PROBLEMS WITH ROOT-KNOT NEMATODE ON NEMATODE RESISTANT TOMATOES:

Mi-1 IS A SINGLE DOMINANT GENE
ALL VARIETIES HAVE THE SAME RESISTANCE GENE
RESISTANT TO MELOIDOGYNE INCognita, M. JAVANICA, M. ARENARIA.
NOT RESISTANT TO M. HAPLA
PLANTS WITH UP TO 5 GALLS ARE CONSIDERED “RESISTANT”
RESISTANCE BREAKING RACES FIRST FOUND IN 1995
SELECTED FROM WITHIN NATIVE POPULATION IN THE FIELD
WILLIAMSON LAB (UCDAVIS):
9 RESISTANCE BREAKING RACES IN CULTURE
6 FROM YOLO COUNTY
2 FROM LOS BANOS
1 FROM NORTH CAROLINA
WHEN SHOULD YOU SAMPLE FOR NEMATODES?

1998 SOUTH COAST FIELD STATION - ROOT-KNOT NEMATODE

- CARROT (xy)
- SUGARBEET (lmnop)
- TOMATO (abcd)

TWO POINTS WHICH ARE NOT IDENTIFIED BY THE SAME LETTER ARE SIGNIFICANTLY DIFFERENT FROM EACH OTHER ACCORDING TO FISHER'S PROTECTED LSD TEST AT P = 0.05.

WHEN SHOULD YOU TREAT FOR NEMATODES?
SAMPLING FOR NEMATODES:

NEMATODES ARE NOT TYPICALLY UNIFORMLY DISTRIBUTED - MULTIPLE SUBSAMPLES / SAMPLE
EFFECT OF SOIL TYPE ON NEMATODE REPRODUCTION:
SANDY SOILS TEND TO HAVE HIGHER POPULATIONS THAN CLAY SOILS
BUT POPULATIONS IN CLAY SOILS GET HIGH ENOUGH TO CAUSE A PROBLEM
TESTING FOR RESISTANCE BREAKING RACES:
MICROSCOPIC EXAMINATION OF JUVENILES - NO
PERINEAL PATTERN ANALYSIS - NO
ISOZYME ELECTROPHORESIS OF ADULTS - NO
BIOASSAY - RECENTLY DEVELOPED BY
WILLIAMSON LAB
PCR MARKERS FOR JUVENILES - UNDER
INVESTIGATION BY WILLIAMSON LAB
CULTURAL PRACTICES:
- CROP ROTATION
- RESISTANT VARIETIES
- FALLOWING / WEED CONTROL
- COVER CROPS / GREEN MANURES /
  BIOFUMIGATION
- TRAP CROPS
- FLOODING
- DATE OF PLANTING
- SOIL AMENDMENTS

HOW LONG BEFORE YOU CAN PLANT TOMATOES AGAIN?
TYPICAL CROPS AND GROWING SEASONS FOR YOLO COUNTY:

* TOMATOES (SUMMER)
* CUCURBITS (SUMMER)
* SUGARBEETS (FALL OR SPRING PLANTED)
* ALFALFA (PERENNIAL)
* GRAIN (WHEAT, OATS, BARLEY) (WINTER)
* CORN (SUMMER)
* SUNFLOWER (SUMMER)
* SAFFLOWER (SUMMER)
* BEANS (SUMMER)
* RICE (SUMMER)
* FALLOW

STEM & BULB NEMATODE ON ALFALFA
<table>
<thead>
<tr>
<th>COMMON NAME</th>
<th>SCIENTIFIC NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROOT KNOT</td>
<td>MELOIDOGYNE INCOGNITA (I)</td>
</tr>
<tr>
<td></td>
<td>(80% OF THE TIME)</td>
</tr>
<tr>
<td></td>
<td>MELOIDOGYNE ARENARIA (A)</td>
</tr>
<tr>
<td></td>
<td>MELOIDOGYNE JAVANICA (J)</td>
</tr>
<tr>
<td></td>
<td>MELOIDOGYNE HAPLA (H)</td>
</tr>
<tr>
<td>SUGARBEET CYST</td>
<td>HETERODERA SCHACHTII</td>
</tr>
<tr>
<td>LESION</td>
<td>PRATYLENCHUS THORNEI (T)</td>
</tr>
<tr>
<td></td>
<td>PRATYLENCHUS NEGLECTUS (N)</td>
</tr>
<tr>
<td>STEM &amp; BULB</td>
<td>DITYLENCHUS DIPSACI</td>
</tr>
<tr>
<td></td>
<td>(SEVERAL BIOTYPES)</td>
</tr>
</tbody>
</table>
HOST RANGE:

<table>
<thead>
<tr>
<th>CROP</th>
<th>ROOT KNOT</th>
<th>NEMATODE CYST</th>
<th>LESION</th>
<th>STEM &amp; BULB</th>
<th>RESISTANT VARIETIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOMATOES</td>
<td>YES</td>
<td>NO</td>
<td>N</td>
<td>NO</td>
<td>I,J,A</td>
</tr>
<tr>
<td>CUCURBITS</td>
<td>YES</td>
<td>NO</td>
<td>T</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>SUGARBEETS</td>
<td>YES</td>
<td>YES</td>
<td>T</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>ALFALFA</td>
<td>YES</td>
<td>NO</td>
<td>N,T</td>
<td>YES</td>
<td>TOLERANT</td>
</tr>
<tr>
<td>GRAIN</td>
<td>I,J,A</td>
<td>NO</td>
<td>T,N</td>
<td>OATS</td>
<td>NO</td>
</tr>
<tr>
<td>CORN</td>
<td>I,J,A</td>
<td>NO</td>
<td>T,N</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>SUNFLOWER</td>
<td>YES</td>
<td>NO</td>
<td>?</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>SAFFLOWER</td>
<td>YES</td>
<td>NO</td>
<td>?</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>BEANS</td>
<td>YES</td>
<td>NO</td>
<td>T</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>RICE</td>
<td>?</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>FALLOW</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td></td>
</tr>
</tbody>
</table>

ROOT-KNOT SPECIES:
I = INCOGNITA   J = JAVANICA
A = ARENARIA

LESION SPECIES:
T = THORNEI   N = NEGLECTUS
**WHAT ARE THE BEST ROTATION CROPS?**

### HOST RANGE:

<table>
<thead>
<tr>
<th>CROP</th>
<th>ROOT KNOT SUSCEPTIBLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOMATOES</td>
<td>YES</td>
</tr>
<tr>
<td>CUCURBITS</td>
<td>YES</td>
</tr>
<tr>
<td>SUGARBEETS</td>
<td>YES</td>
</tr>
<tr>
<td>ALFALFA</td>
<td>TOLERANT</td>
</tr>
<tr>
<td>GRAIN I,J,A</td>
<td></td>
</tr>
<tr>
<td>CORN I,J,A</td>
<td></td>
</tr>
<tr>
<td>SUNFLOWER</td>
<td>YES</td>
</tr>
<tr>
<td>SAFFFLOWER</td>
<td>YES</td>
</tr>
<tr>
<td>BEANS</td>
<td>YES (RESISTANT VARIETIES)</td>
</tr>
<tr>
<td>RICE</td>
<td>?</td>
</tr>
<tr>
<td>FALLOW</td>
<td>NO</td>
</tr>
</tbody>
</table>

### ROOT-KNOT SPECIES:

I = *INCOGNITA*     J = *JAVANICA*     A = *ARENARIA*
HOW LONG BEFORE YOU CAN PLANT TOMATOES AGAIN?

ROOT KNOT NEMATODE ON PROCESSING TOMATOES
- SAN JOAQUIN VALLEY

NUMBER OF LARVAE/GRAM OF SOIL

<table>
<thead>
<tr>
<th>FALL</th>
<th>PERCENT</th>
<th>SPRING INCREASE</th>
<th>FALL</th>
<th>% OF NORMAL YIELD</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01</td>
<td>1000 X</td>
<td>10.0</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>0.31</td>
<td>85</td>
<td>0.05</td>
<td>500 X</td>
<td>23.8</td>
</tr>
<tr>
<td>1.56</td>
<td>85</td>
<td>0.25</td>
<td>150 X</td>
<td>37.3</td>
</tr>
<tr>
<td>4.06</td>
<td>85</td>
<td>0.65</td>
<td>75 X</td>
<td>48.0</td>
</tr>
<tr>
<td>6.25</td>
<td>85</td>
<td>1.00</td>
<td>55 X</td>
<td>54.8</td>
</tr>
</tbody>
</table>

THE USE OF NEMATODE DAMAGE/ECONOMIC THRESHOLDS IS OFTEN LIMITED BY THE METHODS AVAILABLE TO DETECT NEMATODES.
FALLOW
NO CROP - NO WEEDS -
NEMATODES STARVE
EFFECTIVENESS -
EXCELLENT -
COST - ??

DRY VS WET,
SOIL DISTURBANCE,
COST OF WEED
CONTROL

ROOT-KNOT NEMATODE
RATE OF YEARS
DECLINE/OF
YEAR FALLOW
85 % 0.25 - 2
TRAP CROPPING:
JUVENILE ENTERS ROOT AND BEGINS FEEDING
IMMATURE FEMALE NO LONGER ABLE TO MOVE
DESTROY CROP BEFORE FEMALE LAYS EGGS
PLANT COMMERCIAL CROP

B. A. JAFFEE
NEMATODE / HOST ASSOCIATION DATABASES

H. FERRIS, E. CASWELL-CHEN, B. WESTERDAHL
FROM URL: http://ucdnema.ucdavis.edu/
SELECT: VIEW DATABASES

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
TO SELECT A COVER CROP
YOU NEED TO KNOW WHICH SPECIES YOU HAVE?

SUMMARY OF HOST-NEMATODE RESPONSES ON COVER CROPS:

<table>
<thead>
<tr>
<th></th>
<th>Root Knot</th>
<th>Root Knot</th>
<th>Root Knot</th>
<th>Root Knot</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Northern</strong></td>
<td><strong>Southern</strong></td>
<td><strong>Javanese</strong></td>
<td><strong>Peanut</strong></td>
</tr>
<tr>
<td></td>
<td><em>Meloidogyne</em></td>
<td><em>Meloidogyne</em></td>
<td><em>Meloidogyne</em></td>
<td><em>Meloidogyne</em></td>
</tr>
<tr>
<td></td>
<td><em>hapla</em></td>
<td><em>incognita</em></td>
<td><em>javanica</em></td>
<td><em>arenaria</em></td>
</tr>
<tr>
<td>Marigold</td>
<td>Host</td>
<td>Host</td>
<td>Host, Trap Crop</td>
<td>Non Host</td>
</tr>
<tr>
<td>Sudan, SS-222</td>
<td>Poor Host</td>
<td>Good Host</td>
<td>Host</td>
<td>Host</td>
</tr>
<tr>
<td>Barley, Columbia</td>
<td>Host</td>
<td>Poor Host</td>
<td>Good Host</td>
<td>Host</td>
</tr>
<tr>
<td>Cahaba White Vetch</td>
<td>Good Host</td>
<td>Poor Host</td>
<td>Host, Trap Crop</td>
<td>Host</td>
</tr>
<tr>
<td>Salina Sweet Clover</td>
<td>Host</td>
<td>Poor Host</td>
<td>Poor Host</td>
<td>Nonhost</td>
</tr>
<tr>
<td>Moapa Alfalfa</td>
<td>Susceptible</td>
<td>Poor Host</td>
<td>Poor Host</td>
<td>Nonhost</td>
</tr>
<tr>
<td>Coker 916 Wheat</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Nova II Vetch</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Blando Brome Grass</td>
<td>Host</td>
<td>Nonhost</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DATA SUMMARY BY M.V. MCKENRY, 1991

+ = PROBABLE HOST, - = PROBABLE NONHOST, BASED ON DATA FROM GEORGIA AND S. CAROLINA
PLANTING IN COOLER SOILS CAN REDUCE DAMAGE
TREATMENT OPTIONS:

SHANK INJECTION -
  TELONE II (1,3-DICHLOROPROPENE)
  TELONE C-17 (WITH CHLOROPICRIN)

DRIP IRRIGATION -
  TELONE EC (TARP)
  INLINE (1,3-D + 33% CP) (TARP)
  METAM SODIUM
  METAM POTASSIUM
  ENZONE
  VYDATE (OXAMYL)
**Time of Discovery / Postplant Treatment Initiation**

"Is it ever too late to initiate treatment?"

- **ROOT GALL SEVERITY (0-8)**

![Bar chart showing severity levels and treatment initiation weeks.](chart)

- **AOV Time**
  - *P*=0.0001

**OXAMYL TREATMENT INITIATION**

- **(weeks prior to harvest)**
  - Started 3 weeks post plant
  - OXAMYL TREATMENT INITIATION

Noling, 1998

"Sooner weekly treatments initiated the better"
• Vydate L in drip – higher frequency at modest rates is most effective. (6x@1qt better 3x@2qt)
• Start Vydate L drip treatments close to planting date.
• Use Highest Vydate L rate in 1st application to get ppm needed.
• Don’t expect miracles from crop rescue, identify problem fields before planting.
• Under high pressure, use 2 qts Vydate L in drip for first two apps.
• Combine Vapam + Vydate L treatments for broadest spectrum
WHEN SHOULD YOU SAMPLE FOR NEMATODES?

WHEN SHOULD YOU TREAT FOR NEMATODES?

1998 SOUTH COAST FIELD STATION - ROOT-KNOT NEMATOIDE

- CARROT (xy)
- SUGARBEET (lmnop)
- TOMATO (abcd)

TWO POINTS WHICH ARE NOT IDENTIFIED BY THE SAME LETTER ARE SIGNIFICANTLY DIFFERENT FROM EACH OTHER ACCORDING TO FISHER'S PROTECTED LSD TEST AT P = 0.05.

JUVENILES / LITER OF SOIL

WEEKS AFTER PLANTING

0 2 4 6 8 10 12 14 16
IF YOU HAVE A RESISTANCE BREAKING RACE:

DON’T PLANT NEMATODE RESISTANT TOMATOES FOR AT LEAST 2 YEARS

USE A PREPLANT FUMIGANT NEMATICIDE FOLLOWED BY A SUSCEPTIBLE VARIETY OR A ROTATION CROP

MOST ROTATION CROPS WILL BE SUSCEPTIBLE TO ROOT-KNOT NEMATODE

NEMATODE RESISTANT ALFALFA IS NOT NEMATODE RESISTANT, IT WILL MAINTAIN THE POPULATION

PLANTING IN COOLER SOIL SHOULD REDUCE DAMAGE NEMATODES REPRODUCE MORE SLOWLY, ROOTS CAN BECOME ESTABLISHED

IF YOU DON’T HAVE A RESISTANCE BREAKING RACE:

ALTERNATE BETWEEN A RESISTANT VARIETY AND FUMIGATION WITH A SUSCEPTIBLE VARIETY OR ROTATION