Low cost phyto-nematode management strategies

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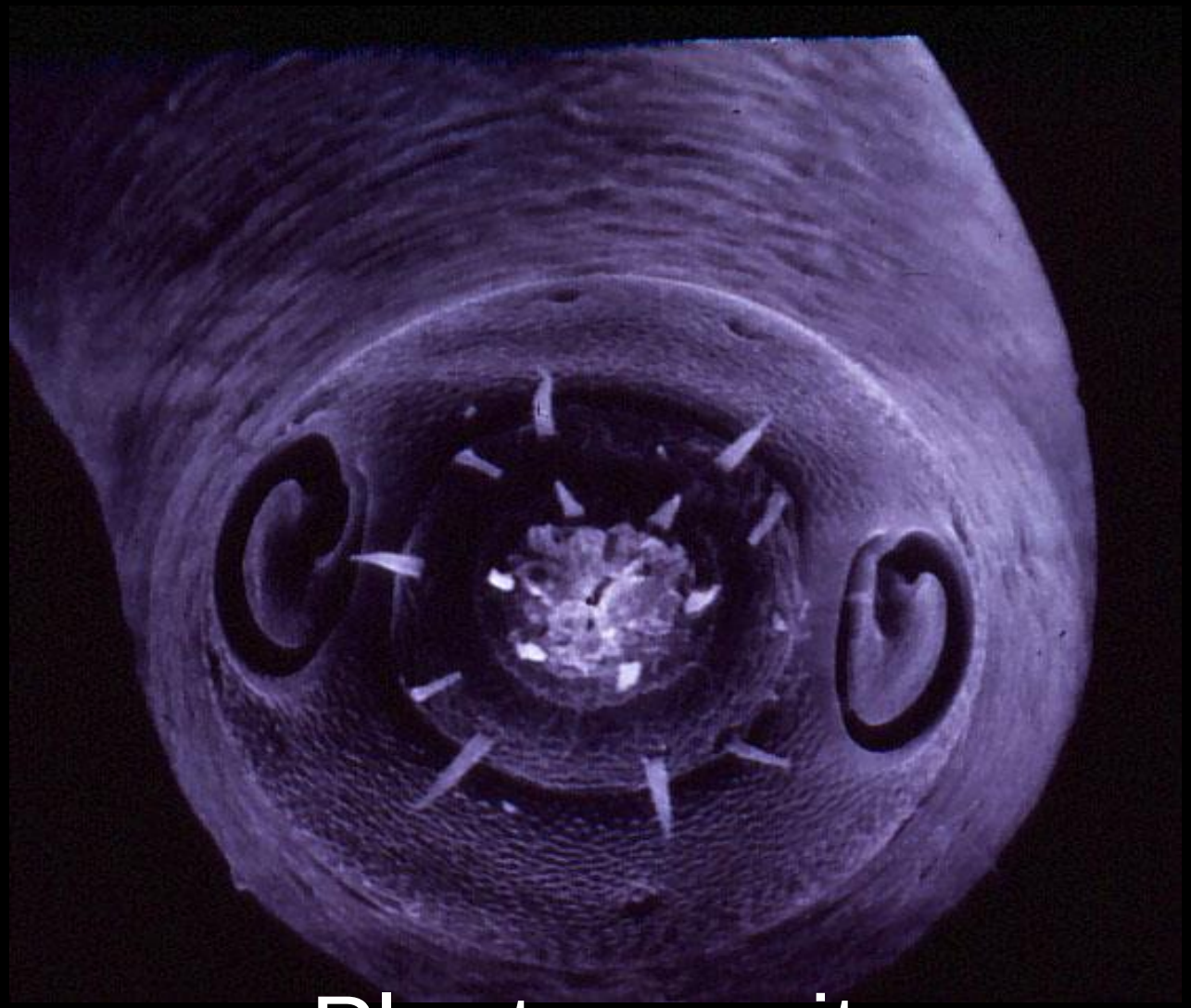
Economic Impact of Nematodes

- Annual crop losses to world agriculture-est $100b and $8b in US
- Some of most damaging pests of tropical, sub-tropical and temperate agriculture.
- Root - knot nematodes (RKN) are the most destructive world wide

Nematodes



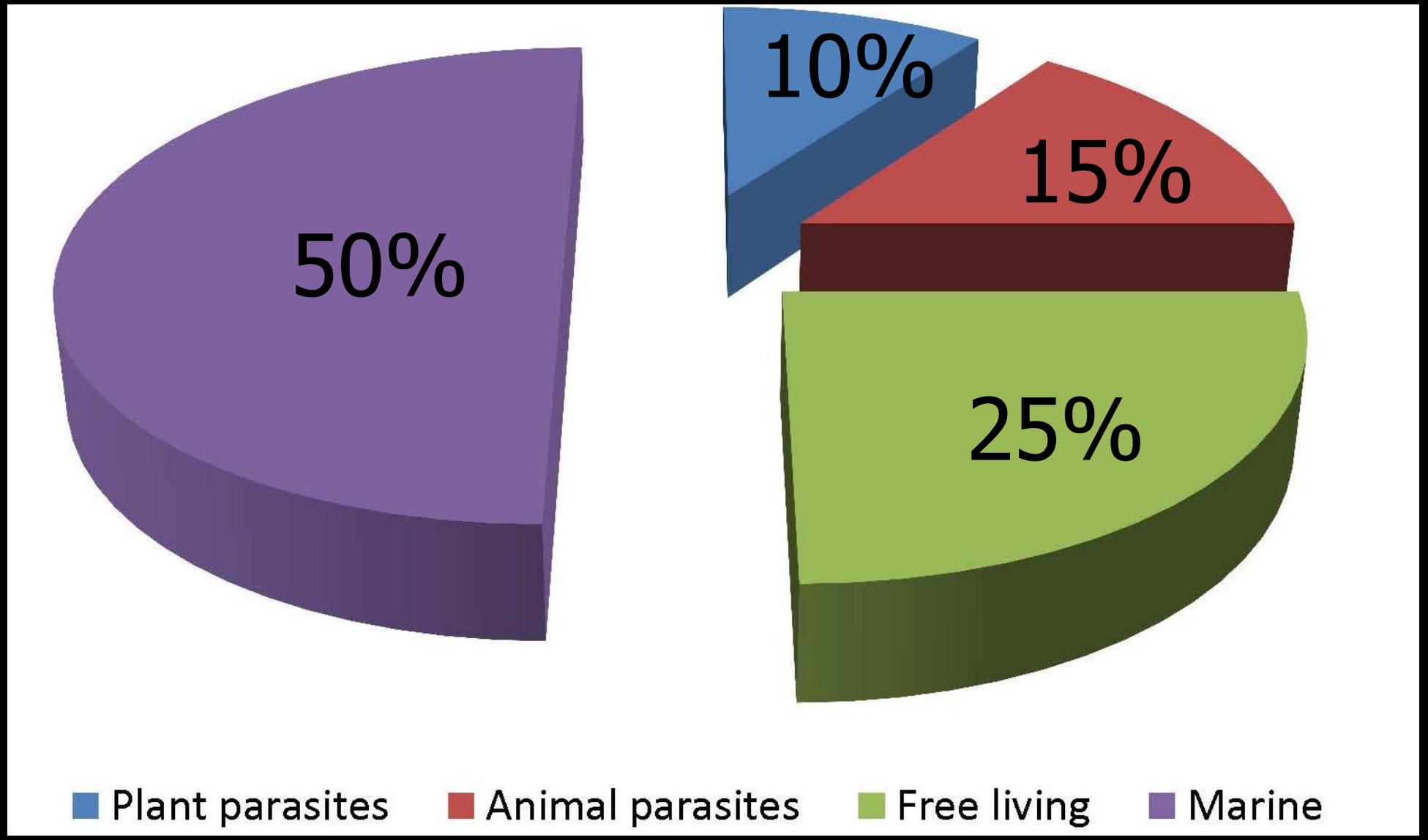
Plant parasite

Animal parasite

What are nematodes?

- Small microscopic worm-shaped animals (0.5-10mm)
- Other shapes (round, pear shaped)
- 25% infect animals and plants
- High fecundity & short life cycle
- Occupy every habitat (freshwater, marine, brackish, terrestrial)
- Numerical dominant - 80, 000sp

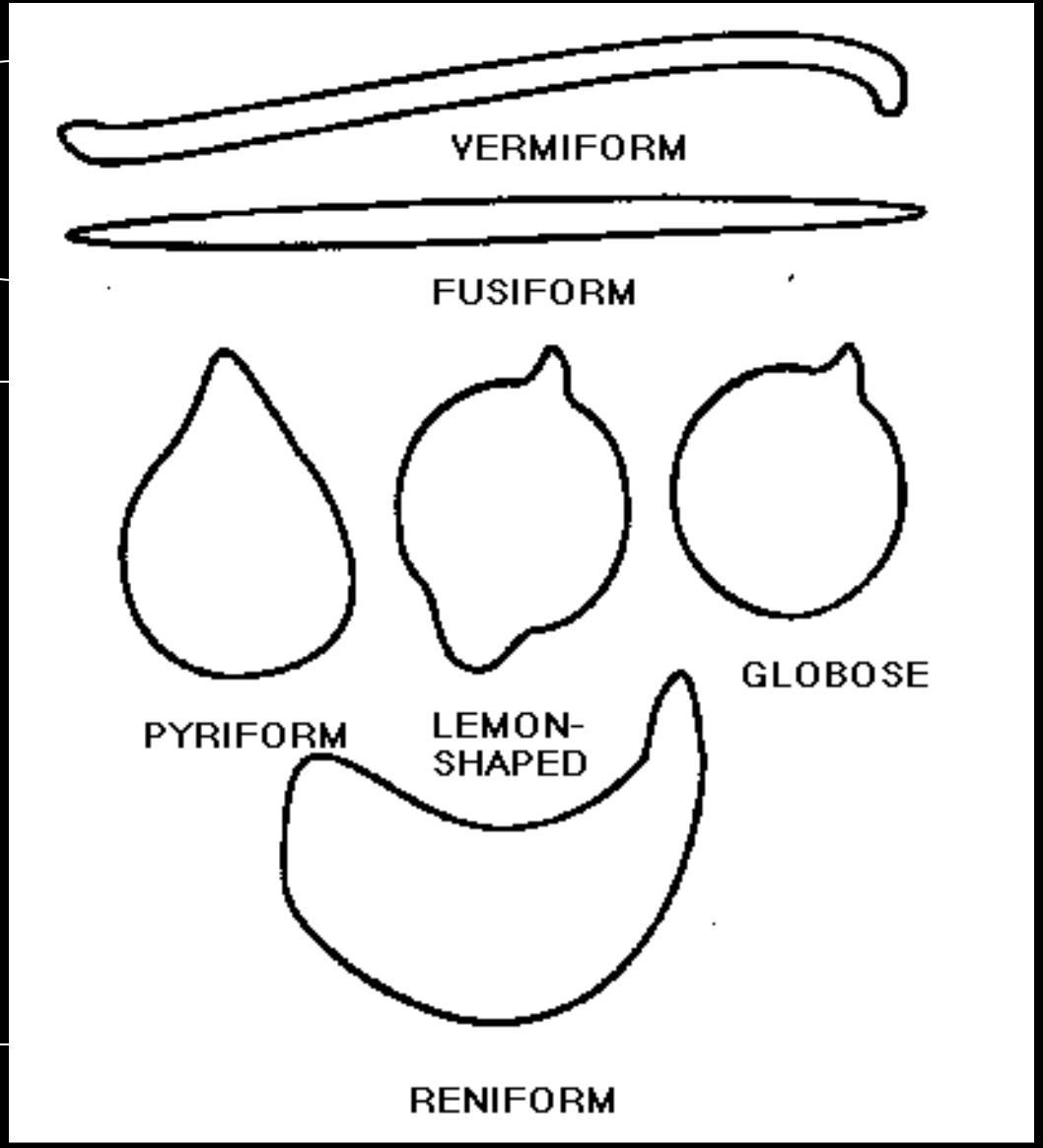
Nematode Groups



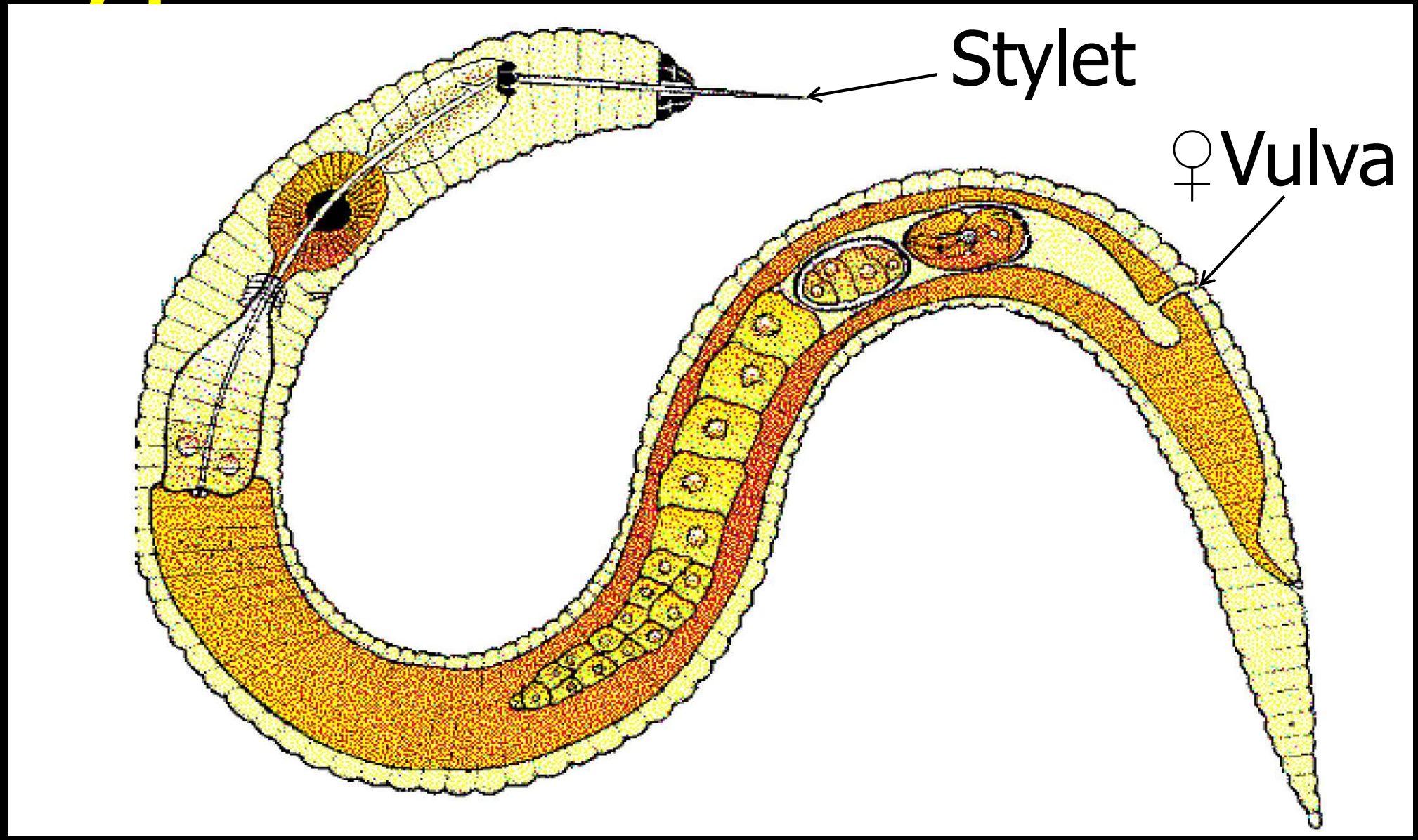
Nematode Body Shapes

95%

5%



Typical Plant Nematode



Nematode Life Cycles

- Complete life cycle ~ 30 days
  - –embryonic, 4 juvenile stages and adult form.
  - –4 molts & 5 stages
  - –Egg →J1(H)→J2→J3→J4→Adult
  - –J2: only infective stage
  - –High fecundity

RKN development

Adult Root-Knot Nematode

Where do nematodes live?

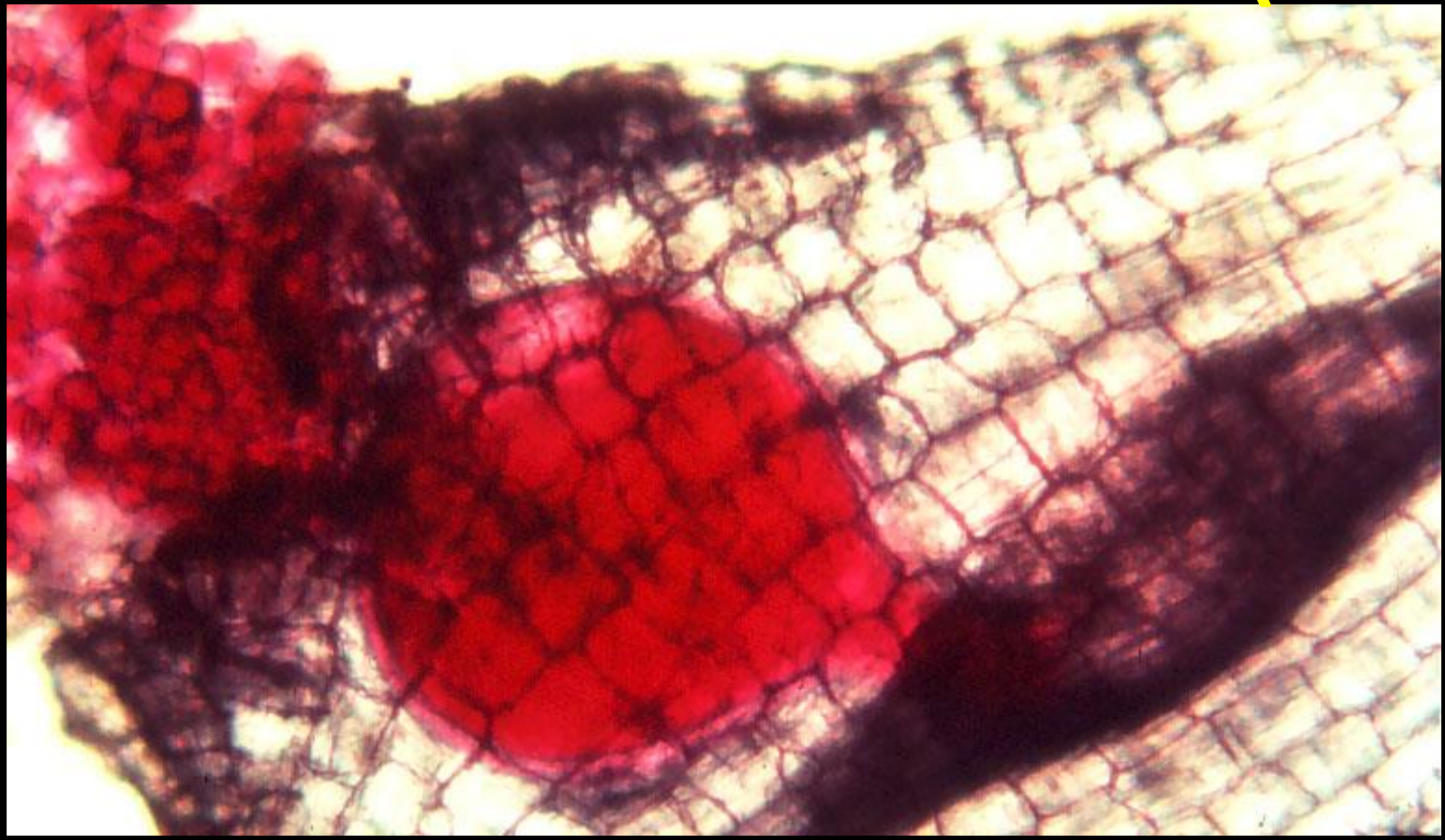
- Ecto-parasites
  - –in soil, feed from outside roots
- Endo-parasites
  - –inside plant roots (RKN)
- Other parts of plant
  - –stem, leaves and seeds

Ecto-parasitic nematode

Endo-parasitic nematodes

Root-knot nematode giant cells

Root-knot nematode (RKN)



Optimal conditions

- Aerated soils – oxygen
- Temperature (25˚– 30˚C)
- Moisture (field capacity)
- Soil texture & structure
  –course textured to loam soils
- Rhizosphere (top 12”soil)

Plants/Crops Infected

- Almost all tropical, sub-tropical and temperate crops
  - Cereals
  - Grains
  - Fruit
  - Vegetables
  - Some ornamentals
  - Grasses - turf

How nematodes damage crops

- Crop roots main target:
  - Direct feeding (ecto/endo)
  - Predisposition to secondary infections
  - Virus transmission
  - Nematode/disease interactions
  - Effect:
    - reduces flow of water & nutrients
    - weaken crops, make them susceptible to stress factors (heat, water & nutritional deficiencies)
    - reduces yield

Severity of Crop Damage

- Depends on:
  - –nematode
  - –infestation levels
  - –crops affected
- Environmental conditions:
  - –soil type
  - –rainfall patterns
  - –temperature

Field Crop Damage Symptoms

- Above ground:
  - reduced or patchy growth
  - stunted growth
  - premature crop wilting
  - chlorosis (yellowing of leaves/stems)
  - reduced vigor/poor yields
- Below ground:
  - root-galling (RKN)
  - excessive root branching
  - necrotic/malformed/distorted roots
  - reduction of root mass

Aerial view - SCN damage

Patchy nematode damage

RKN infected galled roots

RKN infected soy bean-AR

RKN infected soy bean-AR

Reniform infected cotton-TX

Reniform infected cotton-LA

RKN infected Peanuts-FL

RKN infected Peanuts

RKN infected Peanut

RKN infected Cotton

RKN infected Sweet potatoes

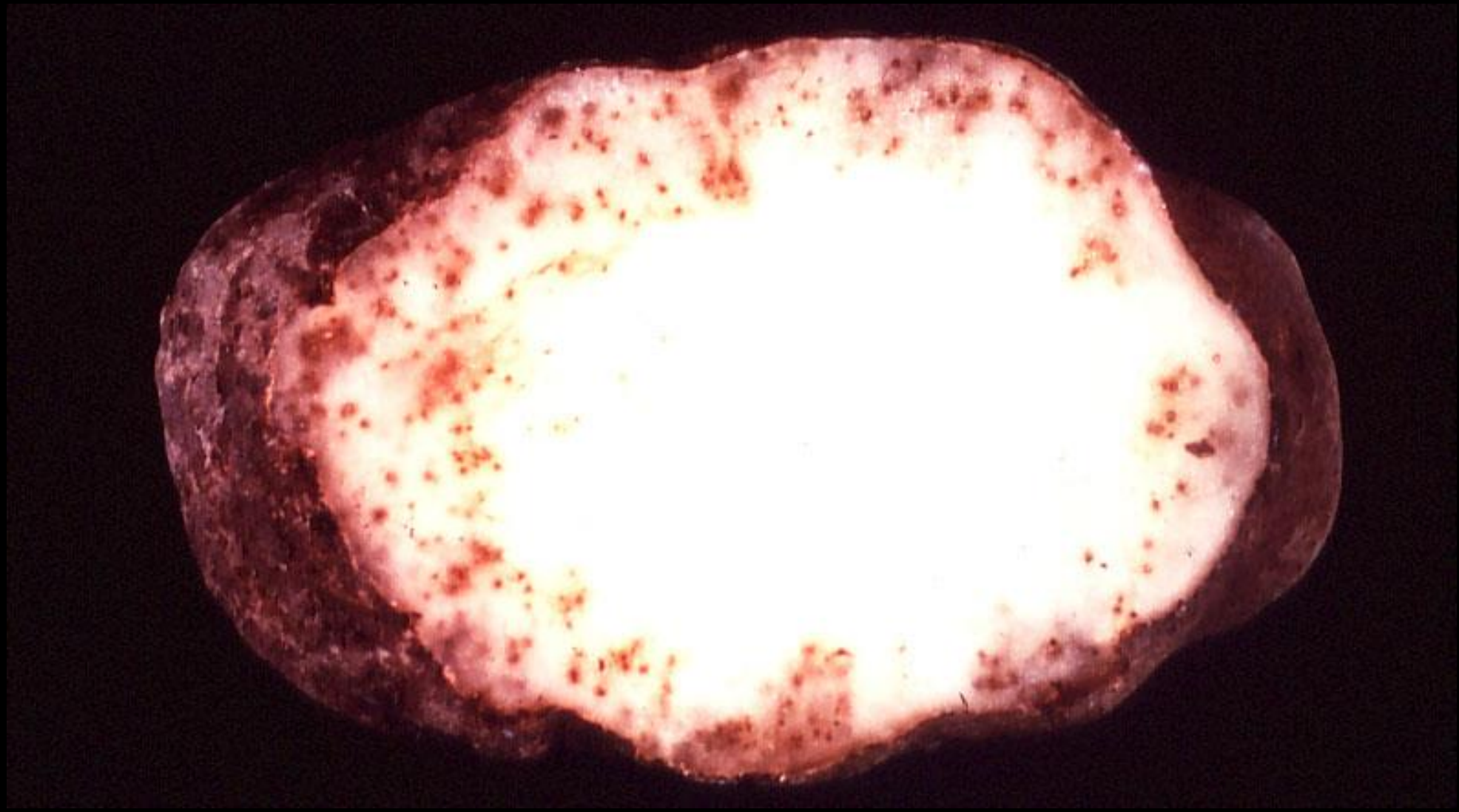
RKN infected wheat

RKN infected Apples

RKN infected Tobacco-NC

Nematode infected root-FL

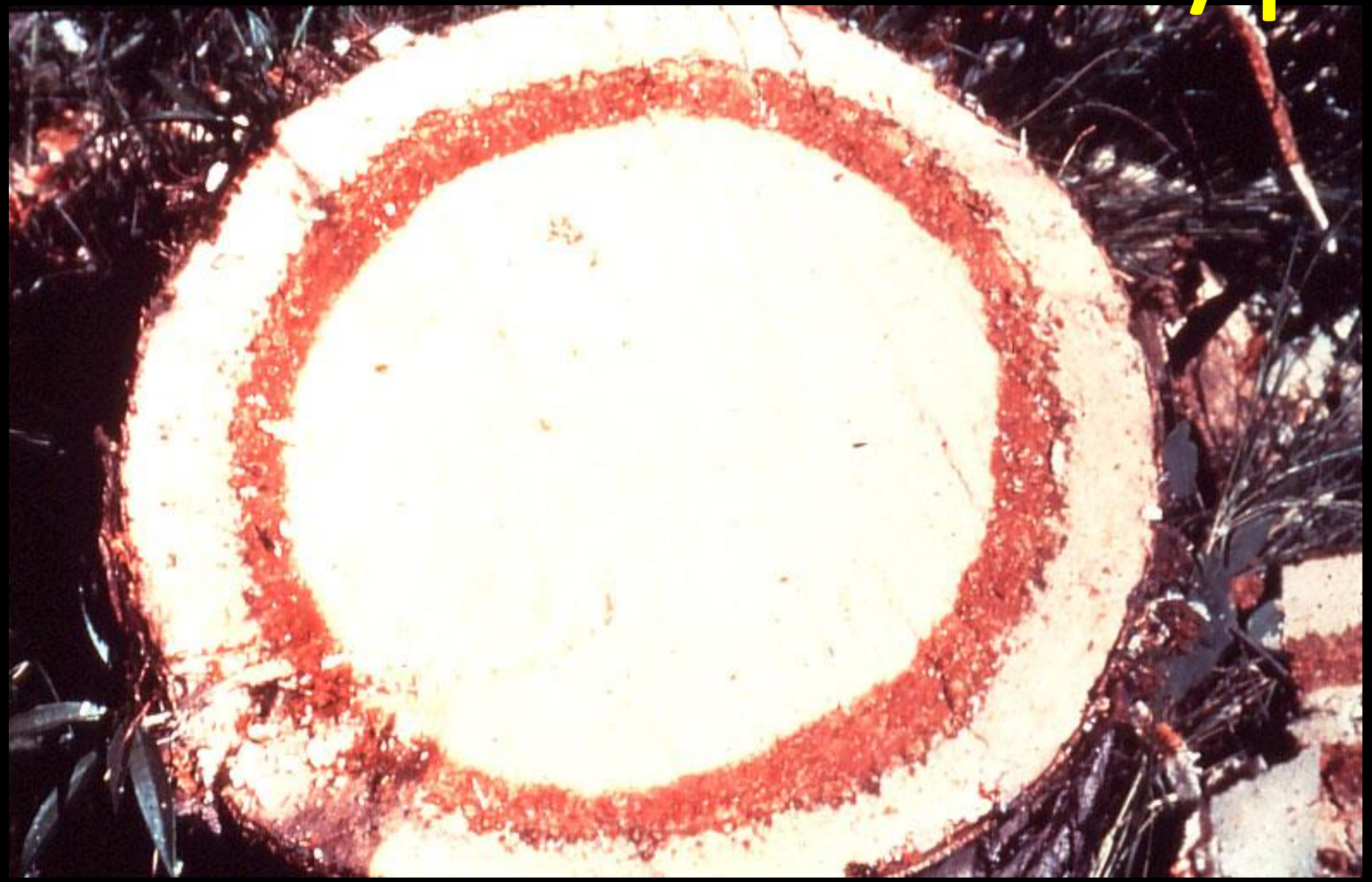
RKN infected Irish Potatoes



RKN infected Carrots

RKN infected Vegetables-FL

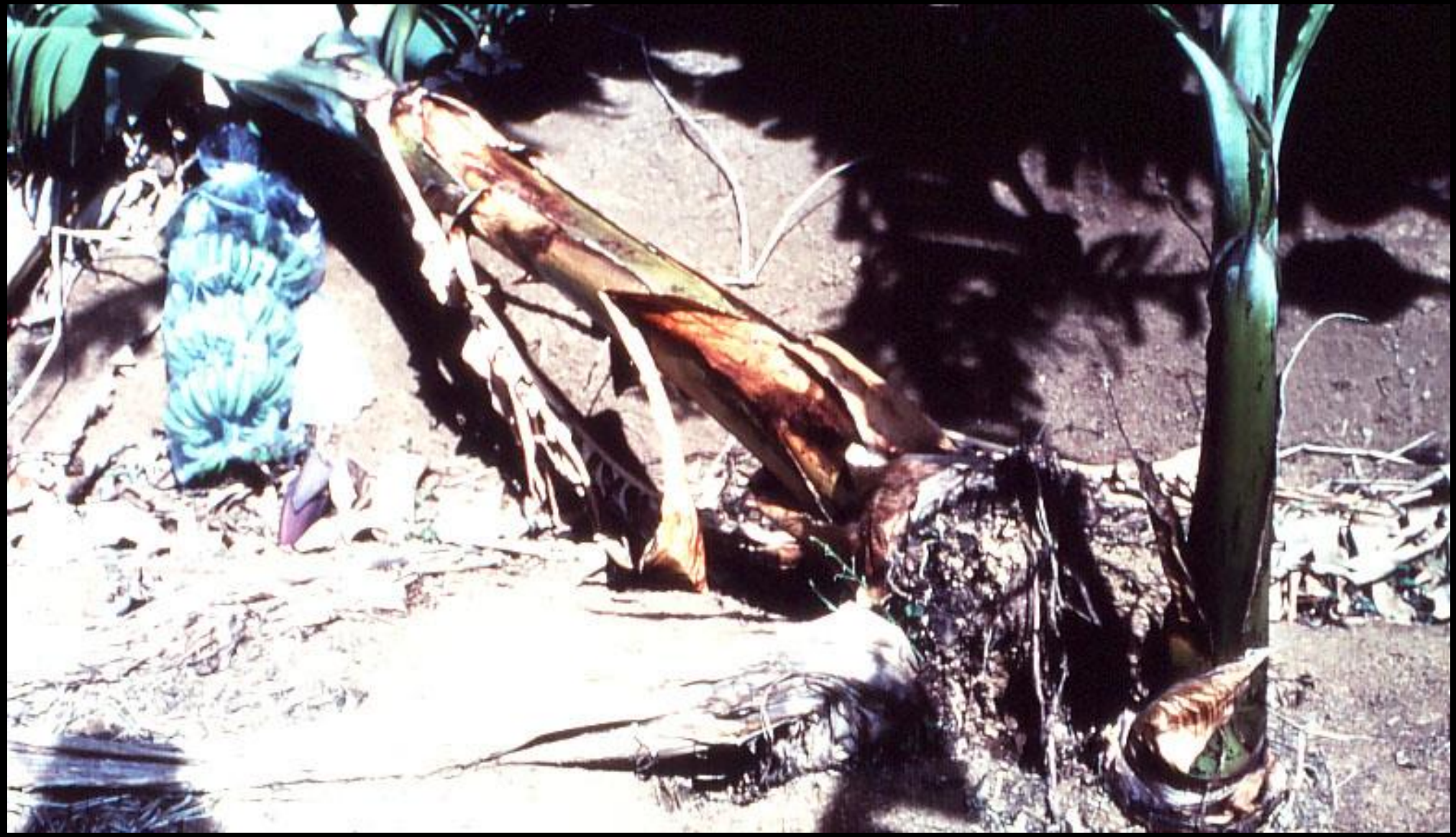
Nematode infected C/palm



Nematode infected Corn-IN

Nematode infected Citrus-FL

Nematode infected Bananas



Nematode infected Turf grass

Management Strategies

- Rarely destroy all phyto-nematodes
- Objective:
  - reduce pop to levels below which economic damage occurs
  - Integrated Ecological approach:
    - Prevention
    - Avoidance
    - Suppression

Prevention

Prevention

- Sound agronomic & crop husbandry
  - Preventive pre-planting activities critical
  - Sample site before planting
  - Timely planting
  - Effective weed control
  - Good soil management
  - Sanitation – cleaning of equipment to prevent spread of nematodes

Avoidance - Crop Resistance

Crop	Resistant variety
Bean, Butter (Lima)	Nemagreen
Bean, Snap	Bountiful
Pea, English	Wando
Pea, Southern (Cowpea)	California Blackeye
Pepper, Bell	Charleston Belle
Pepper, Hot	Carolina Cayenne
Sweet Potato	Jewel
Tomato, Cherry or Grape	Apero F1
Tomato, Plum	Granadero
Tomato, Round	Amelia VR F1

Avoidance - Crop Resistance

Vegetables and Ornamentals	
Broccoli	Lima bean some varieties
Brussel sprouts	Rutabaga
Mustard	Cabbage
Garlic	Sweet corn
Leek	Peach - Nemaguard
Chives	Azalea
Ground cherry	Camellia
Asparagus	Oleander
Horse radish	

Avoidance

Avoidance

- Crop Rotation:
  - –growing a series of dissimilar types of crops in same space in sequential seasons to avoid buildup of nematodes
  - –use of poor/non-host, resistant, susceptible and tolerant crops

Crop Rotation-FL

Suppression

Suppression

- Soil amendments:
  - addition of organic matter, crop residue, animal manures, poultry litter compost
  - decomposing materials release toxic organic compounds
  - encourages release of microorganisms detrimental to nematode survival
  - use of composted manures results in good yields and improved quality produce

Suppression

- Soil amendments (contd):
  - Neem seed meal, leftover material after making neem oil adds nitrogen
  - Crab meal encourages soil microorganisms antagonistic to nematodes
  - Oyster shell flour -diatomaceous earth
  - Black walnut leaves and hulls have natural compound -juglone.

Suppression

- Soil amendments-results depend on:
  - materials used
  - composting/processing of materials
  - application rates
  - test area
  - crop rotation
  - agronomic practices
  - soil type
  - climate & environ factors

Suppression

- Trap/cover crops:
  - Marigolds release a natural compound into the soil which is toxic to RKN
  - can be tilled into soil as green manure
  - Sudan grass (related to sorghum), can be mowed and clippings incorporated in soil as green manure - adds nitrogen
  - Others:
  - Sorghum, Sunn hemp, Cowpea, Oat/Rye
  - Velvet, Jack, Hyacinth beans - suppress RKN

Trap crop – Sunn hemp

Intercrop Cowpea+Sudan grass

Intercrop Sorghum+Sudan grass

Suppression

- Fallowing:
  - ground is left unplanted for a season or more, to remove food used by nematodes
  - rest/sabbatical for soil (Exod 23:10-11)

Suppression

- Tillage:
  - –inverts, mixes soil and exposes deeper soil layers to sun, killing nematodes by desiccation
  - –cultivation of soil 2-3 times in the fall to bring nematodes to surface where exposure to sunlight will kill them
  - –can manage weeds

Suppression

- Flooding:
  - effective as a pre-plant soil treatment in flat, low-lying areas rich in mineral soils where there are seasonally high water tables and abundant water supplies.

Flooding

Suppression

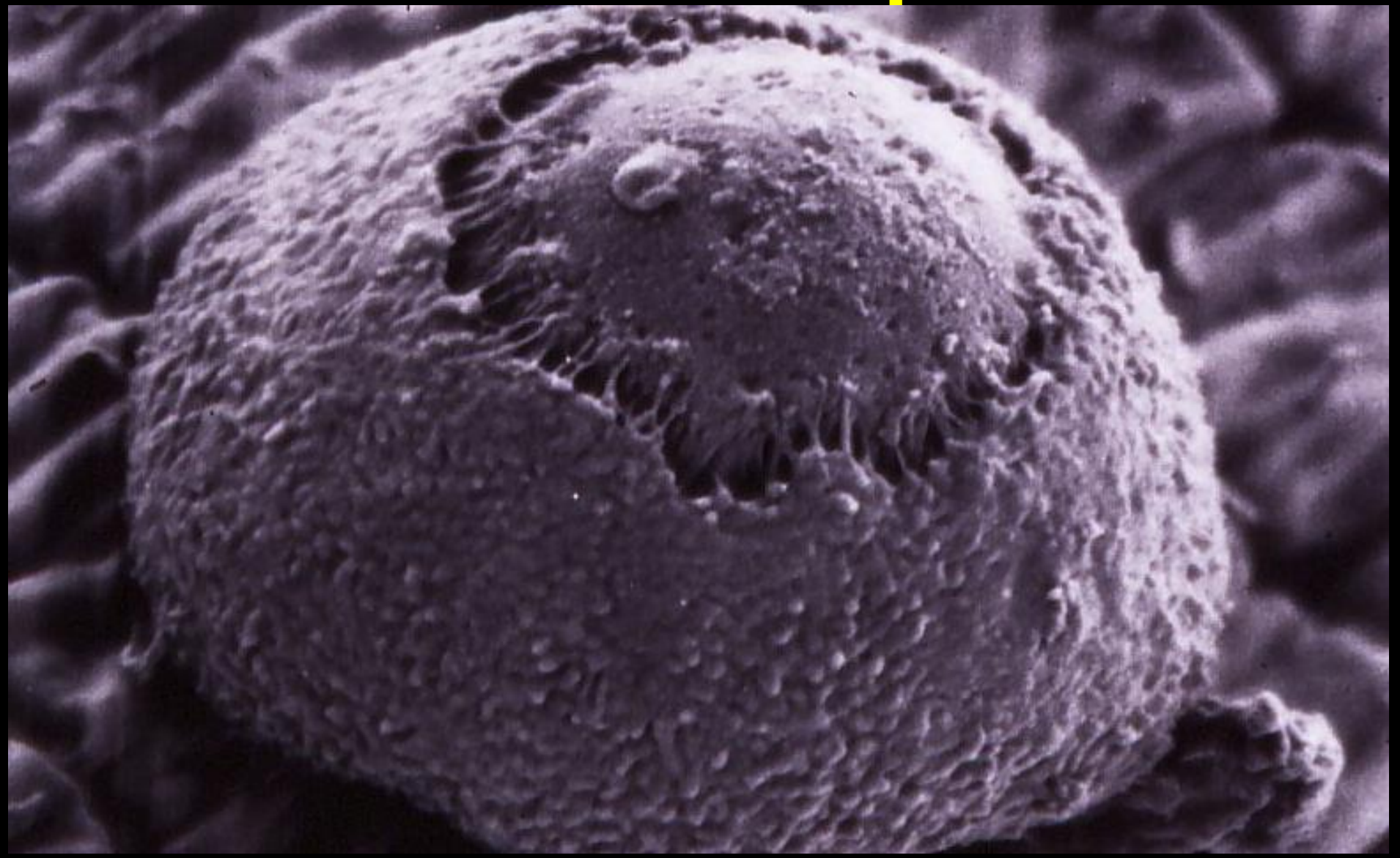
- Solarization:
  - placing clear thin, transparent plastic on top of soil during warm summer months (6-12 wks) can raise soil temperatures high enough to kill nematodes in top soil.
  - successful in (loamy to clay soils) rather than sandy soils

Solarization

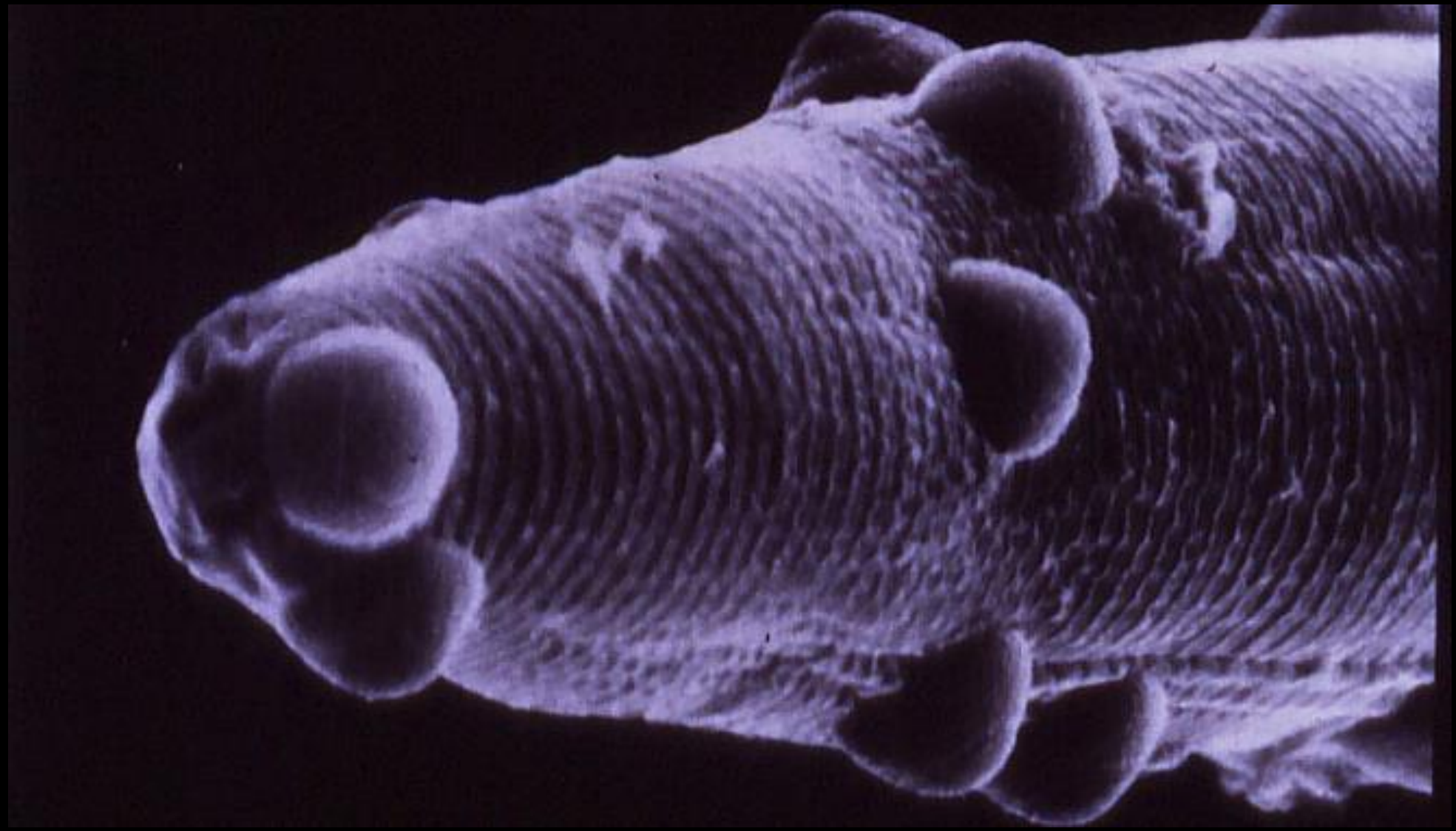
Suppression

- Biological control:
  - Bacterial nematode parasites (*Pasteuria penetrans*)
  - Fungal parasites (*Paecilomyces* sp. *Verticillium* sp.)
  - Nematophagous fungi.
  - Nematode-trapping fungi with adhesive knobs, rings, or net structures trap nematodes and kill them.

Bacterial spore

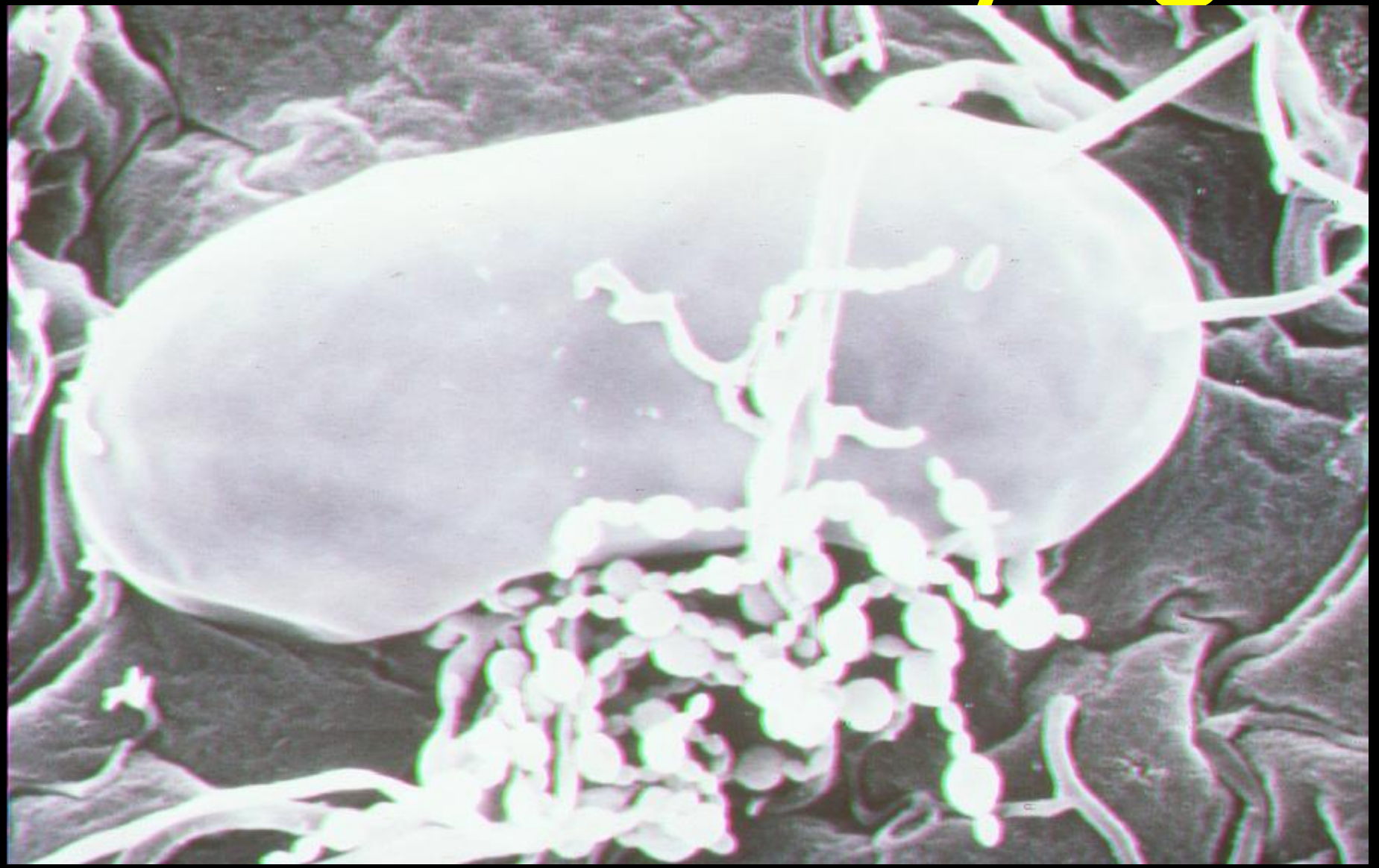


Bacterial spore



Nematode trapping fungi

Nematode destroying fungi



Begin with what farmers know, compliment, improve and slowly change

Thank you for your attention!