



**NEM 204: RECOGNIZING A NEMATODE PROBLEM**



**ESTIMATED LOSSES DUE TO NEMATODES IN CALIFORNIA:**

CROP	ESTI- MATED % LOSS	ACRES	FARM \$ VALUE	\$ LOSS
FIELD CROPS	6	1,091,166	2,791,345,185	307,047,970
FRUITS & NUTS	12	1,883,204	4,026,765,267	483,211,832
VEGETABLES	11	6,402,613	2,947,240,705	176,834,442
ORNAMENTALS	10		1,185,878,000	118,587,800
<b>TOTAL</b>				<b>1,085,682,045</b>

TOTAL CALIFORNIA CASH FARM VALUE = \$16,838,870,235

(NOTE: % LOSS ESTIMATES ARE FROM THE SOCIETY OF NEMATOLOGISTS FOR U.S. AS A WHOLE)

**ESTIMATED LOSSES DUE TO NEMATODES IN CALIFORNIA:**

CROP	ESTI- MATED % LOSS	ACRES	FARM \$	\$ LOSS VALUE
CITRUS	15	326,660	1,181,597,142	177,239,571
COTTON	5	1,280,071	1,008,713,000	50,435,650
POTATOES	10	51,977	157,981,100	15,798,110
TOMATOES	15	252,968	477,111,728	71,566,759

(NOTE: % LOSS ESTIMATES ARE FROM THE USDA FOR U.S. AS A WHOLE)

1991 California growers' economic losses from nematode damage on the nine crops with greatest historic usage of 1,3-D = \$106.8 million (Landels, 1992)

**Millions of Dollars Lost  
ROOT-KNOT NEMATODE (RKN)**

Tomatoes	13.4
Cotton	9.8
Sweet potatoes	7.5
Potatoes	0.4
Carrots	15.1

**ROOT-KNOT NEMATODE  
(MELOIDOGYNE SP.)  
ON CARROT**

<b>SUGARBEET CYST &amp; (RKN)</b>	
Broccoli	15.7
Cauliflower	7.9
Sugar beets	6.1
Brussel sprouts	0.7



IN 1991, 18.7 MILLION POUNDS OF METHYL BROMIDE WERE USED IN CALIFORNIA:

<u>USE</u>	<u>PERCENT</u>
STRAWBERRY FIELDS	24
STRUCTURAL FUMIGATION	18
GREENHOUSE SOIL - NURSERY CROPS	11
GRAPES - PREPLANT & POSTHARVEST	10
STONE FRUITS - PREPLANT & POSTHARVEST	8
CARROTS	7

THE MOST COMMON GENERA OF PLANT PARASITIC NEMATODES IN CALIFORNIA:

ECTOPARASITES

*Trichodorus* - Stubby Root\*  
*Xiphinema* - Dagger\*  
*Longidorus* - Needle\*  
*Helicotylenchus* - Spiral  
*Mesocriconema* - Ring  
*Paratylenchus* - Pin  
*Hemicyclophora* - Sheath

MIGRATORY ENDOPARASITES

*Pratylenchus* - Lesion  
*Ditylenchus* - Stem & Bulb  
*Aphelenchoides* - Foliar

SEDENTARY ENDOPARASITES

*Meloidogyne* - Root Knot  
*Anguina* - Seed & Leaf Gall  
*Tylenchulus* - Citrus  
*Heterodera* - Cyst

SOME GENERA CONTAIN SEVERAL IMPORTANT SPECIES

\*Vectors of plant viruses

SYMPTOMS & SIGNS OF NEMATODE DAMAGE:

VISIBLE ABOVE GROUND -

Stunting  
 Chlorosis  
 Mid-day Wilting  
 Leaf Drop  
 Small Fruit  
 Yellowing  
 Curling and Twisting of Leaves and Stems  
 Patches of Poor Growth in Field  
 Lack of Response to Treatment  
 Premature Maturity  
 Delayed Maturity  
 Reduced Yield  
 "Unthriftiness"

ROOT SYMPTOMS -

Galls or Swellings  
 Stubby Roots  
 Lesions or Dark Spots  
 Stunting  
 "Dirty Roots"

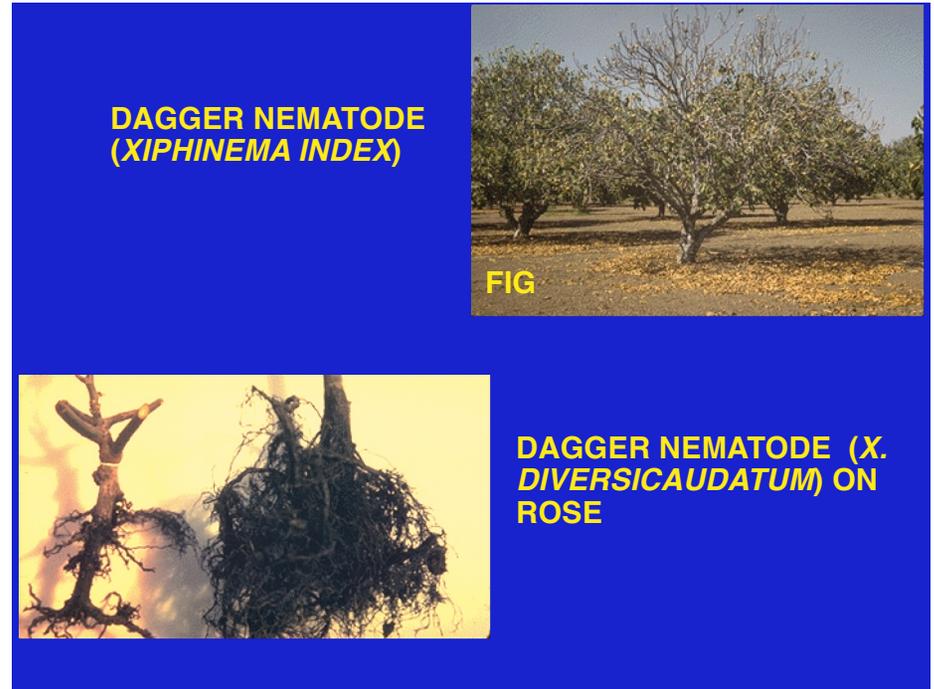


TRICHODORUS OR PARATRICHODORUS (STUBBY ROOT NEMATODE) ON ONIONS AND CHIVES





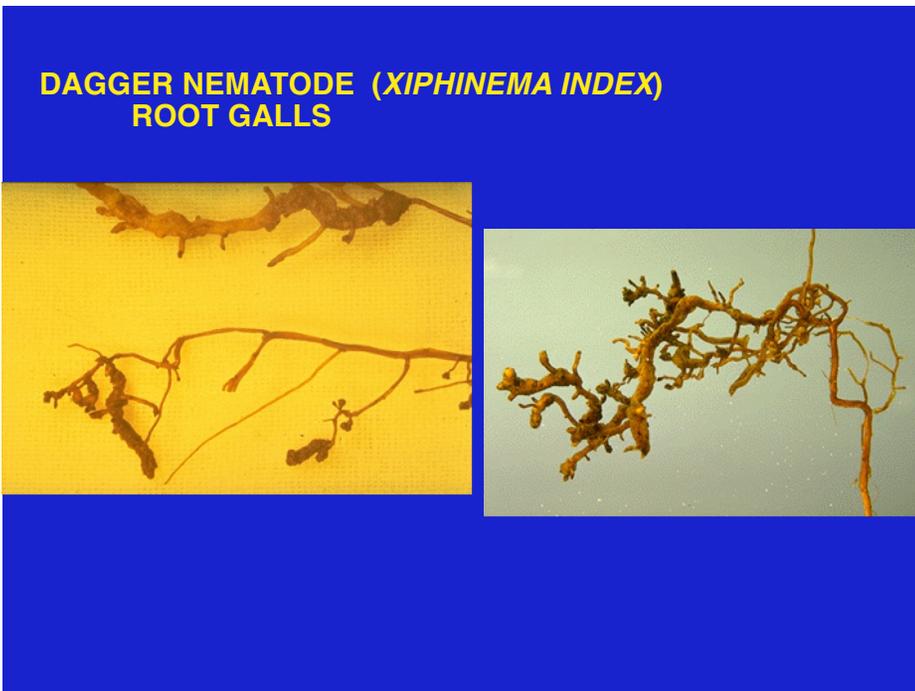
**CORKY RING SPOT  
(TOBACCO RATTLE VIRUS)  
ON POTATOES  
TRANSMITTED BY  
*TRICHODORUS* OR  
*PARATRICHODORUS*  
(STUBBY ROOT NEMATODE)**



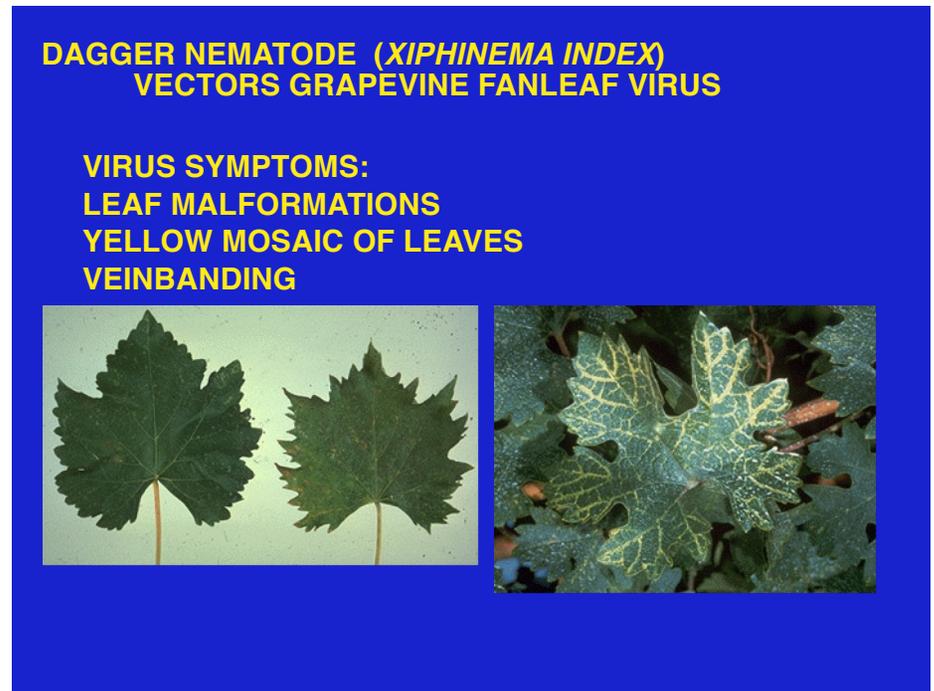
**DAGGER NEMATODE  
(*XIPHINEMA INDEX*)**

**FIG**

**DAGGER NEMATODE (*X. DIVERSICAUDATUM*) ON ROSE**



**DAGGER NEMATODE (*XIPHINEMA INDEX*)  
ROOT GALLS**



**DAGGER NEMATODE (*XIPHINEMA INDEX*)  
VECTORS GRAPEVINE FANLEAF VIRUS**

**VIRUS SYMPTOMS:  
LEAF MALFORMATIONS  
YELLOW MOSAIC OF LEAVES  
VEINBANDING**

**DAGGER NEMATODE (*XIPHINEMA INDEX*) ON GRAPE**

**VIRUS SYMPTOMS:  
SMALL BUNCHES  
POOR FRUIT SET  
IRREGULAR RIPENING**



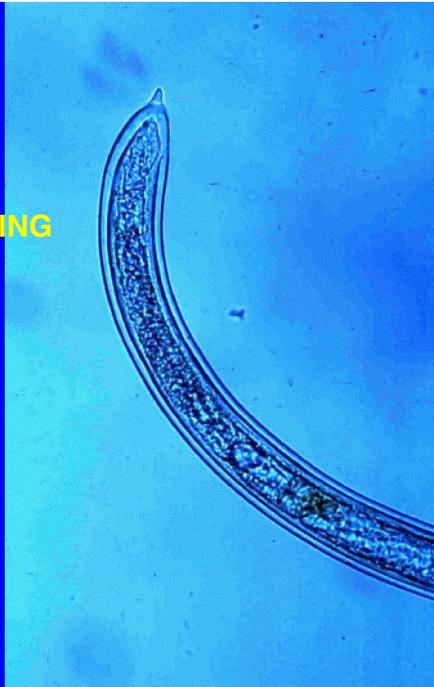
**DAGGER NEMATODE (*XIPHINEMA INDEX*) ON GRAPE**

**VIRUS SYMPTOMS:  
ABNORMAL SHOOT  
BRANCHING**

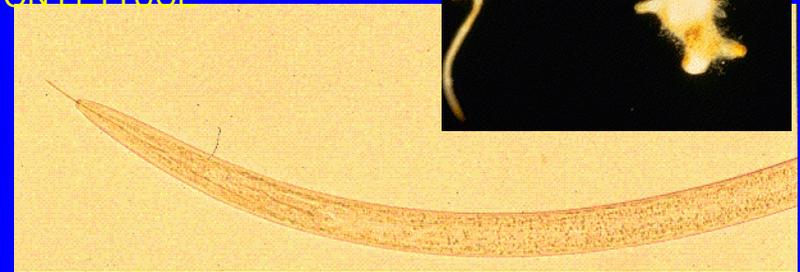
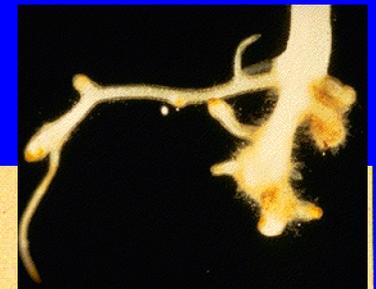
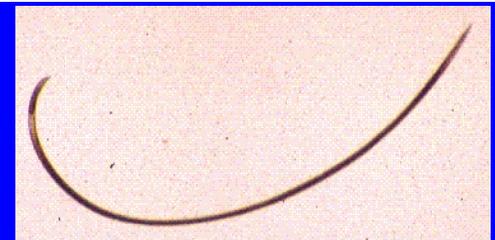


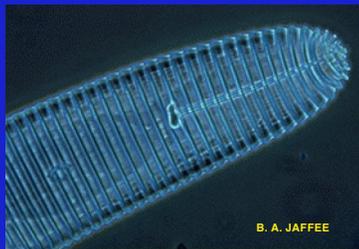
***XIPHINEMA INDEX* - VECTORS  
GRAPEVINE FANLEAF VIRUS**

**THE VIRUS IS:  
BOUND TO ESOPHAGEAL LINING  
LOST AT MOLT  
DOES NOT PASS THRU EGG  
STAGE  
DOES NOT REPLICATE IN  
NEMATODE**



***LONGIDORUS AFRICANUS*  
(NEEDLE NEMATODE)  
ON LETTUCE**





B. A. JAFFEE

**RING NEMATODE  
(MESOCRICONEMA  
XENOPLAX)**



B. A. JAFFEE

**PEACH**

**RING NEMATODE - BACTERIAL CANKER COMPLEX**

Susceptible - almond, apricot, cherry, kiwi, nectarine, peach, pear, plum, prune.

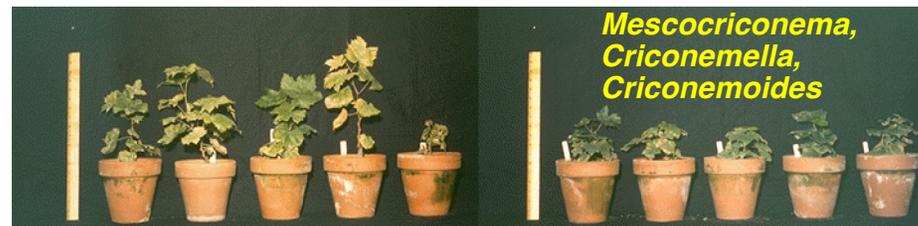
Bacteria (*Pseudomonas syringae*) is usually present in orchards.

Ring nematode stresses trees.

Stress predisposes trees to bacterial canker.

Usually associated with younger trees.

Usually associated with sandy soils.



**HEALTHY**

**INFESTED**



**RING NEMATODE (MESOCRICONEMA XENOPLAX) ON GRAPE**



**TURFGRASS NURSERY**

**SHEATH NEMATODE (HEMICYCLIOPHORA ARENARIA)**



**LESION NEMATODE  
(PRATYLENCHUS VULNUS)**



**LESION NEMATODE  
(PRATYLENCHUS  
PENETRANS)**

**EASTER LILY**

**BEGONIA**



**BEFORE FUMIGATION**

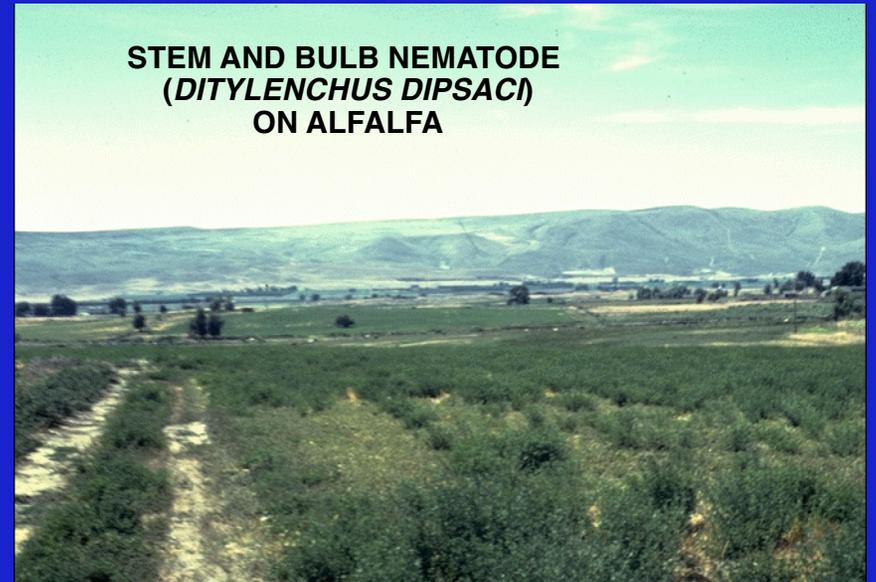


**AFTER FUMIGATION**

**STEM AND BULB NEMATODE (*DITYLENCHUS DIPSACI*)**



**STEM AND BULB NEMATODE  
(*DITYLENCHUS DIPSACI*)  
ON ALFALFA**

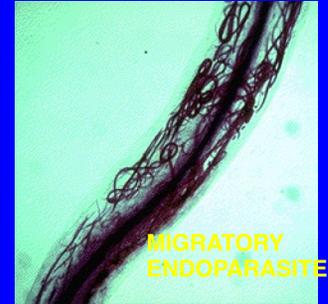




**STEM AND BULB NEMATODE  
(DITYLENCHUS DIPSACI)  
ON DAFFODIL**

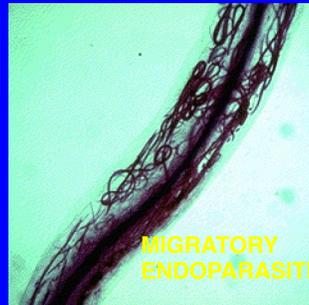


**DITYLENCHUS DIPSACI  
(STEM AND BULB NEMATODE)  
ON GARLIC**



**MIGRATORY  
ENDOPARASITE**

**DITYLENCHUS DESTRUCTOR  
(STEM AND BULB NEMATODE)  
ON POTATO**



**MIGRATORY  
ENDOPARASITE**



**FERN**



**EASTER LILY**

**FOLIAR NEMATODE  
(APHELENCHOIDES  
FRAGARIAE)  
AFRICAN VIOLET  
(HEALTHY IN CENTER)**





FOLIAR NEMATODE  
(*APHELENCHOIDES FRAGARIAE*)

CHRYSANTHEMUM



STRAWBERRY

ROOT-KNOT NEMATODE



HEALTHY

INFESTED



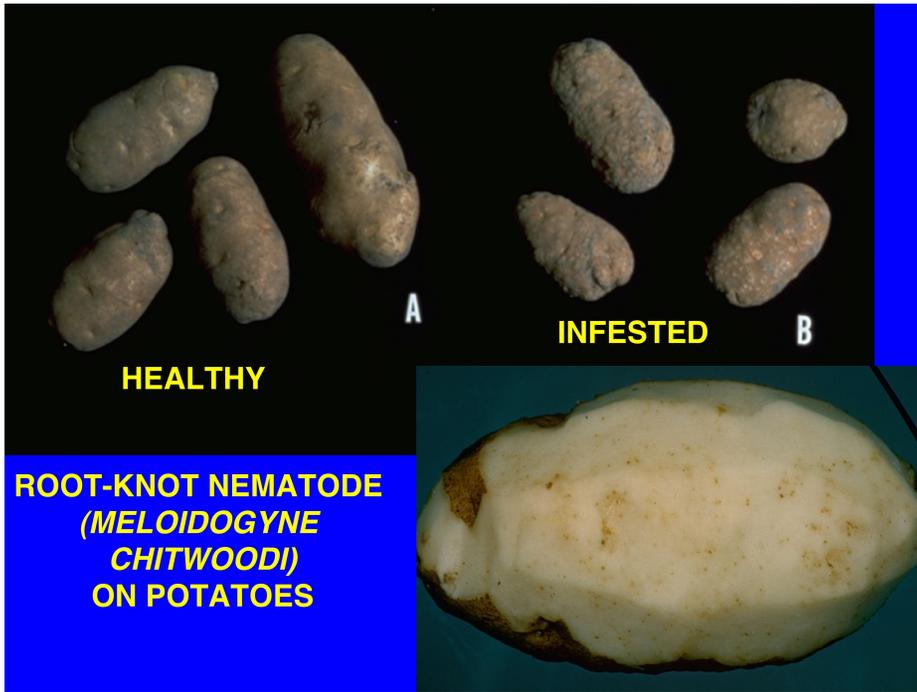
HEALTHY

INFESTED

ROOT-KNOT NEMATODE  
(*MELOIDOGYNE SP.*)  
ON CARROTS

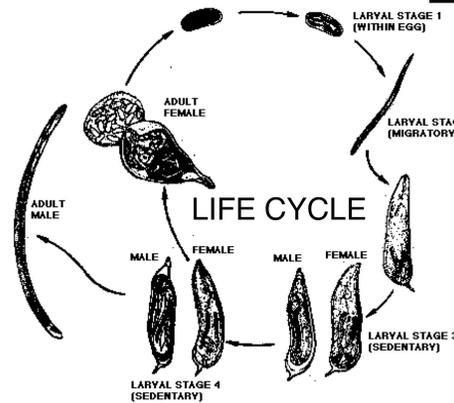
ROOT-KNOT NEMATODE (*MELOIDOGYNE SP.*)  
ON SWEET POTATOES



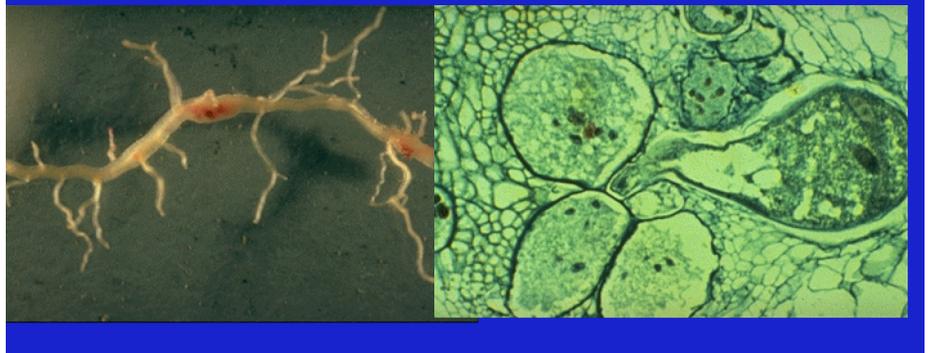


**ROOT-KNOT NEMATODE  
(MELOIDOGYNE SP.)**

**TOMATO ROOTS WITH  
(RIGHT) AND WITHOUT  
(LEFT) ROOT-KNOT GALLS**



**NEMATODE INFESTED  
TOMATO FIELD**





**ROOT-KNOT NEMATODE  
(*MELOIDOGYNE SP.*)  
ON GRAPE**

M. V. MCKENRY



**CHECK ON LEFT,  
NEMACUR  
TREATMENT ON RIGHT**

M. V. MCKENRY

**SEED AND LEAF GALL NEMATODE  
(*ANGUINA TRITICI*)**



**SEED AND LEAF GALL NEMATODE  
(*ANGUINA PACIFICA*)  
ON TURF**

L. R. COSTELLO



L. R. COSTELLO



**HETERODERA SCHACHTII**  
(SUGARBEET CYST  
NEMATODE)



**ADULT FEMALE (CYST)**



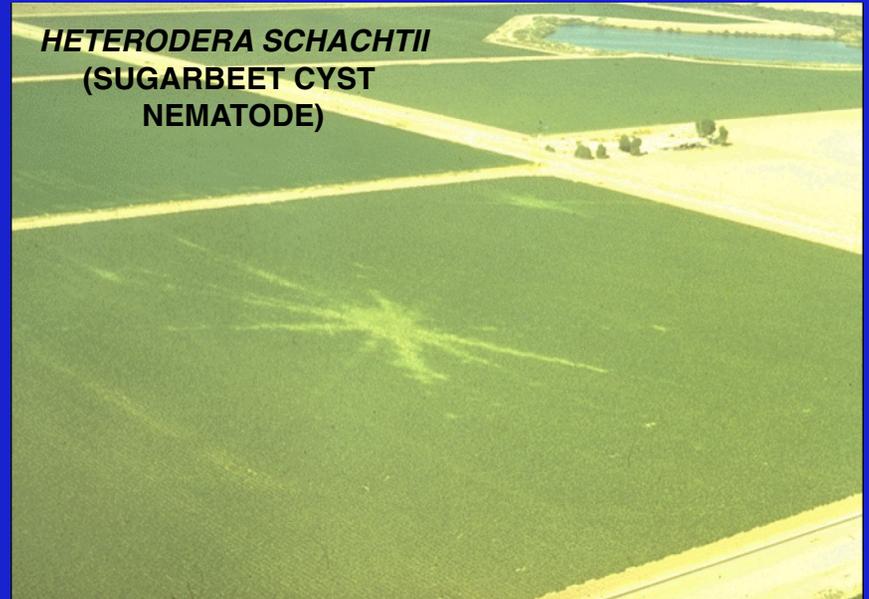
**HETERODERA SCHACHTII**  
(SUGARBEET CYST  
NEMATODE)



**HETERODERA SCHACHTII**  
(SUGARBEET CYST  
NEMATODE)



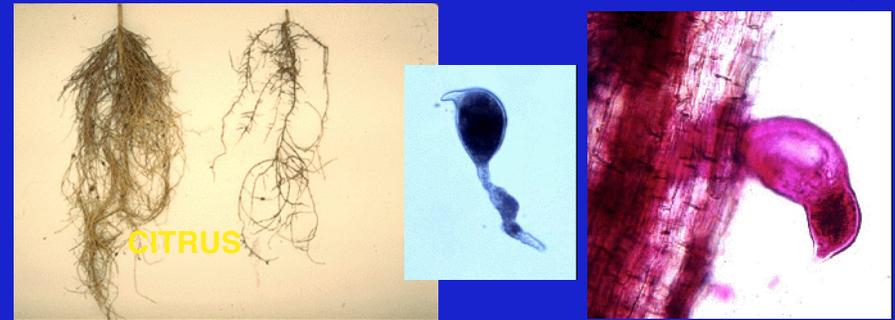
**HETERODERA SCHACHTII**  
(SUGARBEET CYST  
NEMATODE)



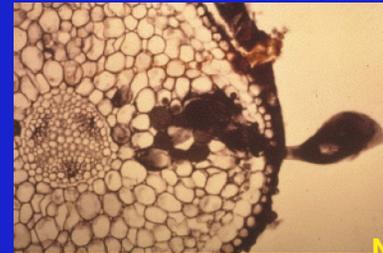
**HETERODERA SCHACHTII  
(SUGARBEET CYST  
NEMATODE)**



**CITRUS NEMATODE (TYLENCHULUS SEMIPENETRANS)**



**HEALTHY INFESTED**

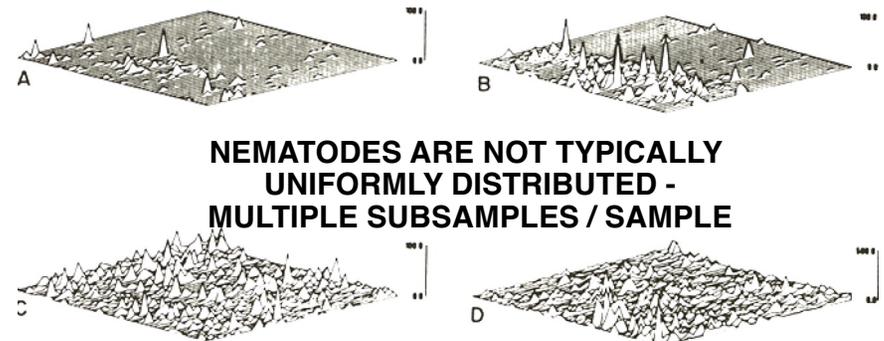


**GRAPES - CHECK ON LEFT,  
NEMACUR TREATMENT ON RIGHT**

**HOW NEMATODES INJURE PLANTS:**

1. Mechanical injury - penetration and movement through tissues
2. Cellular changes
  - A. Death of cells (necrosis)
  - B. Changes in growth of cells
3. Physiological changes in host
  - A. Interruption in uptake and flow of water and nutrients from roots
  - B. Interaction in flow of food from leaves to roots
4. Create openings for entry of other microorganisms
5. Interaction with other disease producing agents
6. Transmission of other disease producing agents
7. Increase susceptibility to environmental stress

**SAMPLING FOR NEMATODES:**

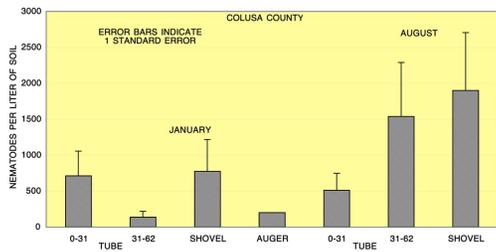
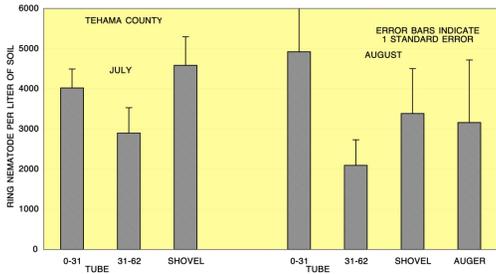


**NEMATODES ARE NOT TYPICALLY  
UNIFORMLY DISTRIBUTED -  
MULTIPLE SUBSAMPLES / SAMPLE**

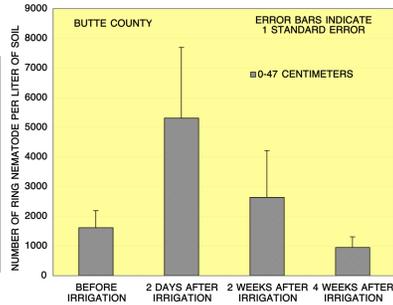
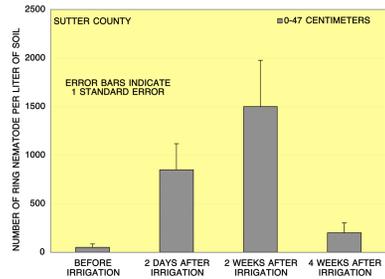


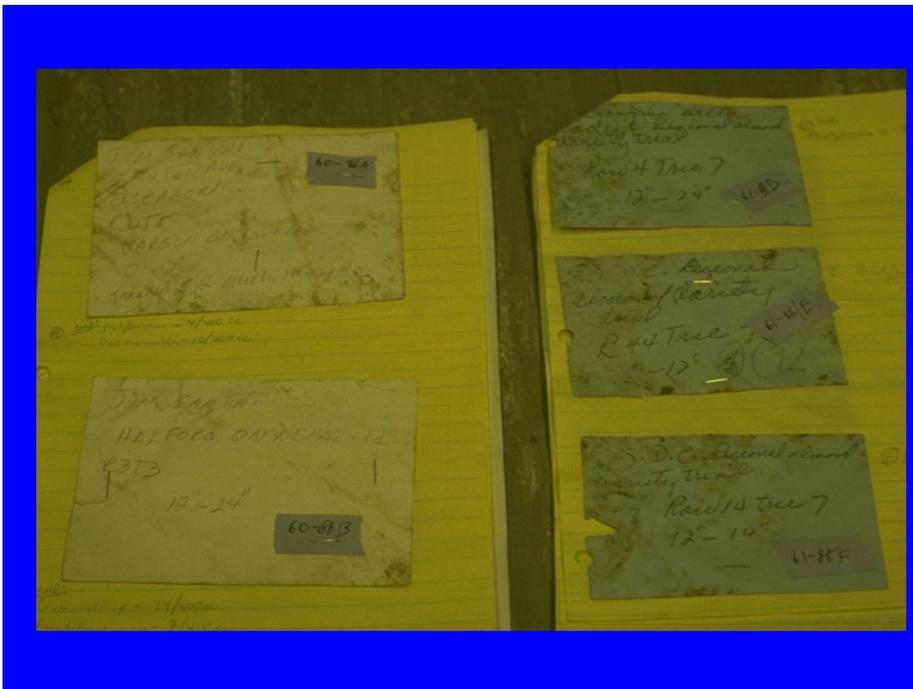


**WHAT SHOULD I SAMPLE WITH?**



**DOES SOIL MOISTURE AT TIME OF SAMPLING MAKE A DIFFERENCE?**





### SAMPLING FOR NEMATODES:

- Sample in root zone where moisture is present
- Place soil and roots into plastic bag
- Soil from several places can be combined
- Collect about 1 quart of soil and roots
- Sample healthy areas also and place in separate bag
- Seal bags and keep cool (do not freeze)
- Label bags - name, address, sample location, date, site history
- Notify laboratory that is to receive samples



## FENWICK CAN EXTRACTION



## NEMATODE / HOST ASSOCIATION DATABASES

H. FERRIS, E. CASWELL-CHEN, B. WESTERDAHL

NEMABASE Nematode-Host Association Database

(can also be obtained from ucipm website)

Nematode Common-Scientific Name Database

Plant Common-Scientific Name Database

Lownsbery Nematode-Host Association Database

Radewald California Ornamental

Nematode-Host Association Database

Nematode Primer Database

Knowledge Planning Database

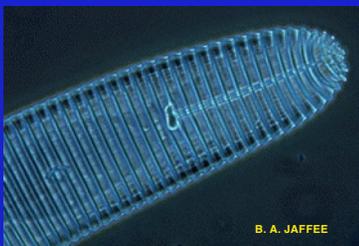


## SURVEY OF PRUNE ORCHARDS:

B. F. Lownsbery, 1974.

97 orchards sampled.

Pin ( <i>Paratylenchus</i> sp.)	67%
Dagger ( <i>Xiphinema americanum</i> )	62%
Ring ( <i>Mesocriconema</i> sp.)	38%
Lesion ( <i>Pratylenchus vulnus</i> )	7%



B. A. JAFFEE



B. A. JAFFEE

## SURVEY OF WALNUT ORCHARDS:

Compiled by B. F. Lownsbery  
from CDFA and UC records.

### MIGRATORY ECTOPARASITES -

Ring ( <i>Mesocriconema</i> sp.)	19%*
Dagger ( <i>Xiphinema americanum</i> )	17%
Pin ( <i>Paratylenchus</i> sp.)	6%
Spiral ( <i>Helicotylenchus</i> sp.)	2%

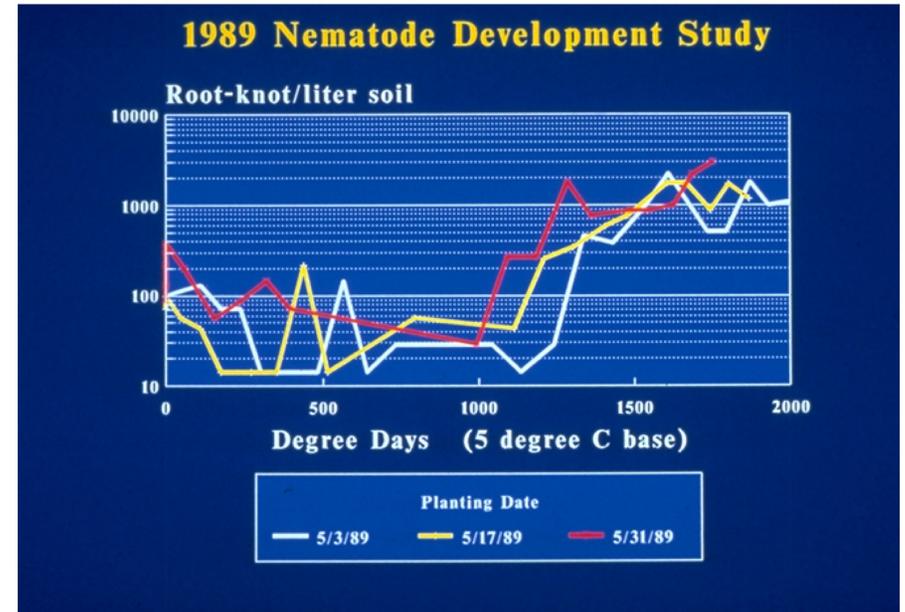
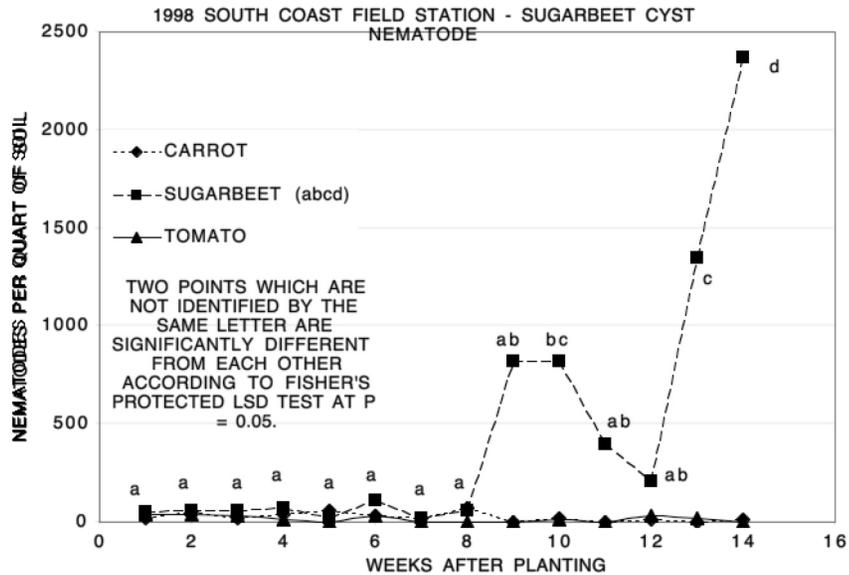
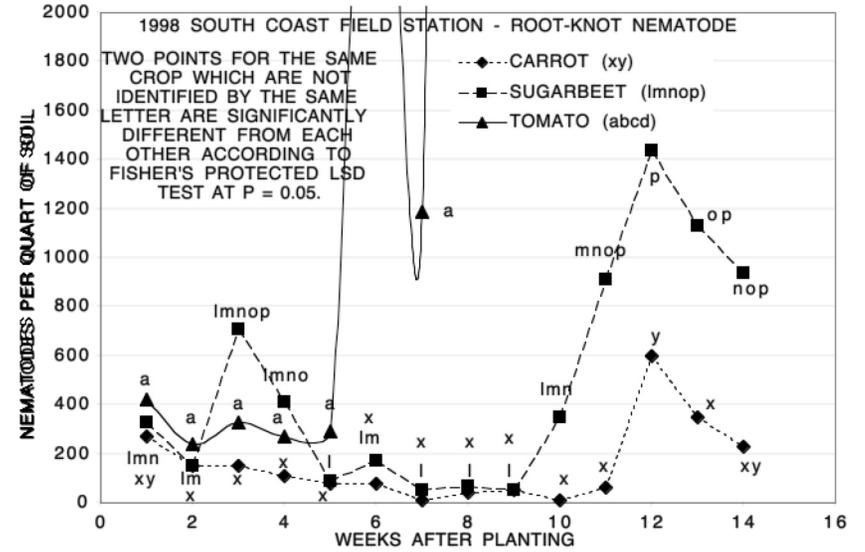
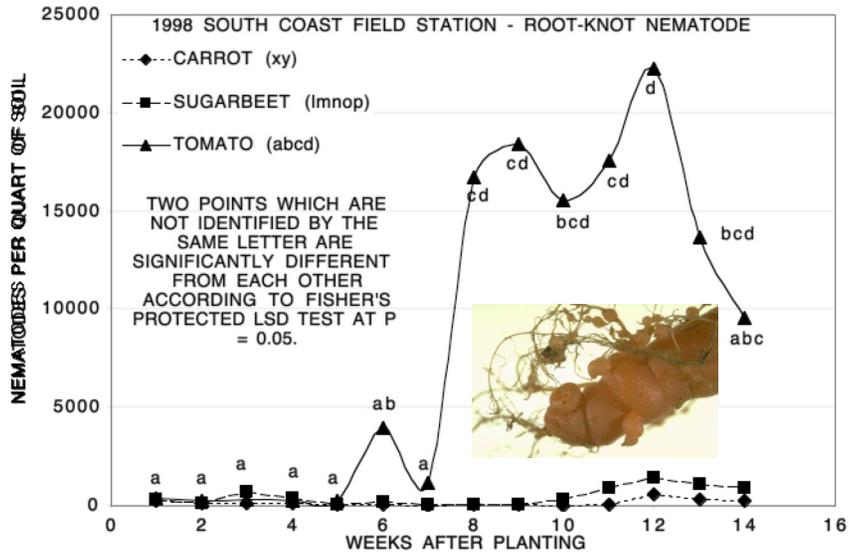
### MIGRATORY ENDOPARASITE -

Lesion ( <i>Pratylenchus</i> sp.)	51%*
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### SEDENTARY ENDOPARASITE -

Root knot ( <i>Meloidogyne</i> sp.)	15%*
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\*LIKELY TO CAUSE DAMAGE



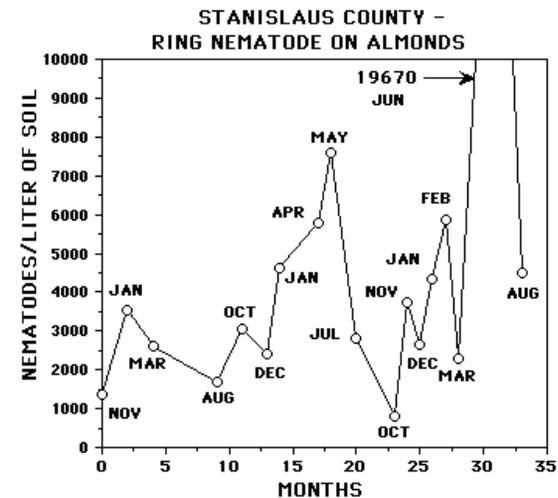
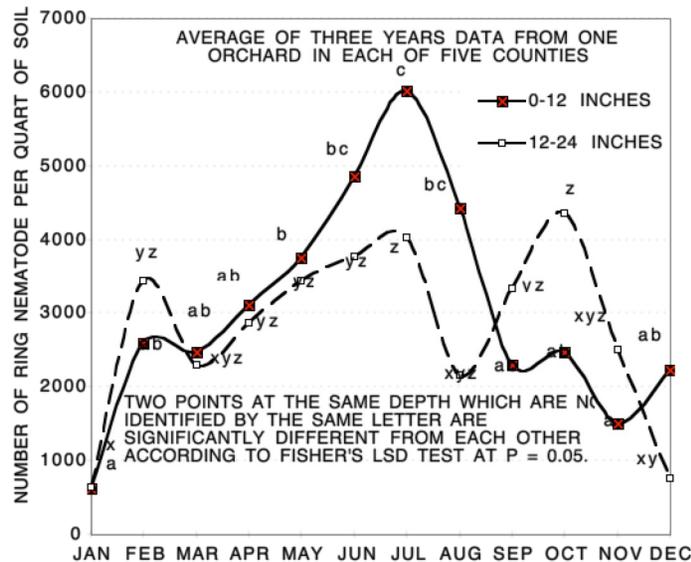
## ROOT KNOT NEMATODE ON PROCESSING TOMATOES - SAN JOAQUIN VALLEY

NUMBER OF LARVAE/GRAM OF SOIL		FALL PERCENT INCREASE		FALL PERCENT DECLINE	
		0.01	1000 X	10.0	100
0.31	85	0.05	500 X	23.8	98
1.56	85	0.25	150 X	37.3	85
4.06	85	0.65	75 X	48.0	65
6.25	85	1.00	55 X	54.8	53

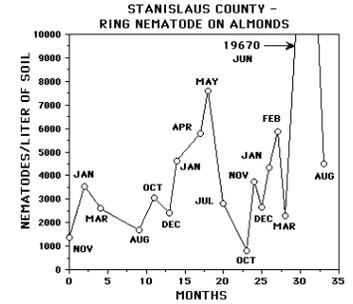
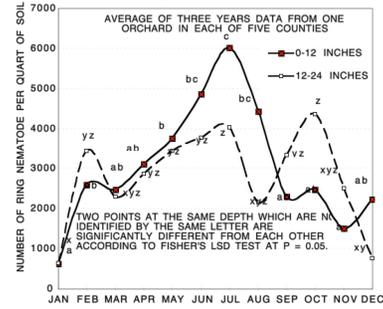
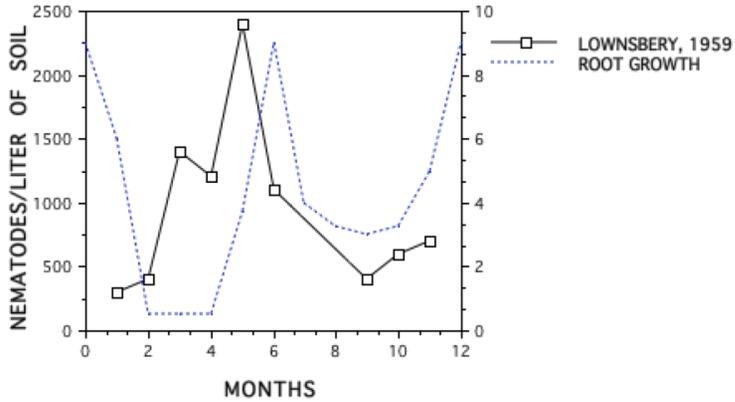
THE USE OF NEMATODE DAMAGE/ECONOMIC THRESHOLDS IS OFTEN LIMITED BY THE METHODS AVAILABLE TO DETECT NEMATODES.



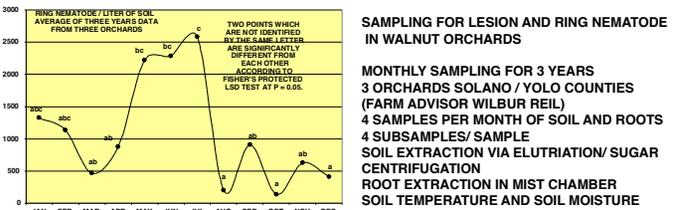
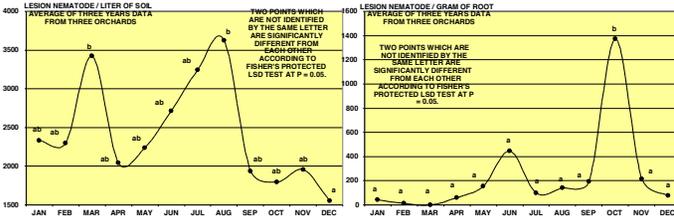
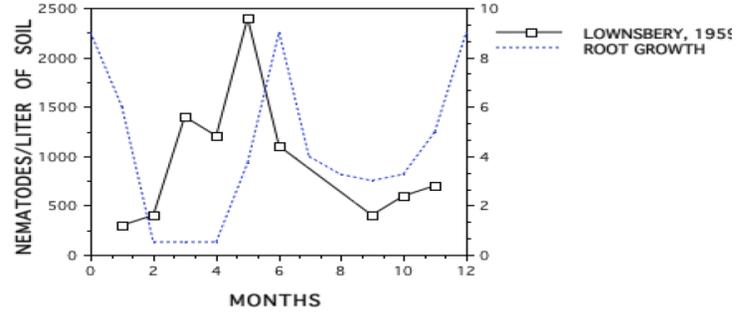
SUGARBEET DAMAGE THRESHOLD TRIAL



**RING NEMATODE ON PEACHES IN MERCED COUNTY**

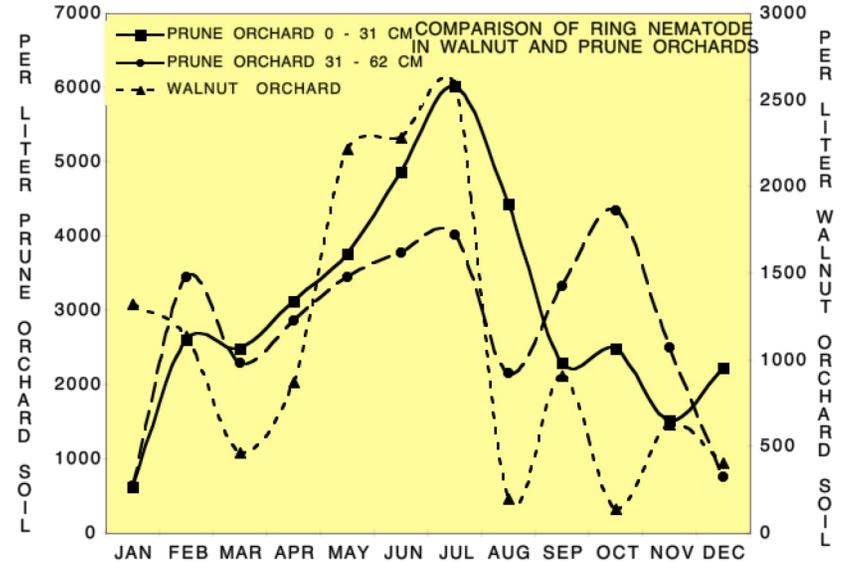


**RING NEMATODE ON PEACHES IN MERCED COUNTY**

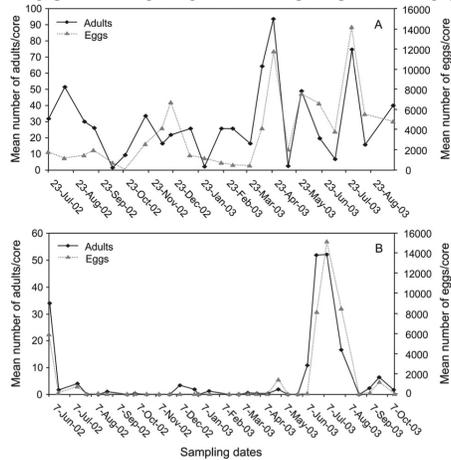


**SAMPLING FOR LESION AND RING NEMATODE IN WALNUT ORCHARDS**

MONTHLY SAMPLING FOR 3 YEARS  
 3 ORCHARDS SOLANO / YOLO COUNTIES (FARM ADVISOR WILBUR REIL)  
 4 SAMPLES PER MONTH OF SOIL AND ROOTS  
 4 SUBSAMPLES/ SAMPLE  
 SOIL EXTRACTION VIA ELUTRIATION/ SUGAR CENTRIFUGATION  
 ROOT EXTRACTION IN MIST CHAMBER  
 SOIL TEMPERATURE AND SOIL MOISTURE

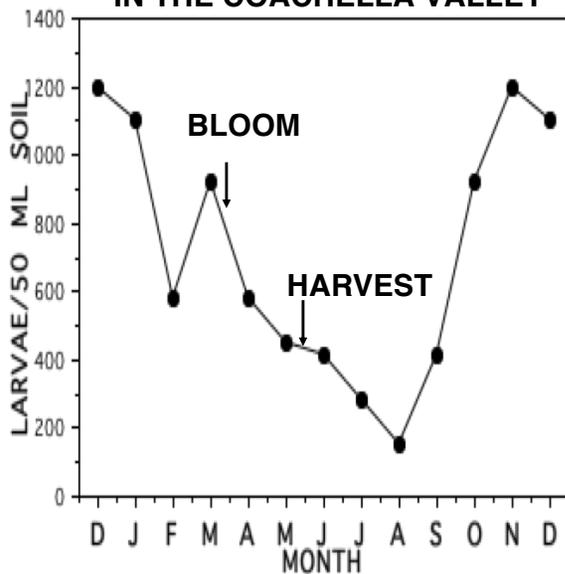


**ANGUINA PACIFICA – ADULTS AND EGGS**

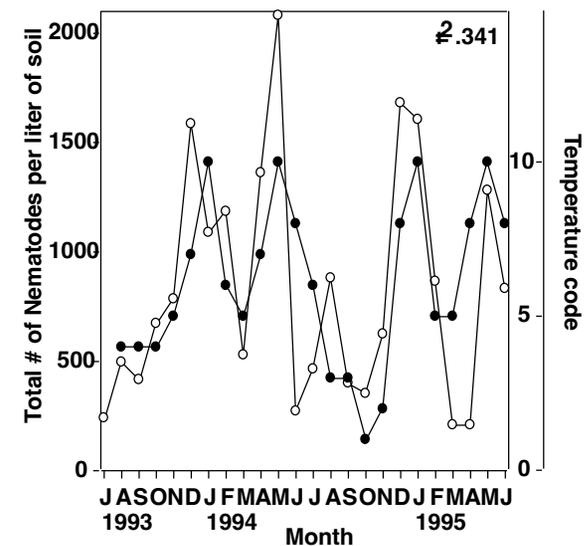


**GRAPE GROWING REGIONS:**  
**NORTH & CENTRAL COAST - DEWEY RASKI**  
**SAN JOAQUIN VALLEY - MIKE MCKENRY**  
**SOUTHERN CALIFORNIA - JOHN RADEWALD**

**CITRUS NEMATODE ON GRAPES IN THE COACHELLA VALLEY**



**XIPHINEMA INDEX ON GRAPES**



NEMATODE	REGION		
	NORTH	SAN JOAQ	S CA
DAGGER	X	X	0
RING	X	X	0
LESION	X	X	0
STUBBY ROOT	X	X	X
ROOT KNOT	X	X	X
CITRUS	0	X	X
NEEDLE	0	0	X

TYPE OF GRAPES	REGION		
	NORTH	SAN JOAQ	S CA
WINE	X	X	0
RAISIN	0	X	0
TABLE	0	X	X

SOIL TYPE	REGION		
	NORTH	SAN JOAQ	S CA
FINE	X	0	0
MEDIUM	X	X	0
COARSE	0	X	X

IRRIGATION TYPE	REGION		
	NORTH	SAN JOAQ	S CA
NONE	X	0	0
SPRINKLER	X	0	0
FLOOD/FURROW	0	X	0
DRIP(Low VOLUME)	0	X	X

**COACHELLA VALLEY  
CITRUS NEMATODE ON GRAPES**

