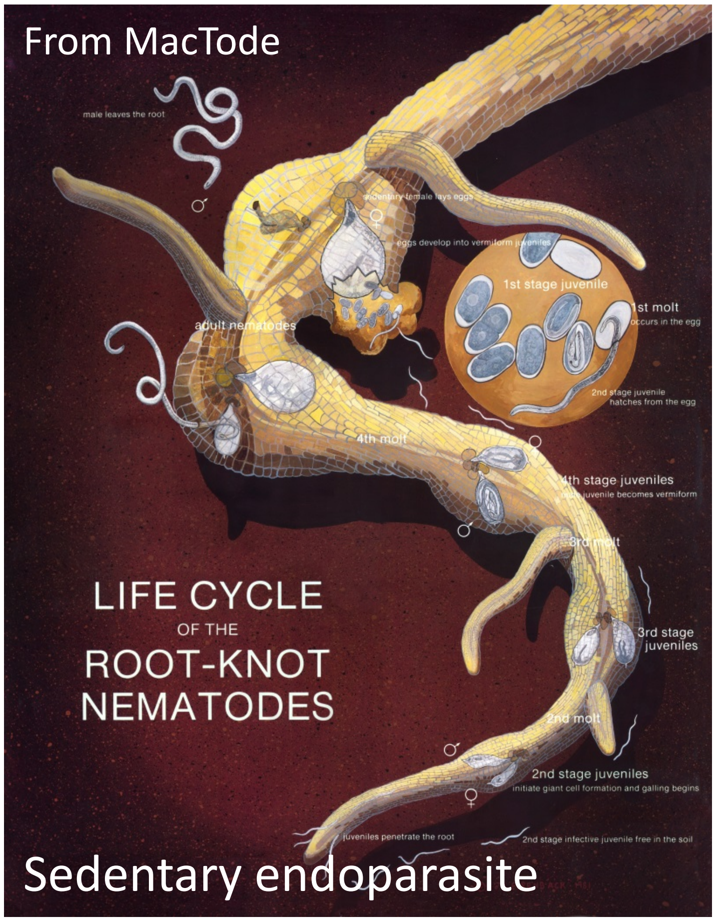
Nematodes and grapes worldwide

- Plant-parasitic nematodes are production limiting in most grape producing regions
- Species present will depend upon location
- Most commonly found genera:
  - *Meloidogyne* (root-knot)
  - *Xiphinema* (dagger)
  - *Mesocriconema* (ring)

Meloidogyne spp. (Root-knot)

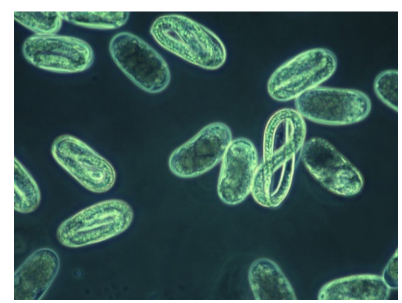


Many hosts:

Potato, alfalfa, mint, onion, dandelion, chickweed, nightshade, clover, mustards

Species:

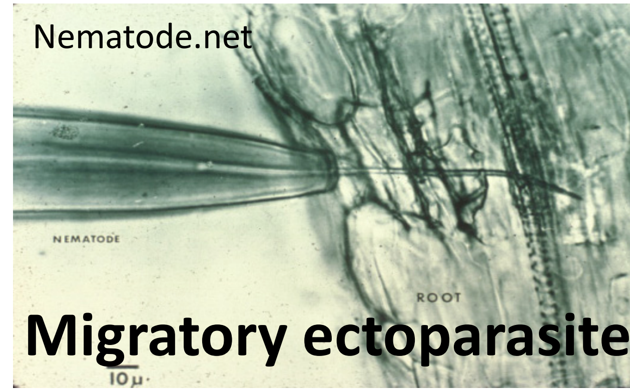
M. hapla
M. incognita
M. javanica
M. arenaria



Pictures from ipcnet.org

Xiphinema spp. (Dagger)

Hosts and Distribution:
Worldwide, mostly woody perennials and broadleaf weeds



Migratory ectoparasite

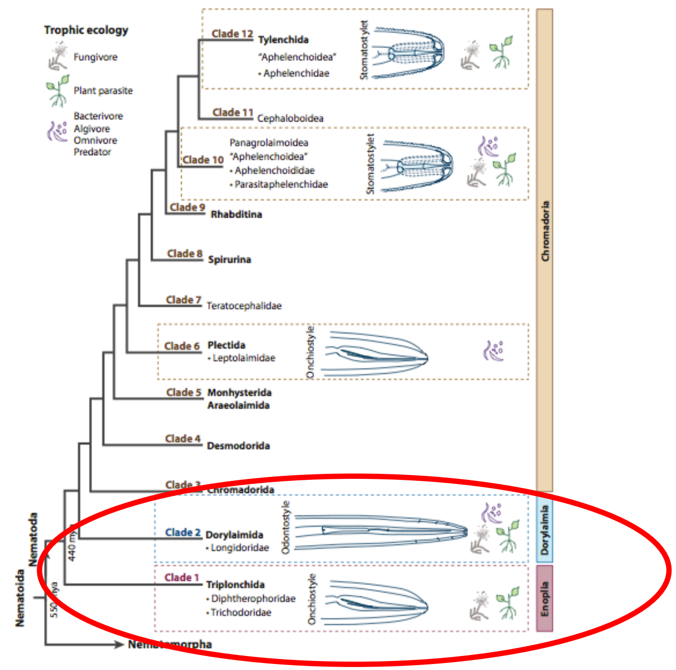
Important species in grape:
X. americanum, X. revesi, X. pachticum, X. index

All stages feed and survive

Nematode transmitted viruses:
Tomato ringspot virus
Grape fanleaf virus
Tobacco ringspot virus

Fact or Fiction? Dagger nematodes

Many types of nematodes can transmit viruses.
FICTION



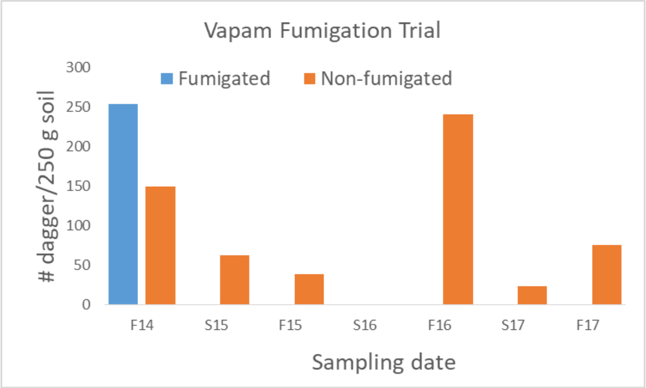
Dagger nematodes are commonly found in WA.
FACT

NEPO viruses are widespread in WA vineyards.
FICTION

Fact or Fiction? Dagger nematodes

Dagger nematodes are difficult to control.

FICTION and FACT

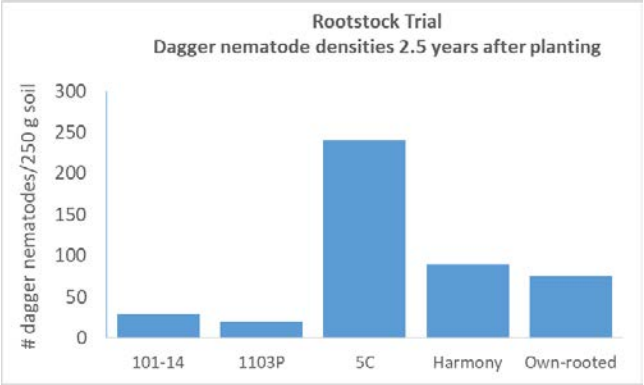


Planting vines free of viruses is the best way to manage nematode transmitted viruses.

FACT

There are rootstocks resistant to dagger nematode.

FICTION (for now)

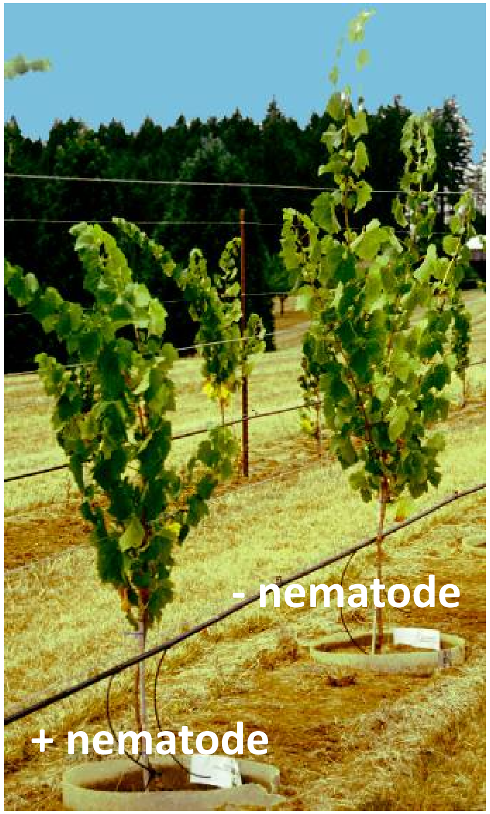


Predatory nematodes can be used to control dagger nematodes.

FICTION (for now)

Mesocriconema xenoplax (Ring)

Migratory ectoparasite



Picture from Jack Pinkerton

All stages feed and survive

Hosts and Distribution:
Worldwide, mostly woody perennials

Research on Concord grape in WA

Effects of Macroposthonia xenoplax **on the Growth of Concord Grape**[1]

G. S. SANTO and W. J. BOLANDER[2]

Abstract: Concord grape (*Vitis labrusca*) plants were inoculated with *Macroposthonia xenoplax* at levels of 100, 1,000, and 10,000 nematodes. After 4 months, plants inoculated with 10,000 *M. xenoplax* were stunted, and root systems were darker and had fewer feeder roots than those in other treatments. The lower nematode inoculation levels suppressed top growth but did not affect root growth. *M. xenoplax* reproduced well on Concord grapes. *Key Words: Vitis labrusca*, ring nematode, reproduction.

- Research conducted in 1976
- No other information available

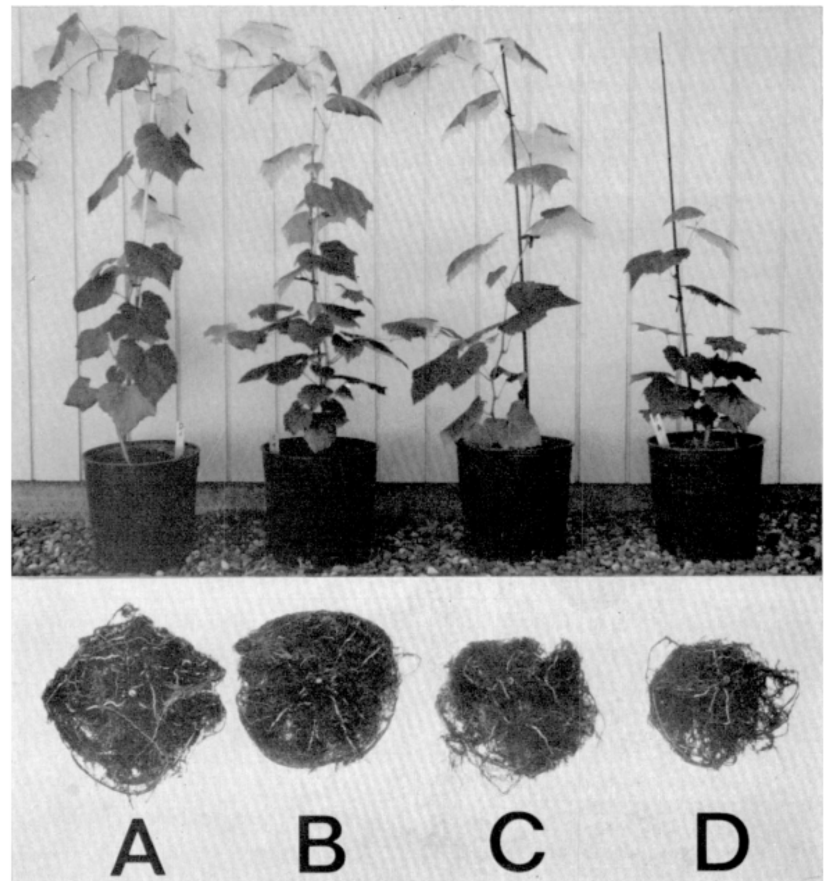
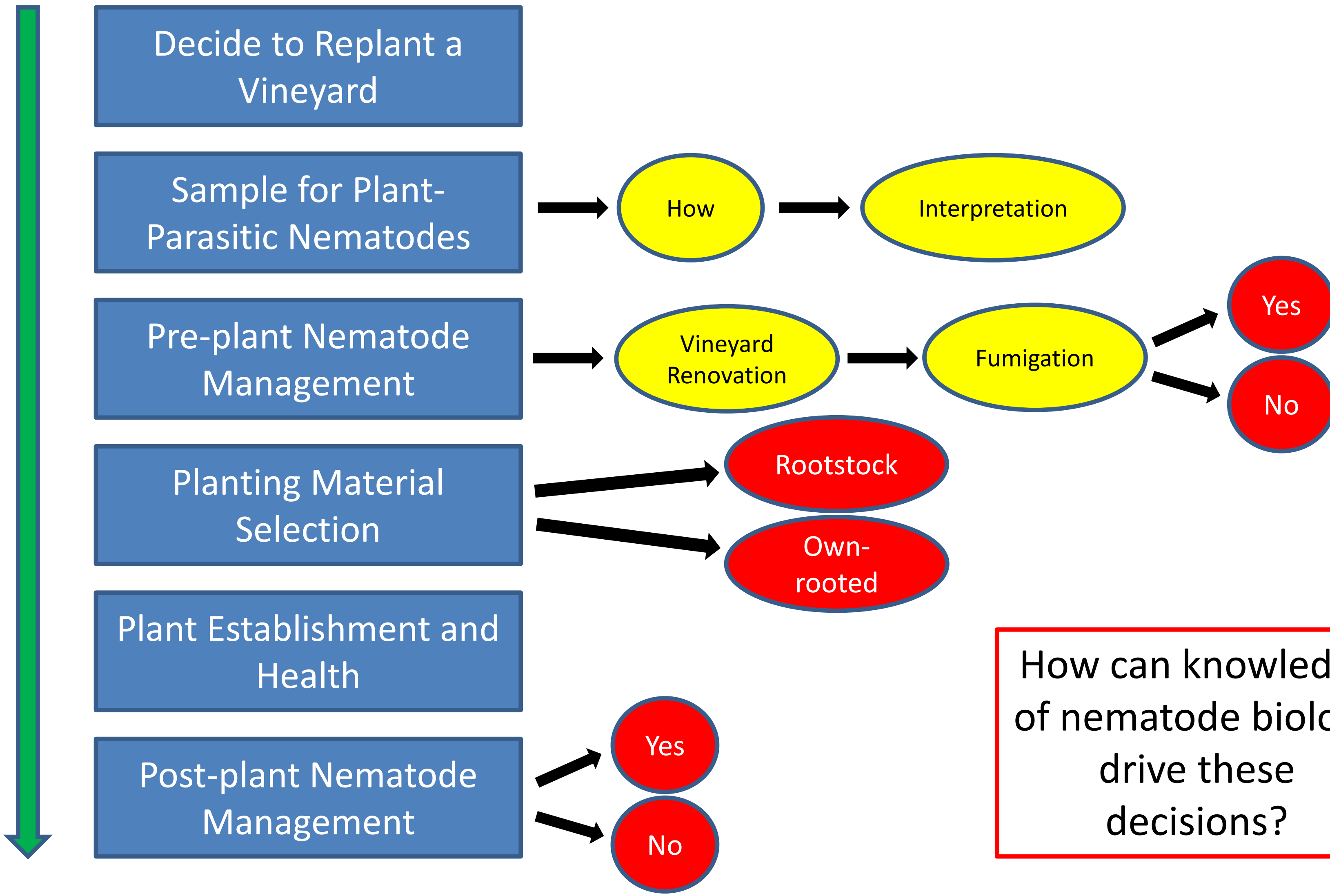


FIG. 1-(A-D). Influence of *Macroposthonia xenoplax* on the growth of Concord grapes. *A)* No nematodes; *B)* 100 nematodes; *C)* 1,000 nematodes; *D)* 10,000 nematodes.

Current status of nematode management

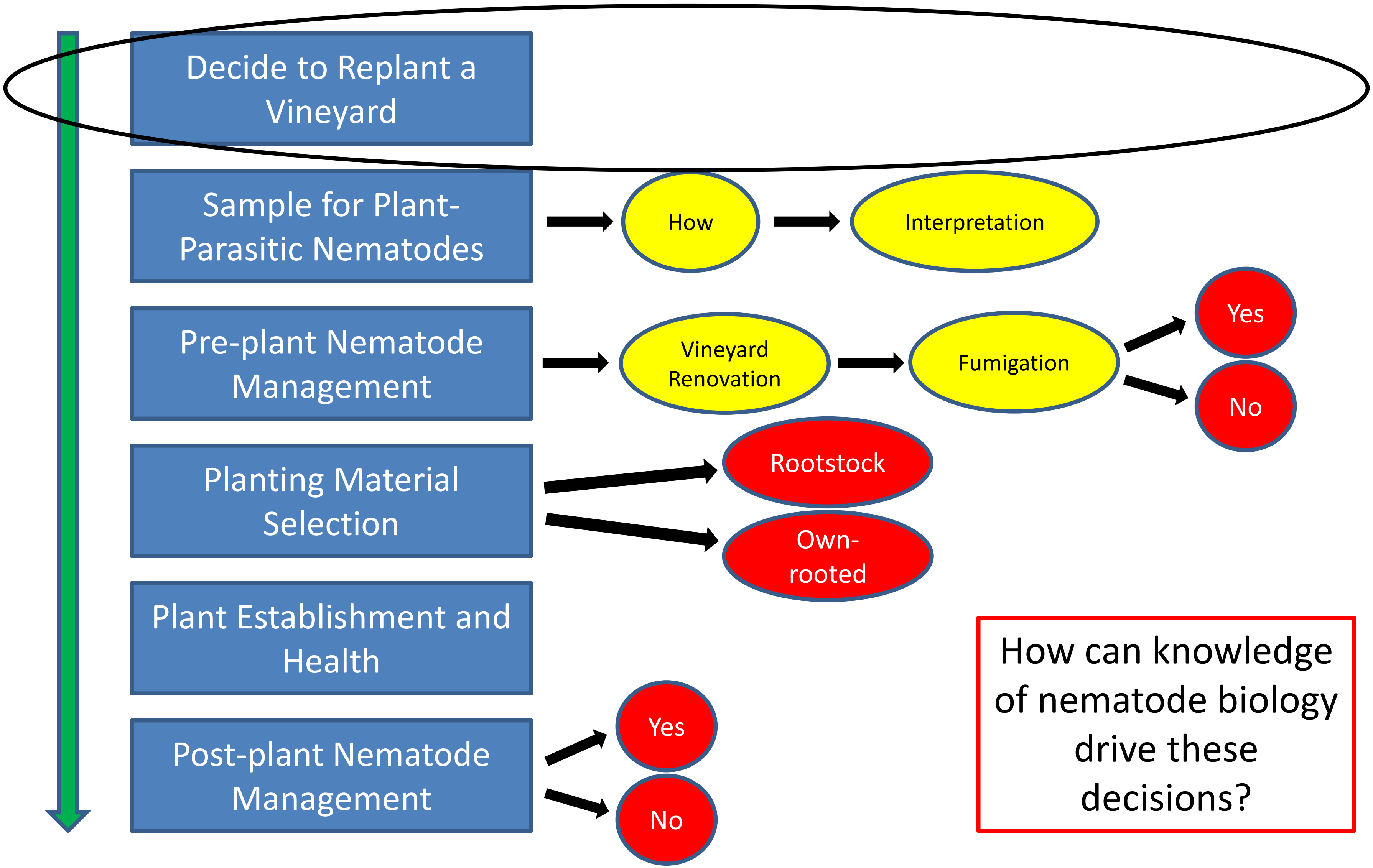
- Limited number of products available
- Restrictions on the use of soil fumigants
- Alternative management practices exist (rotation, cover crops, biological control)
- Plant resistance cornerstone to any nematode management program
- Future methods and targets?

Decision-making for nematode management



How can knowledge of nematode biology drive these decisions?

Decision-making for nematode management

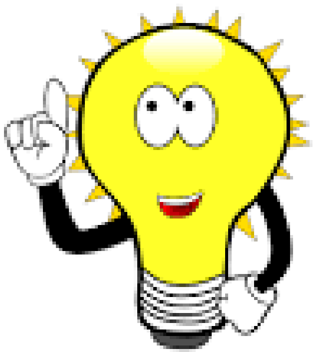


How can knowledge of nematode biology drive these decisions?

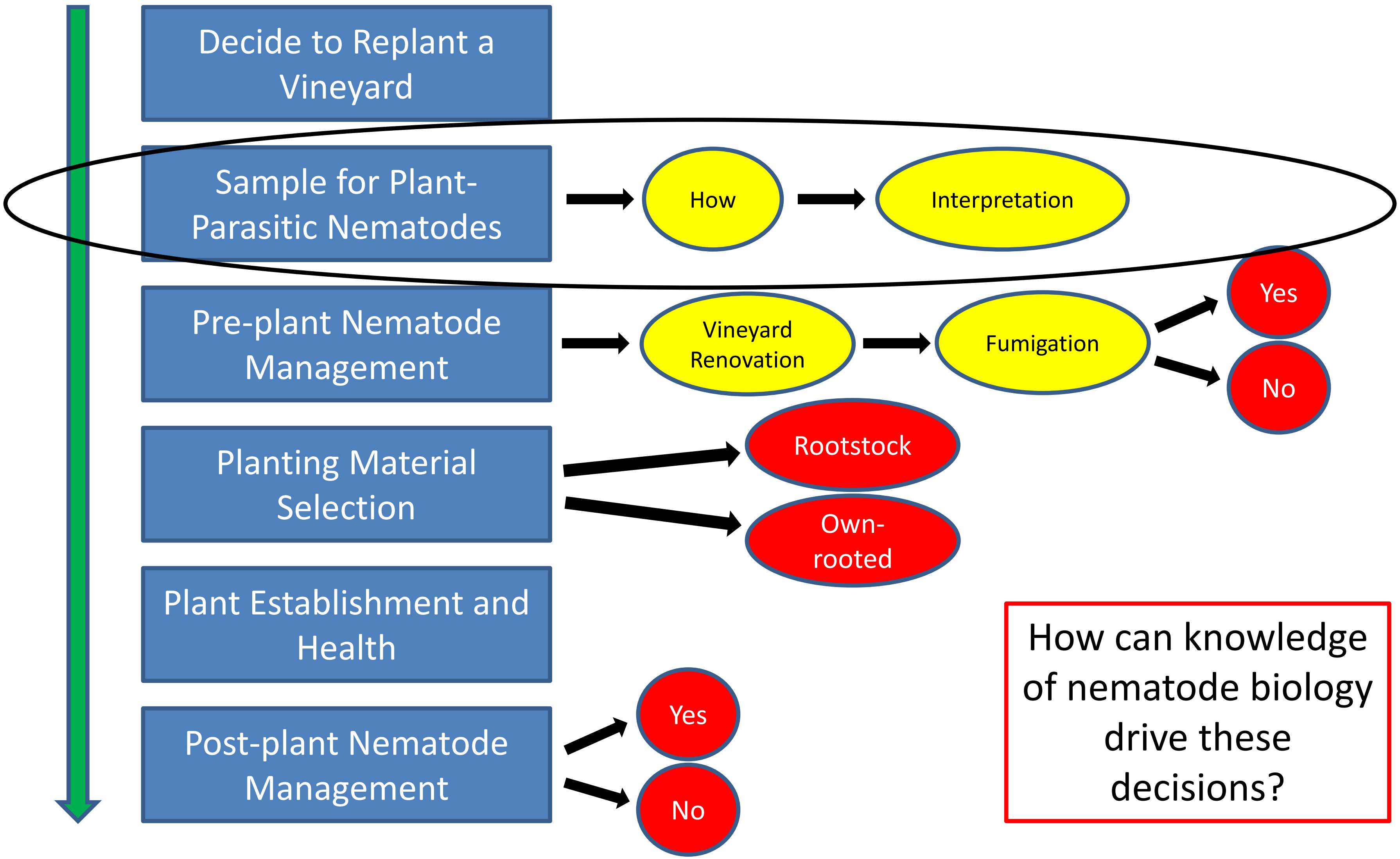
Cropping history

Scenarios that may cause you to pause and think:

- Old orchard with history of nematode transmitted viruses
- Vineyard replant site
- Field with a history of potato, alfalfa, or mint production

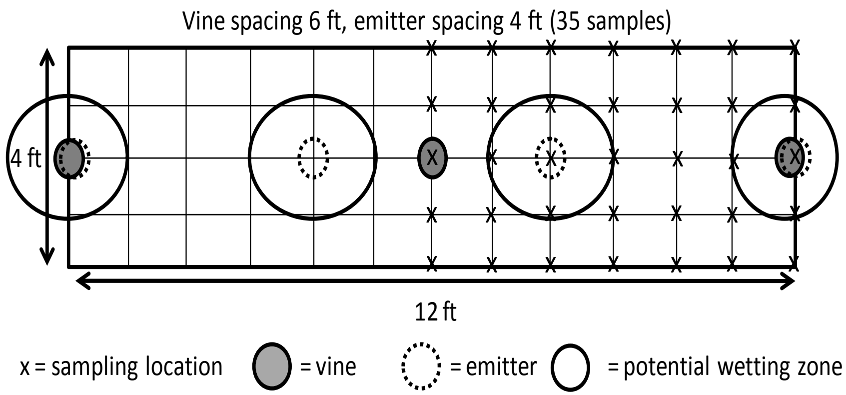


Decision-making for nematode management



Biology-driven sampling

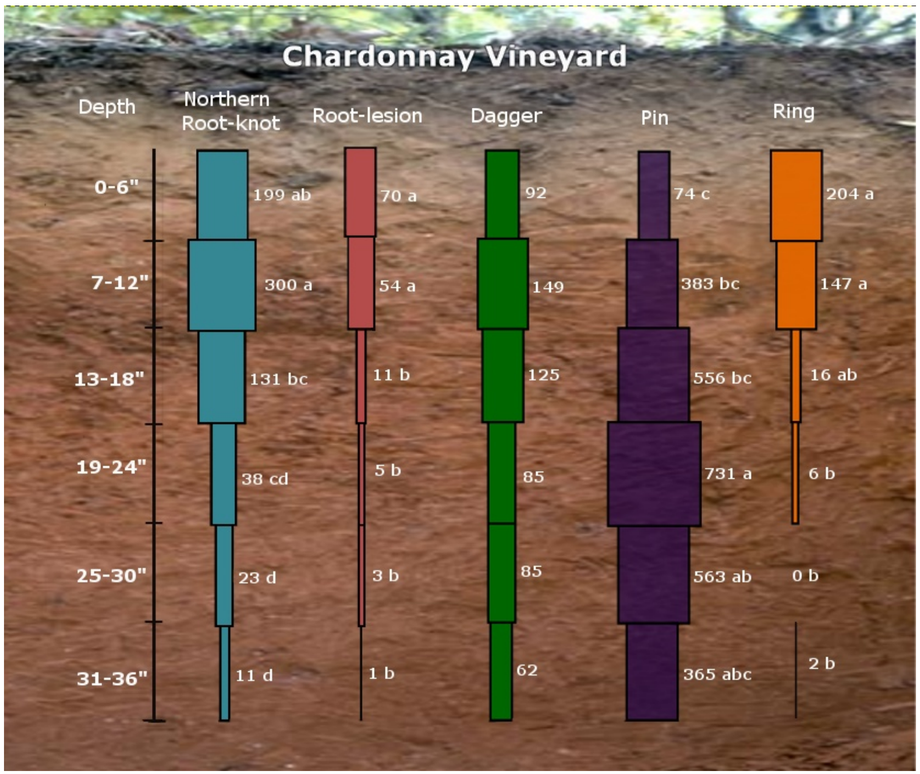
Horizontal



Vertical

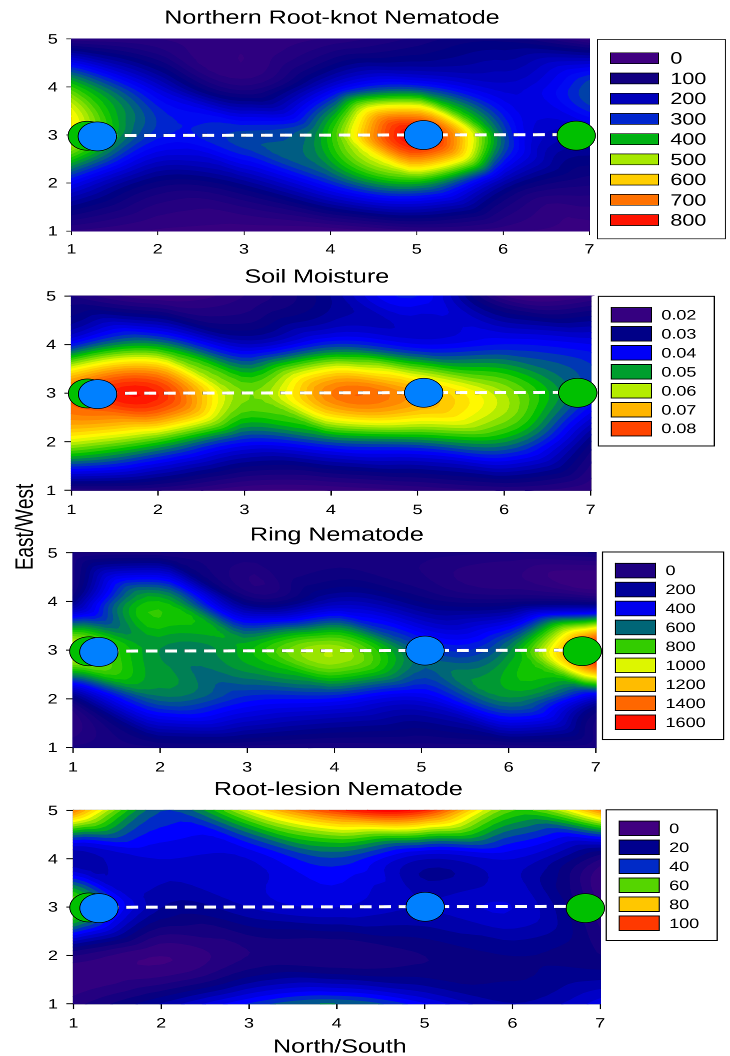
Biology-driven sampling

Vertical



Some nematodes have very defined habitats while others don't…

Horizontal



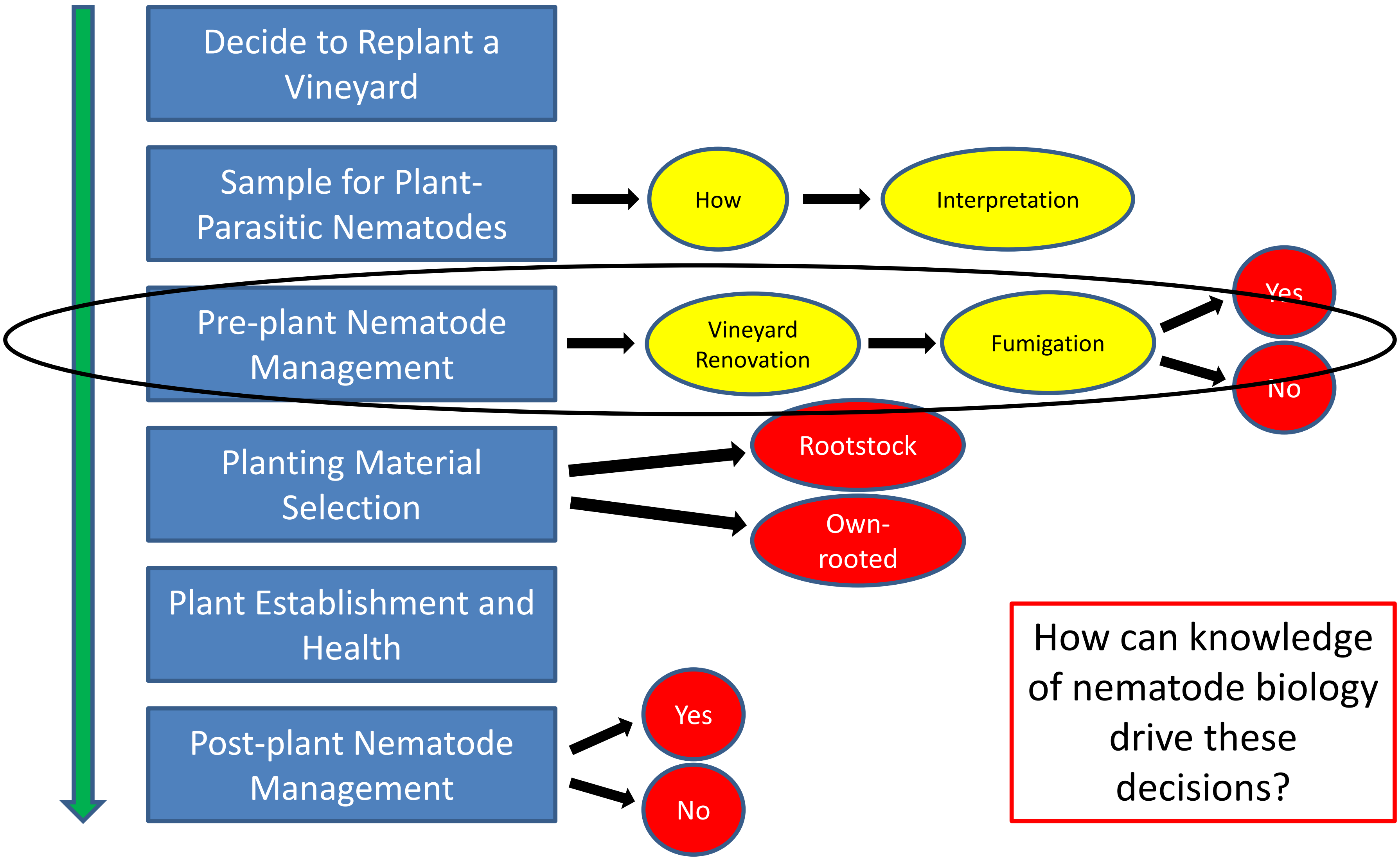
Interpretation of results

Common name	Scientific name	Occurrence (%)	WA threshold (#/250 g soil)	Reported damage potential
Root-knot	*Meloidogyne hapla*	60	100	25-40%
Ring	*Mesocriconema xenoplax*	14	300	12%
Dagger	*Xiphinema americanum*	59	25	?
Lesion	*Pratylenchus* sp.	45	?	?
Pin	*Paratylenchus* sp.	50	None	?

Sampling summary

- Sample directly under emitters to a depth of ~12 inches
- What about overhead irrigated Concord grapes?
- If densities exceed "theoretical" thresholds consider treatment
- Data indicates that *Pratylenchus* is not a parasite of grape in this system
- When considering the presence of *Xiphinema* also consider if viruses are present
- Unfortunately, interpretation of sample reports is not straight-forward

Decision-making for nematode management



How can knowledge of nematode biology drive these decisions?

Soil fumigants

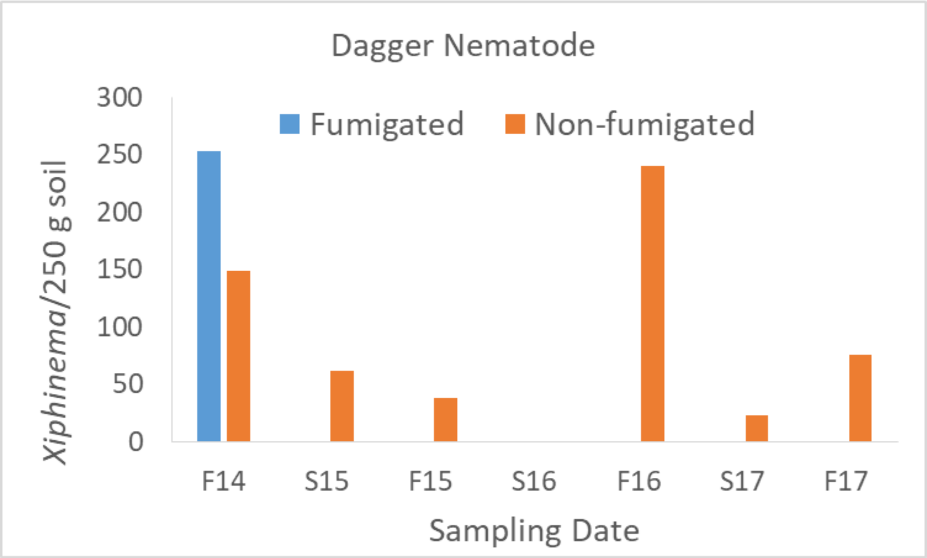
- 1,3-Dicholoropropone plus chloropicrin (Telone products)
  - 1,3-D is the 6th most abundantly used pesticide in the U.S.
- Vapam (metam sodium)
- K-pam (metam potassium)
- Dominus (allyl isothiocyanate)

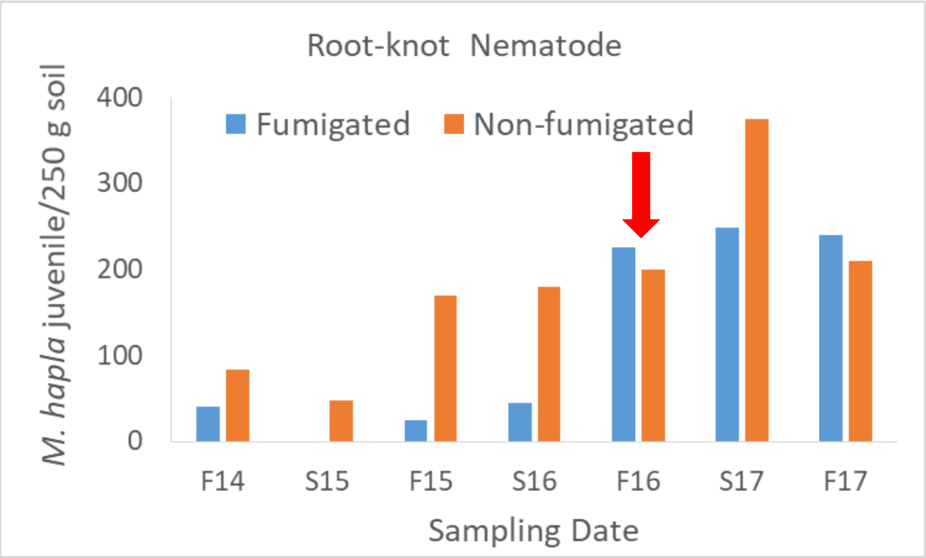
<u>Goal of fumigation</u>: Reduce nematode population densities in an area to allow for successful plant establishment

Vapam drip fumigation trial

- Trial established fall 2014
- Vines treated with glyphosate/Vapam or not
- Replanted spring 2015

<u>Pre-fumigation densities</u>:
73 *M. hapla*/250 g soil
213 *Xiphinema*/250 g soil



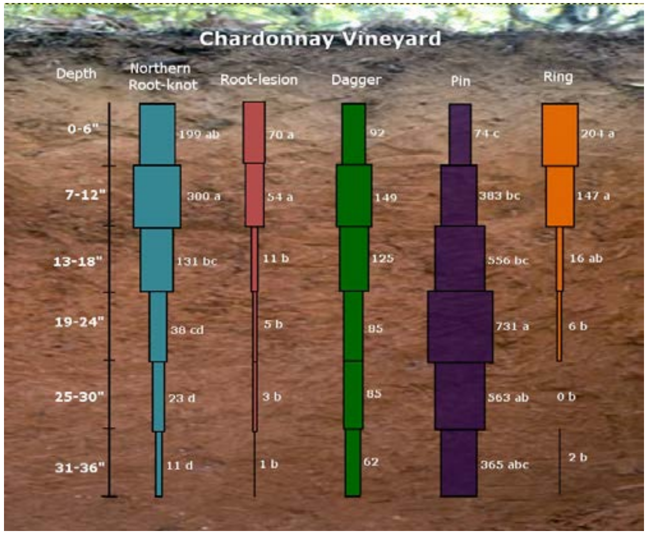


Non-fumigant strategies

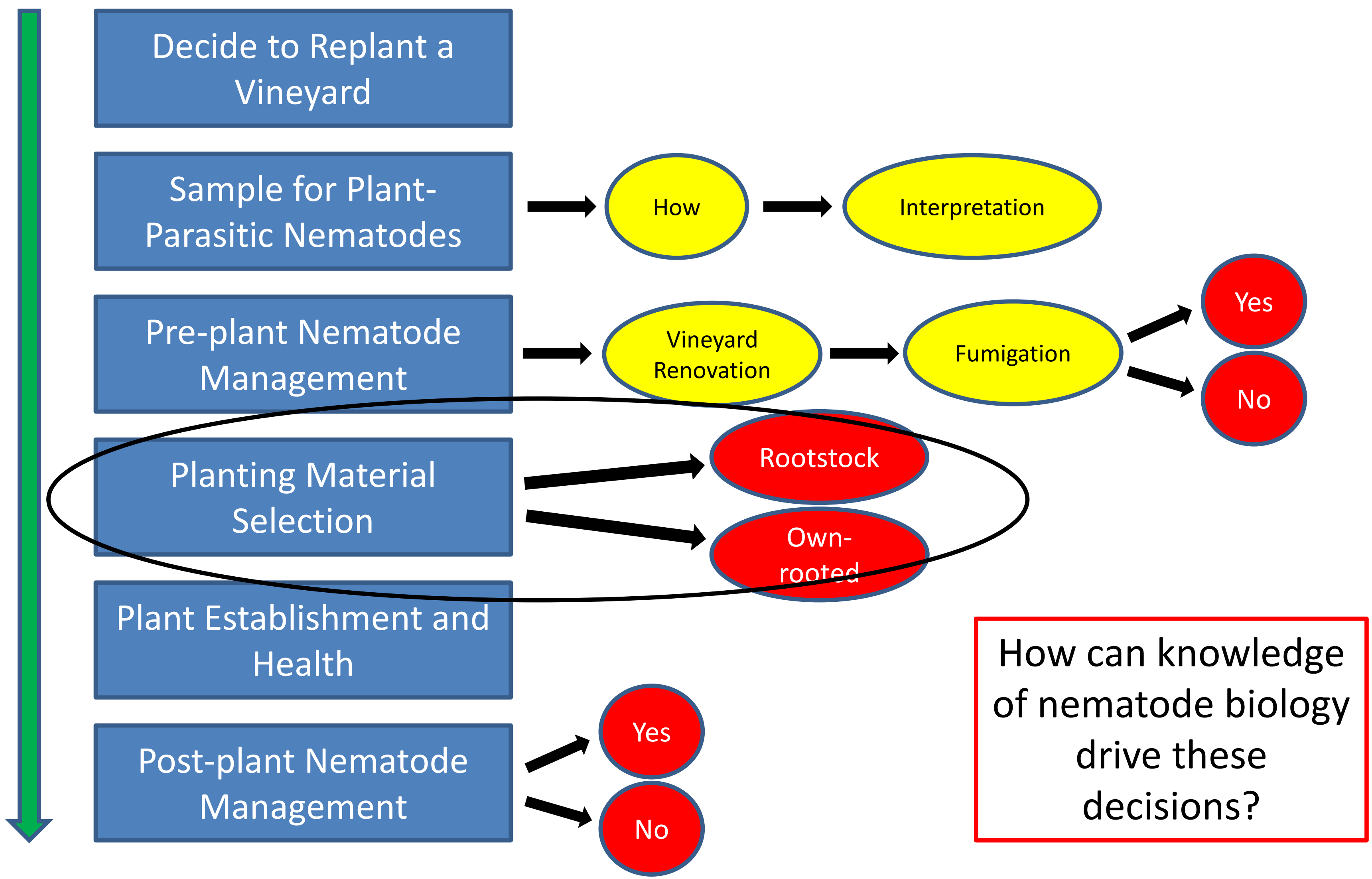
- Cover crops
- Fallow
- Anaerobic soil disinfestation
- Solarization
- Brassica seed meals
- Others?

Pre-plant management summary

- Fumigation does not eliminate nematodes from a vineyard
- Nematodes vary in response to fumigants
- Make every effort to maximize fumigant efficacy
- How do other pre-plant management strategies fit into WA vineyards?



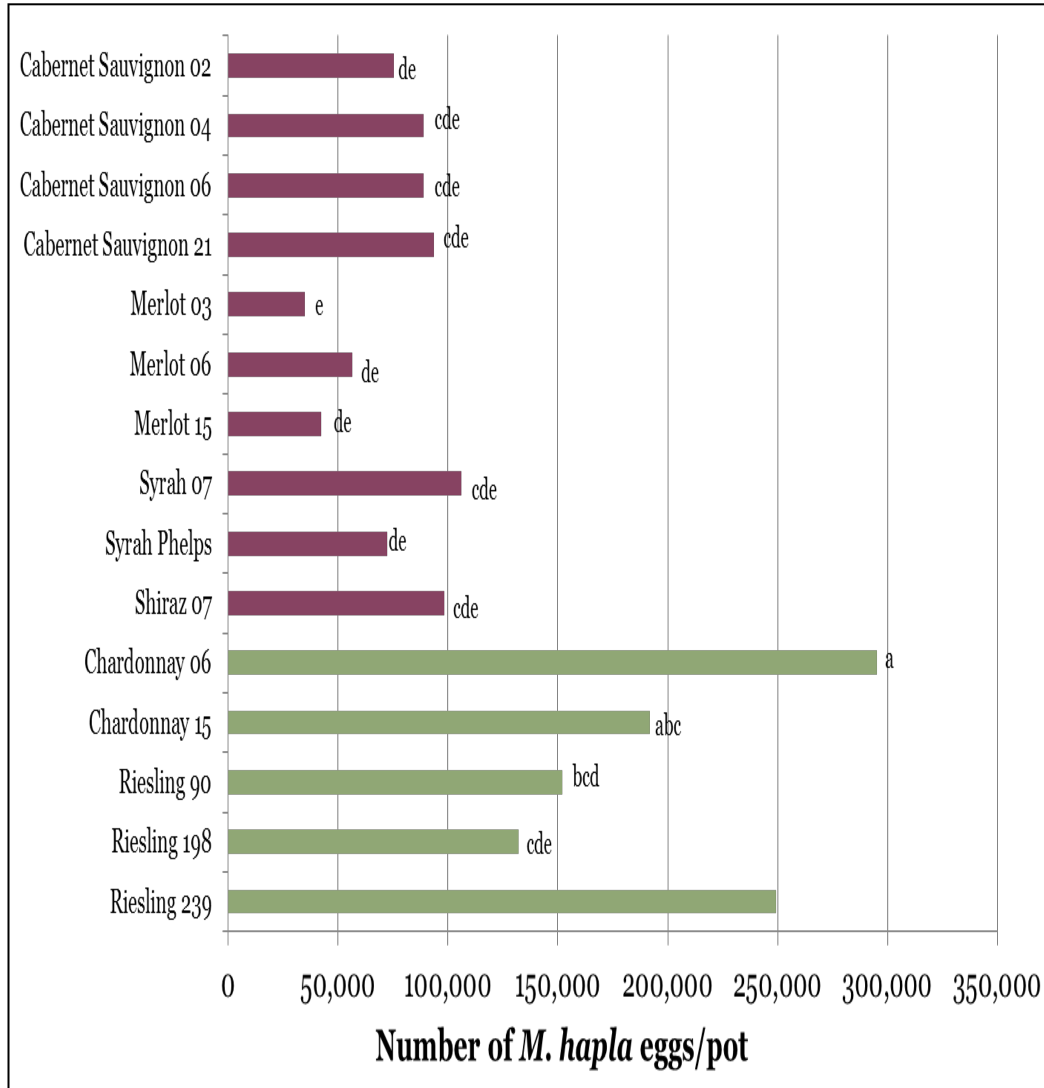
Decision-making for nematode management



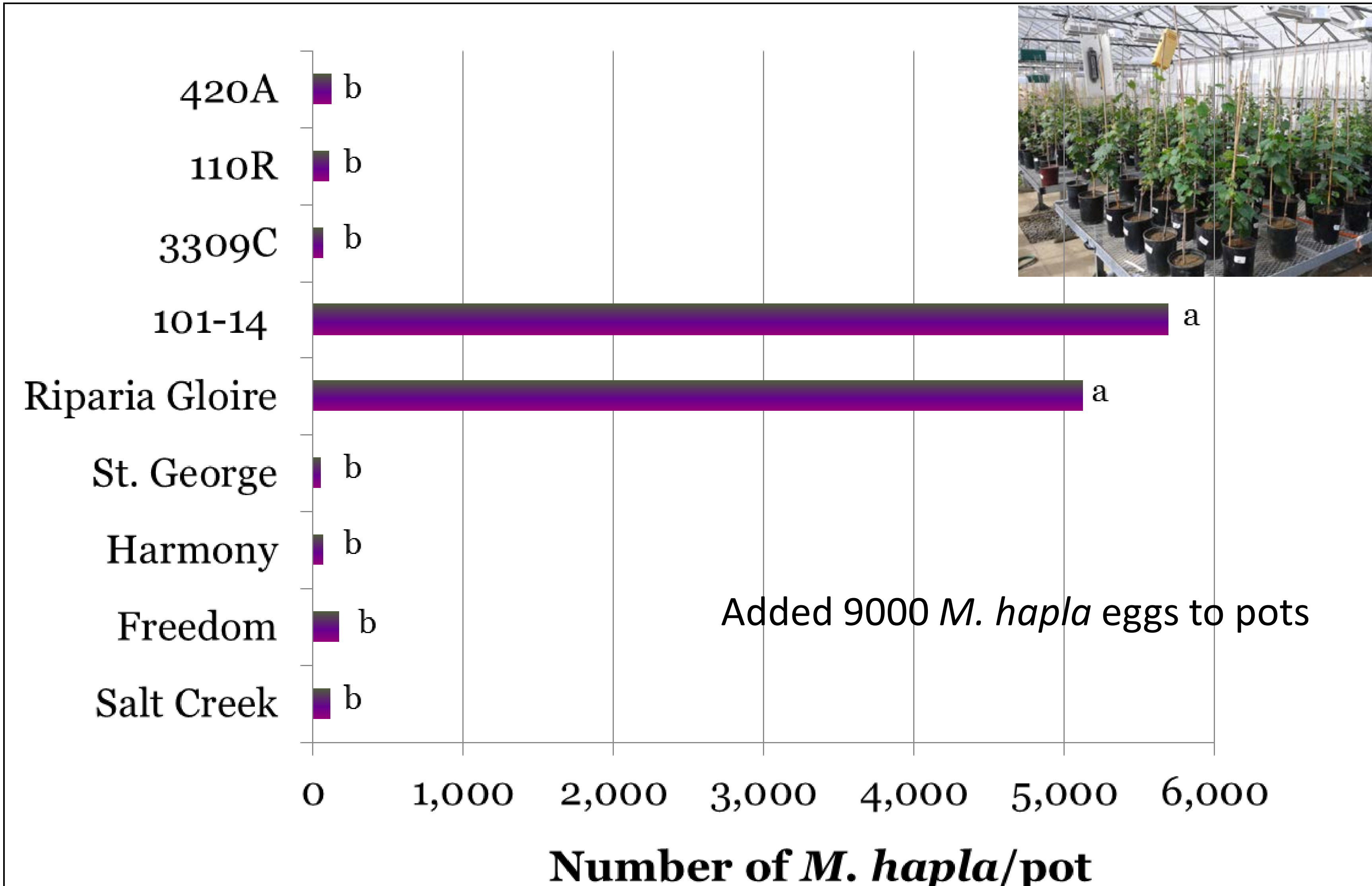
Own-rooted vines in WA

- Own-rooted vines are predominately grown
- Concerns over frost damage
- Limited information on use of rootstocks for nematode management in this region

Northern root-knot nematode prefers Chardonnay



Greenhouse evaluation of rootstocks



Rootstock field trial

- Trial established fall 2014
- Vines treated with glyphosate/Vapam or not
- Subplots vine type
- Replanted spring 2015

Rootstock	Characteristics
101-14 MTG	Moderate to high nematode resistance. Phylloxera and crown gall resistance. Low vigor low drought tolerance.
Harmony	Nematode and crown gall resistant. Not phylloxera resistant.
1103 Paulsen	Moderate nematode resistance. High vigor. Relatively drought tolerant.
Teleki 5C	Moderate nematode resistance. Moderate vigor. Early ripening.

Own-rooted Chardonnay
Industry standard

Rootstock field trial

Added *M. hapla* to some vines (NF+)

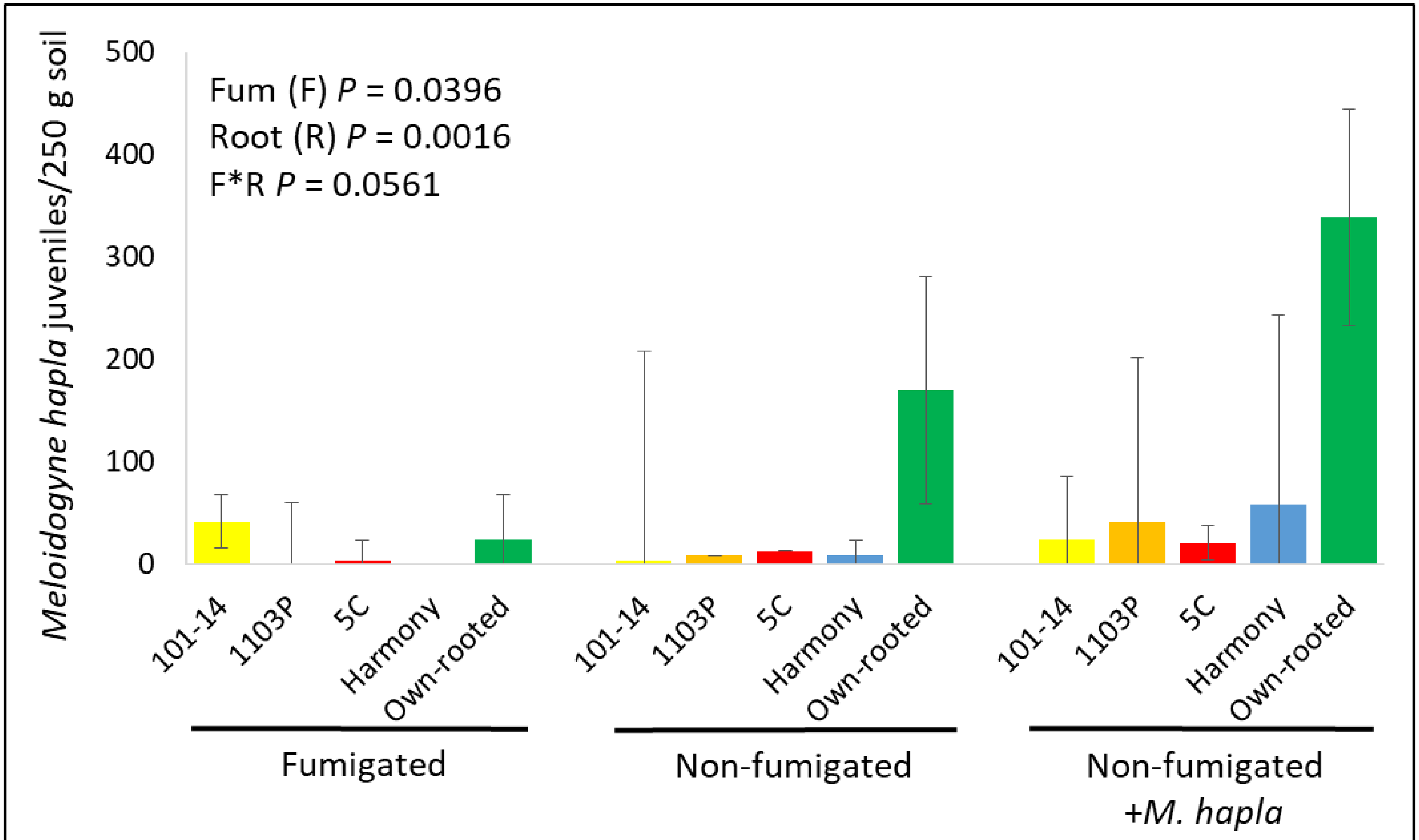
<u>Data collected</u>

- Nematode population densities spring/fall
- *M. hapla* egg densities fall
- Pruning weights
- Fruit yield and quality

Rootstock field trial

<u>Pre-fumigation densities</u>:
73 *M. hapla*/250 g soil

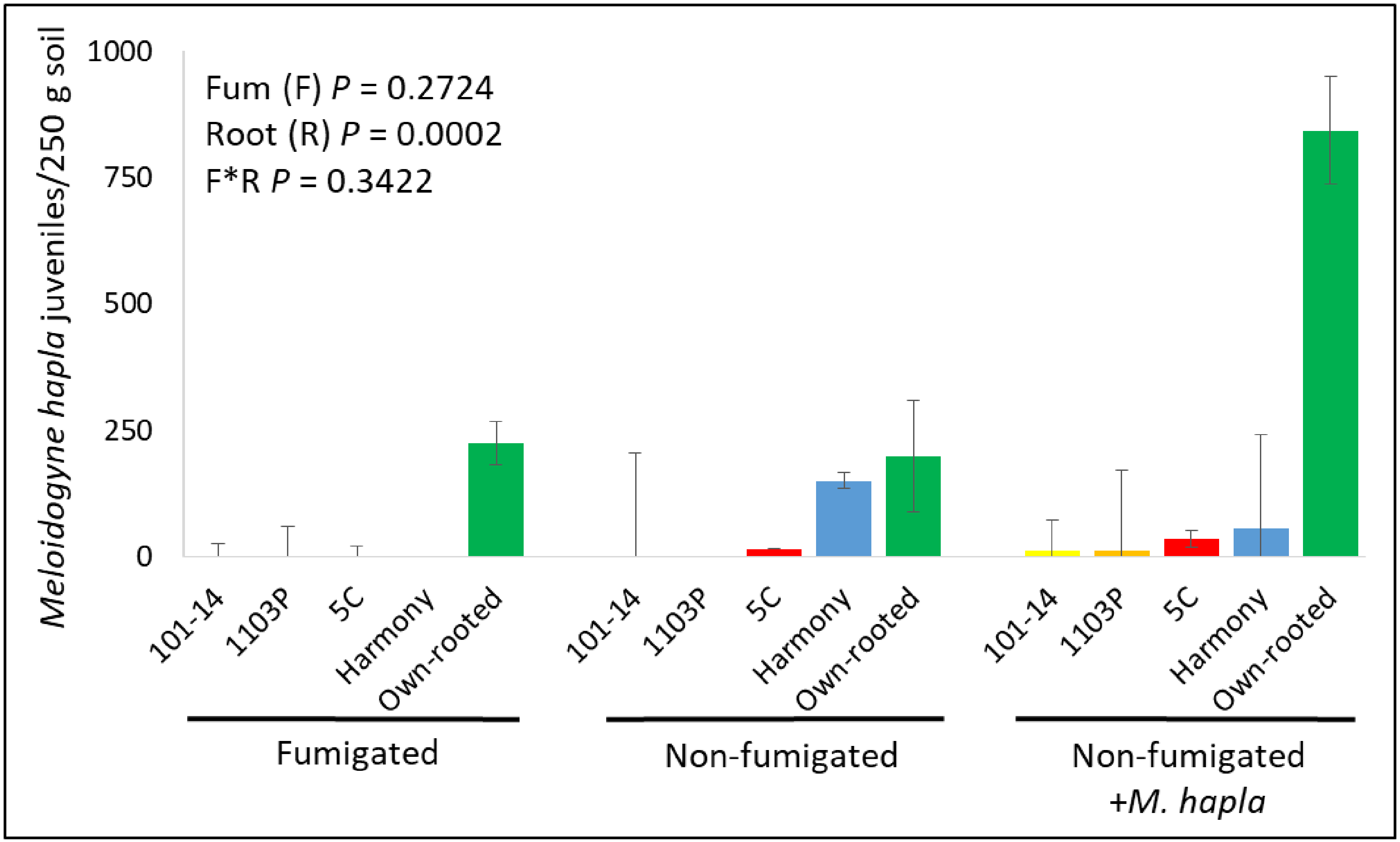
6-months after planting



Rootstock field trial

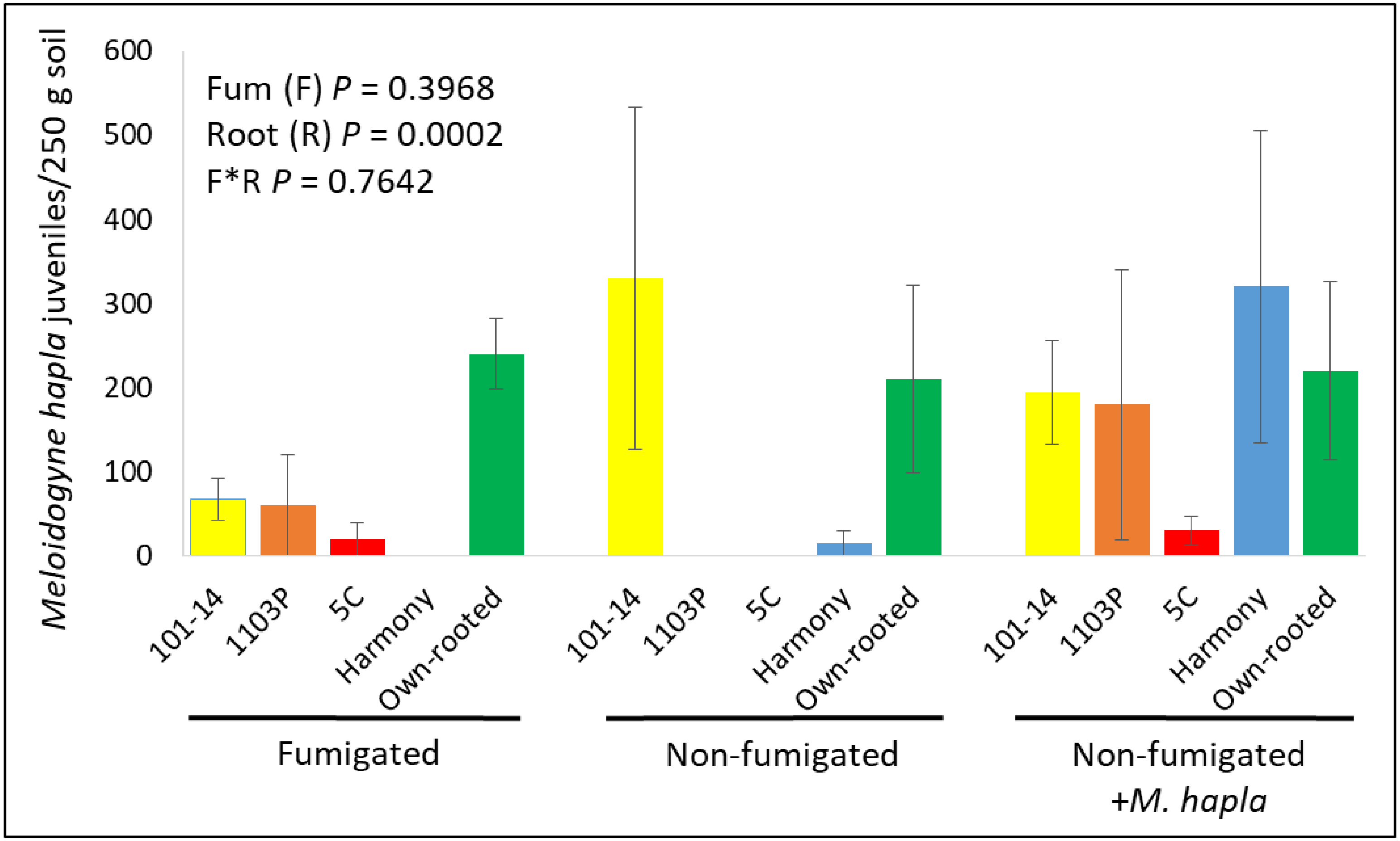
Pre-fumigation densities:
73 *M. hapla*/250 g soil

1.5-years after planting



Rootstock field trial

2.5-years after planting

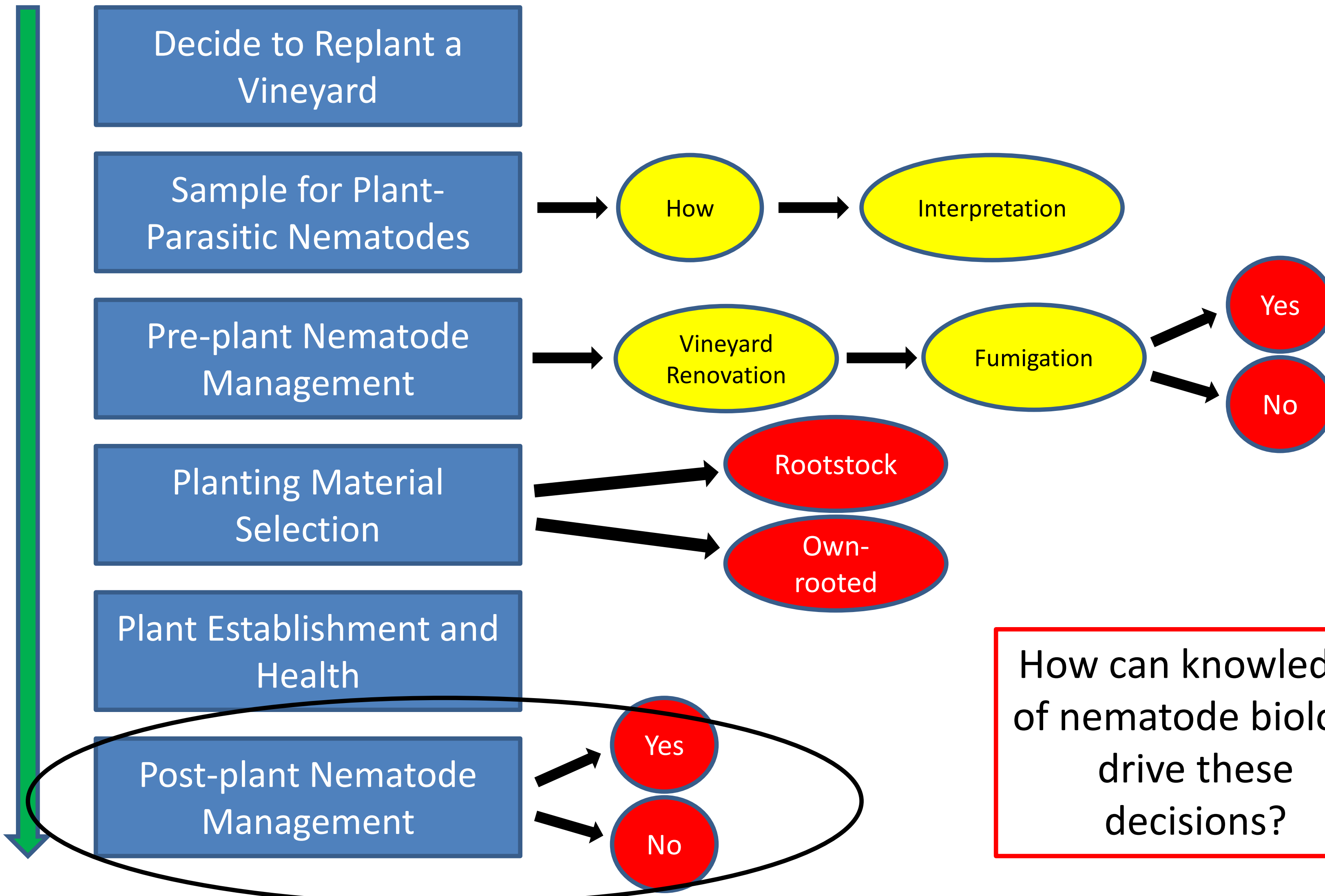


Rootstock field trial

Plant selection summary

- Only plant vines certified free of viruses and nematodes
- Consider the use of red varieties on sites with *M. hapla* to slow population growth
- Teleki 5C appears to support low root-knot nematode populations at a range of densities
- Ability of rootstocks to keep nematode populations low may be density dependent

Decision-making for nematode management



How can knowledge of nematode biology drive these decisions?

Registered post-plant nematicides

- Movento (spirotetramat)
- DiTera (*Myrothecium verrucaria*)
- Nema Q (*Quillaja* saponins)
- Promax (thyme oil)
- Melocon (*Paecilomyces lilacinus* strain 251)
- Cordon (1,3-dicholoropropene)
- Luna Privilege (fluopyram)
- 7 neem products (azadirachtin)
- Employ (harpin)
- Enzone (sodium tetrathiocarbonate)
- Admire/Nuprid/Alias (imidacloprid)

From WSU PICOL – Accessed Nov 1, 2017

Post-plant nematicide trials

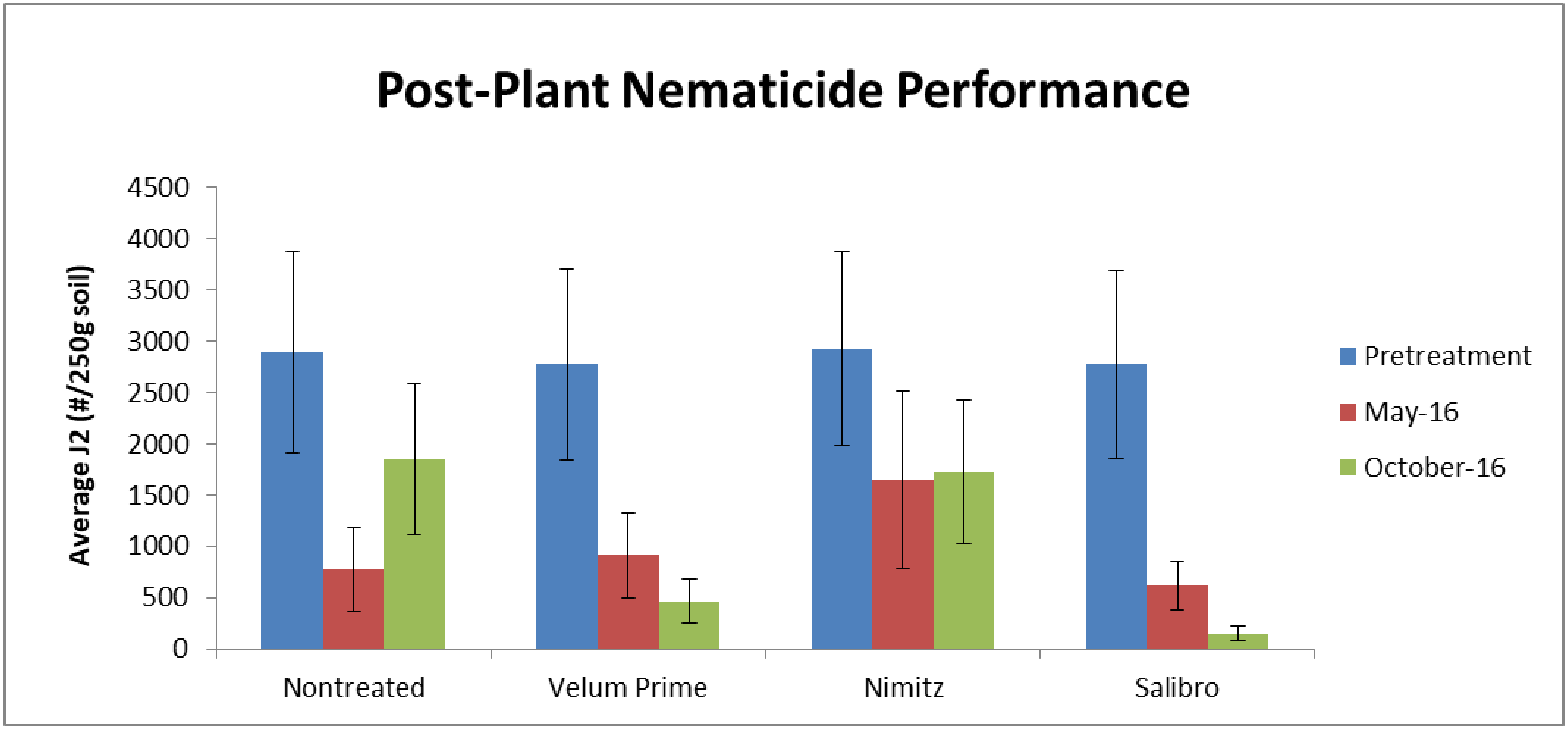
Trials established in spring 2014 and 2015

Trade name	Chemical Name	Mode-of-Action	Application method
Movento	Spirotetramat	Acetyl CoA carboxylase inhibitor	Foliar
Nimitz	Fluensulfone	Affect nematode locomotion, pharyngeal pumping, egg laying	Drip
Velum	Fluopyram	Succinate dehydro-genase inhibitor	Drip
Salibro	Fluazaindolizine	Unknown	Drip

Post-plant nematicide trials

- Products applied per manufacturer protocols
- Pre- and post-plant nematode sampling
- Pruning weights and fruit yield

Post-plant nematicide trials



Biology-driven nematicide application

A developmental model for *M. chitwoodi* on potato

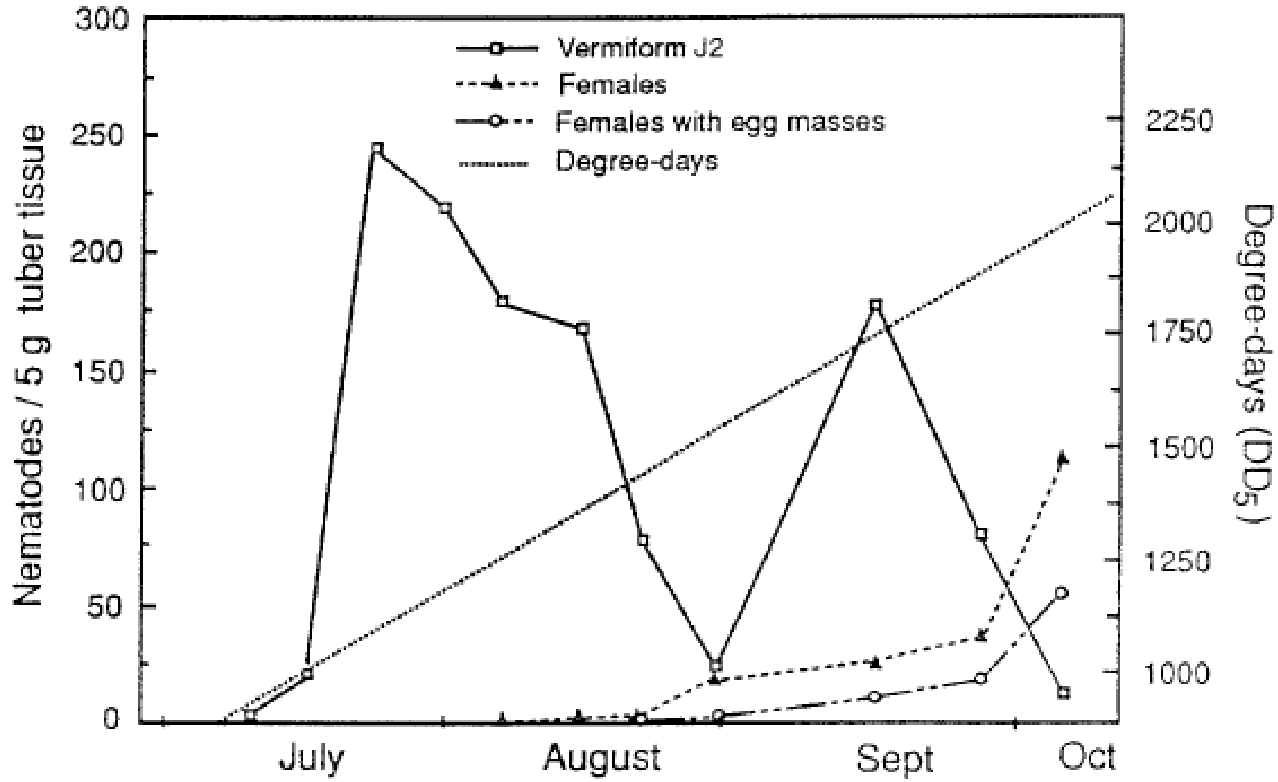
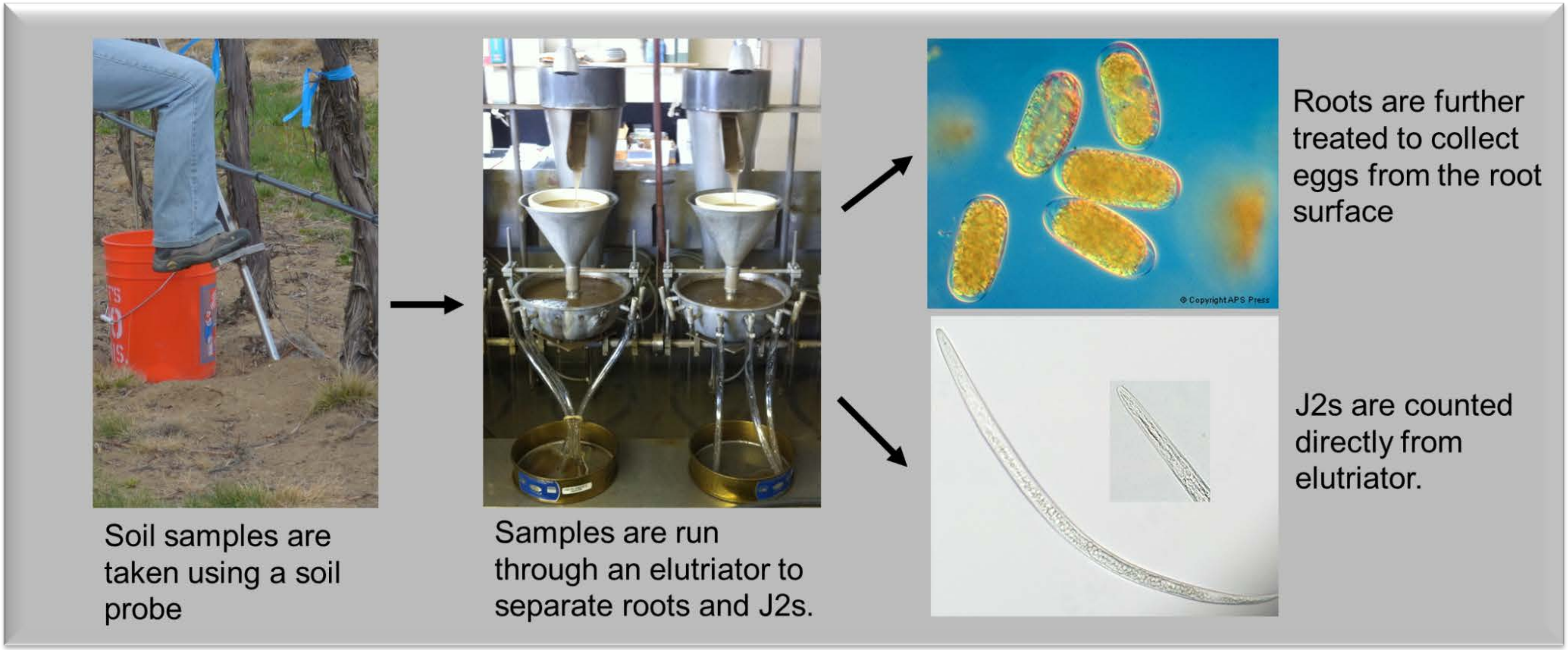


FIG. 3. Penetration and population development of *Meloidogyne chitwoodi* in field-grown Russet Burbank potato tubers during 1985.

Pinkerton et al. (1999)

Biology-driven nematicide application

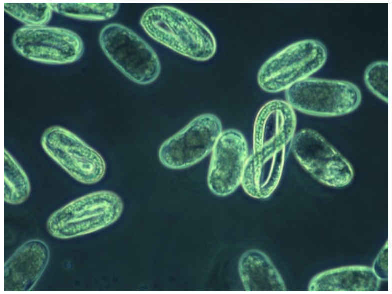
Can something similar be done for *M. hapla* on grape?



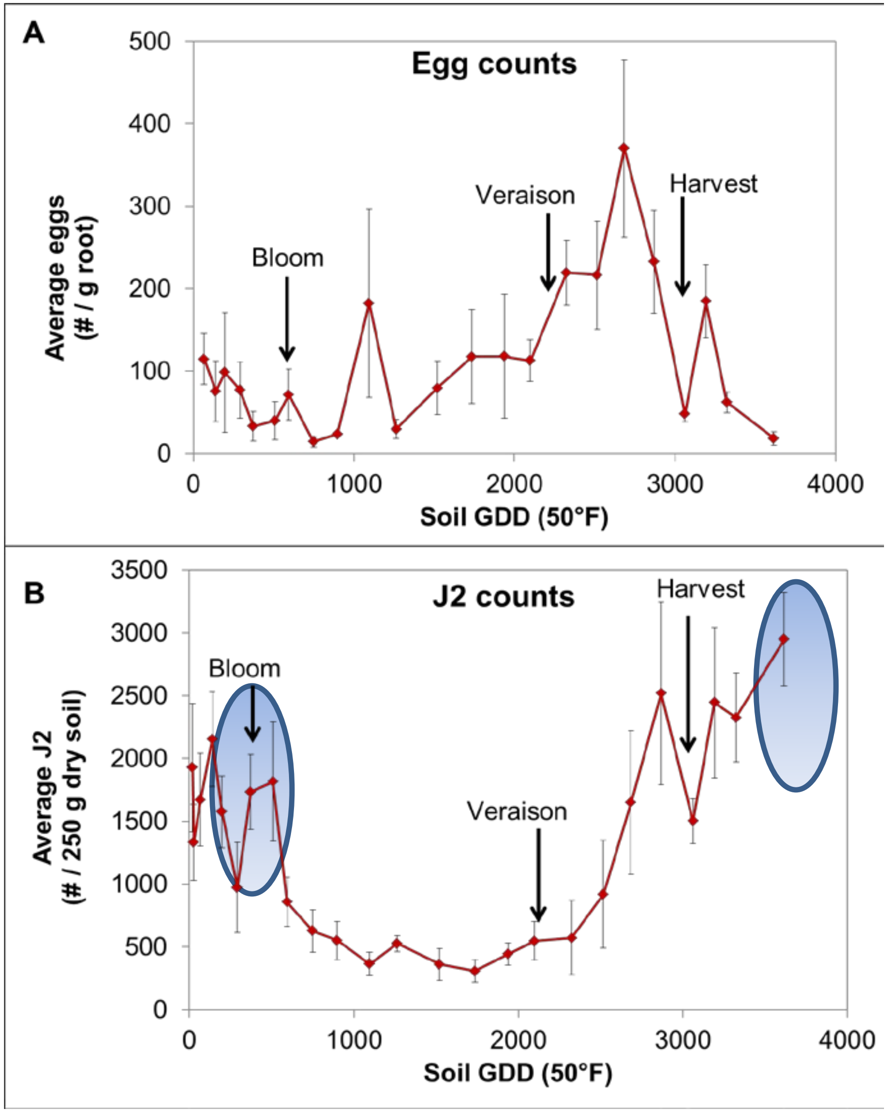
- Samples collect monthly (Oct – April) and weekly (May – Sept) from WA vineyards
- Juveniles in soil, eggs/g root, and root development monitored

Biology-driven nematicide application

Eggs



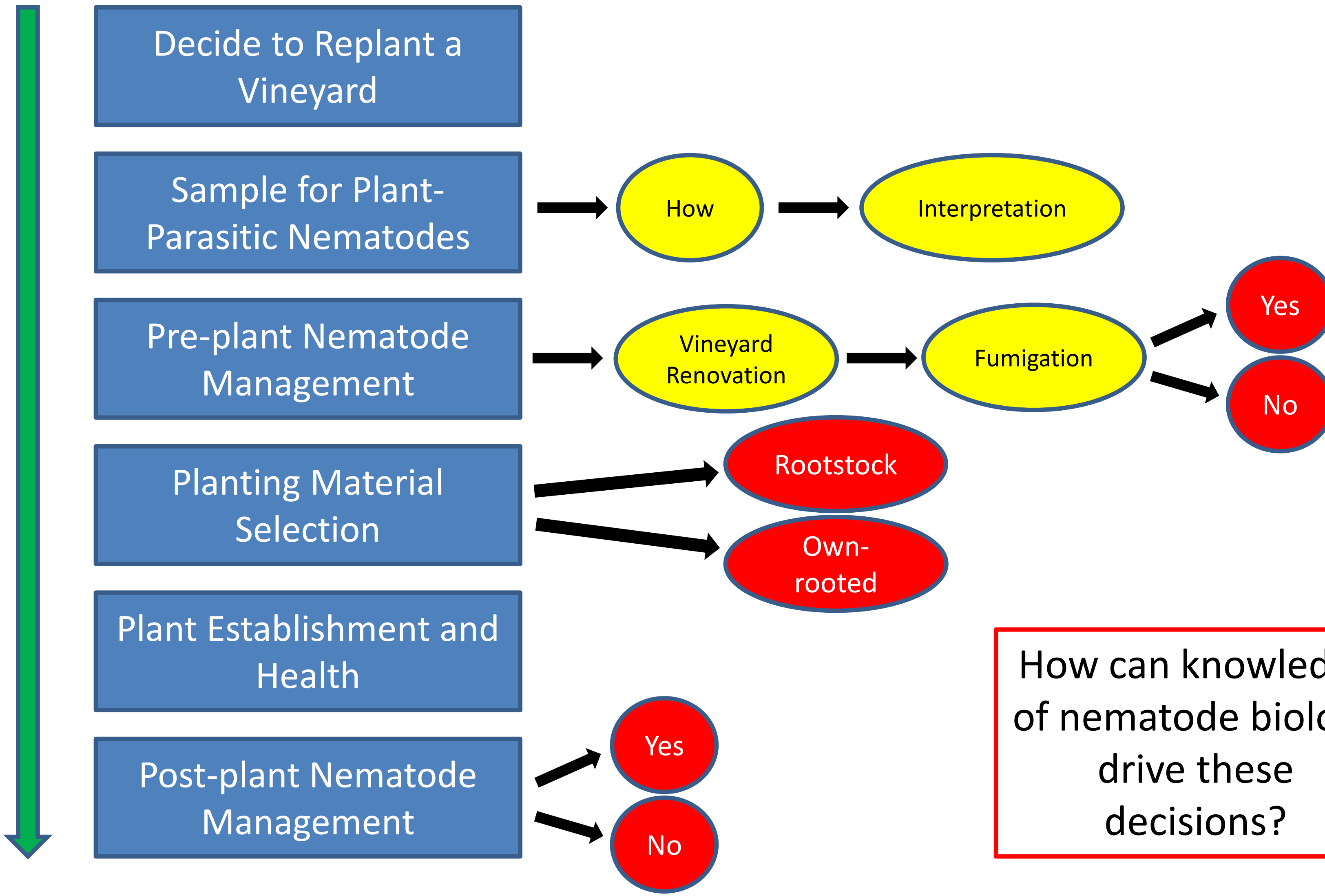
Juveniles



Post-plant nematicide summary

- Optimal timing of post-plant nematicides still to be determined
- A degree-day model of nematode development may help
- Can a vineyard be “rescued” from nematodes?

Conclusions



How can knowledge of nematode biology drive these decisions?

Future directions

- Continue monitoring existing field trials
- Demonstrate impact of nematodes on vine productivity
- Expand research to include Concord grape?

Thank you

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NURSERY

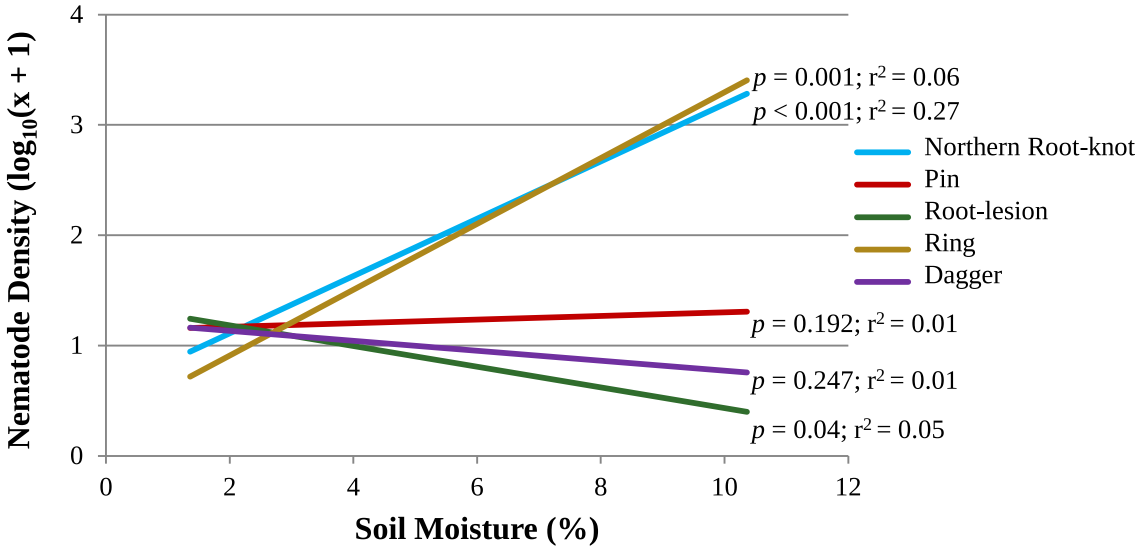
THE HOGUE
CELLARS

Chateau Ste Michelle

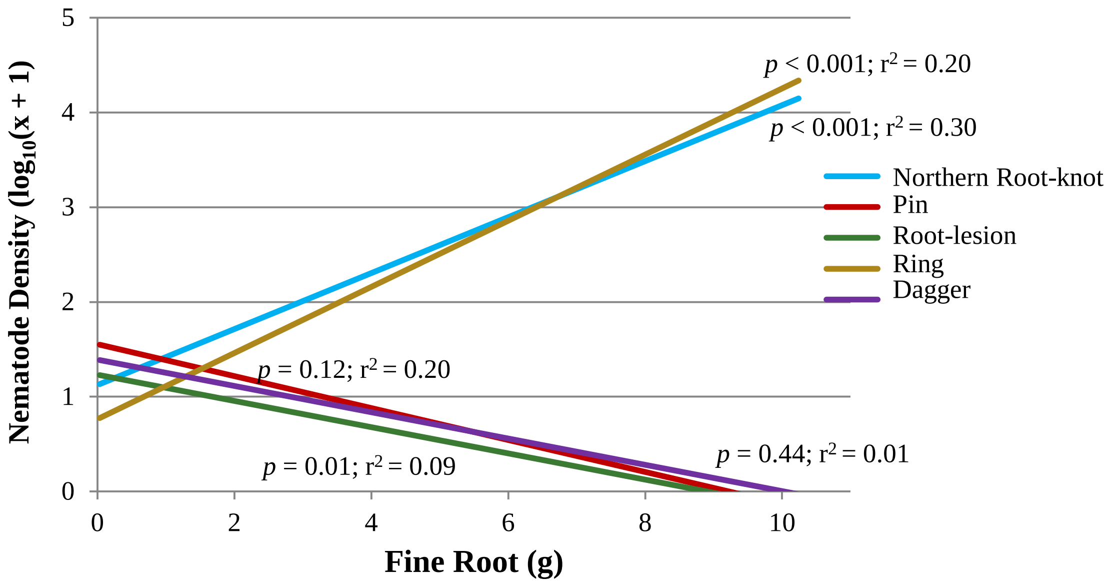
Nematodes in WA wine grape vineyards

Nematode species	Common name	Mean (max) no./250 g soil	% Occurrence relative to total samples collected
Meloidogyne hapla	Northern root-knot	85 (1,088)	60
Xiphinema sp.	Dagger	25 (284)	59
Pratylenchus sp.	Root lesion	9 (155)	45
Mescocriconema xenoplax	Ring	5 (170)	14
Paratylenchus sp.	Pin	54 (981)	50
Tylenchorynchus sp.	Stunt	0 (12)	8
Trichodorus sp.	Stubby	2 (2)	2

Biology-driven sampling

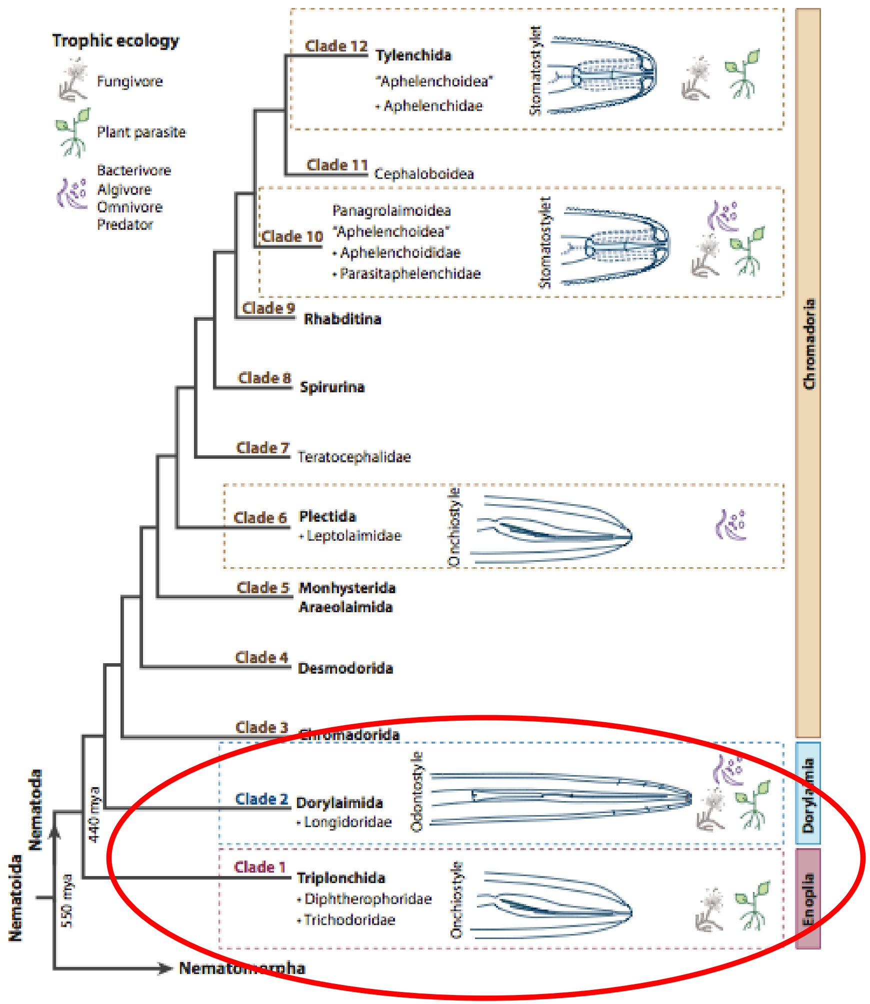


Further support of the relationship between nematodes and vines



Fact or Fiction? Dagger nematodes

- First report of nematode transmitting viruses made in 1958
- Only a few types of nematodes can transmit viruses:
  - 3 genera
  - 30 species
  - 15 viruses



Risk to grape in Washington?

- Limited reports of nematode-transmitted viruses in WA gapes (4-5)
  - Grape fanleaf virus
  - Tobacco ringspot virus
- *Xiphinema* reported in WA
  - *X. revesi* (2014)*
  - *X. pachticum* (2007)
  - *X. americanum* (1993)*
  - ?

Early observations