Nematology Section

SYNOPSIS

• Characteristics & classification of PPN intropics
• Important PPN of arable and permanentcrops in the tropics
• Principles and methods of nematodecontrol and management

INTRODUCTION
• Food and economic crises
• Climate change and global agriculture
• Nigerian Agriculture and the economy
• Covers 94m ha, 91m ha arable, < 30%under cultivation

INTRODUCTION
• Some fundamental questions
– Resource endowment a blessing?
– Have we been able to feed ourselves?
– Why the dwindling agricultural production statistics
– Why food problems? (social, climate, biotic, political)
– How long will it take to be self sufficient in foodproduction?
– What are the solutions?
– What role does nematodes play in limiting food production?

What are nematodes & where do they live?
• nematodes are worm-like organisms (animals) which can be found in the soil, salt and fresh water, plant and animal parts.
– Animal parasites nematodes (Helminths)
• Egs. Intestinal worm (*Ascaris lumbricoides*)

• The guinea worm (*Dracunculus medinensis*)
• The eye worm (*Onchocerca vulvulus*)
• *Wucheria malayi* responsible for Elephanthiasis
• The heart worm (*Dirofilaria spp*.)

What are nematodes & where do they live?
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They consist of the following groups:
– Free-living nematodes (saprophytes)
– Predaceous nematodes
– Entomogenous/entomophagus nematodes, and
– Plant-Parasitic nematodes.
Nematode Types
• **Free-Living nematodes**
(a. k. a. Saprophytic nematodes)
– Feed on decaying matter as well as their products in the soil
– Constitute no threat to crop plants
Eg Rabditida

Nematode Types
• **Predaceous nematodes**
– Prey or predate other microorganism such as bacteria, fungi and even nematodes.
– Microbivorous nematodes or microbial-feeding nematodes.
• fungivores or fungivorous nematodes (e.g. Anguinidae, Aphelenchidae, Tylencholaimidae)

• bacterivores or bacterivorous nematodes (e. g. Alaimidae, Plectidae, Leptolaimidae, Rhabditidae)

– Play vital roles in food web (nutrient recycling) as secondary decomposers

– Beneficial to agriculture especially organic agriculture.

Nematode Types

• **Entomogenous nematodes**

– The entomogenous group consists of nematodes that parasitize insects.

– Useful tool in biological control of insects (e.g. *Zonocerus variegatus*) by *Mermis* spp. of nematode.

• **Plant-Parasitic groups**

– Phytonematodes

– They are thread-like, non-segmented, microscopic, styletbearing organisms which inhabit the rhizosphere of plants

• Interacts with the plants

• Leading to reduction in growth and economic yield.

Some important data

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– 15,000 spp. Described & classified

– 2,200 spp. are plant parasitic (10 or 15%)

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• Others 2 to 5 %

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• 485,000 spp. yet to be described

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Common Name Scientific Name

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_ Complex organisational structure like higher animals

• Feeding and digestive organs

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– Tube within tubes

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– Sex organs (gonads) are also & threadlike

– Female gonad

• Ovary (Eggs develop from germ cell in the ovary)

• uterus (Fertilisation of eggs take place here)

• vulva (vagina) (Copulation)

– Male gonad

• Testes (Sperms are produced here)

• Spicule (sperms are deposited via spicule into the vagina via vulva)

• **Morphology and anatomy (Cont'd)**

– **Life cycle and reproduction**

– Six stages (egg, J1, J2, J3, J4, Adult)

– Moults (4 times)

– Egg production potentials 250 to 25,000/generation or cycle

– A cycle is 28 to 30 days in tropics

– Polycyclic nematode diseases of plants

– Reproduction is by:

• amphimixis (male + female) the most common

• Parthenogenesis (male not involved)

• Hermaphrodism (both sexes present in an individual)

Classification of plant parasitic nematodes

• Why classify?

– Knowing each nematode enhances the understanding of its biology and control

– Approaches in classification are changing

– Integration of morphology and molecular

approaches (DNA sequencing)

• Taxonomy = Science of classification

What is Classification?

• Theory and practice by which kinds of nematodes are delimited to avoid chaotic accumulation of species (the basic entity)

• Principles of classification

– Morphology

– Anatomy

– Physiology

– Ecology

– Genetics

– Biogeography

Classification system

• De Ley (2002) Developed new classification system based on:

– Molecular Biology

– Morphological analysis

• Pictorial and non pictorial identification keys

• The key uses all kinds of characters

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Example:

• Kingdom: Animalia

– Phylum: Nematoda

• Order: Tylenchida

– Family: *Meloidogynideae*

» Genus: *Meloidogyne*

» Species: *Meloidogyne incognita*

Host reaction to nematodes/factors

• **Nematode crop interactions**

– Resistant

– Tolerant

– Susceptible

– Hypersusceptible

• **Environmental factors**

– Temperature

– Soil

– Microbes

• **Host nutrition**

Nematode-plant interactions

• **Crop damage by nematodes**

– Physical injury

– Enzymatic/Physiological/Chemical Changes

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• Above ground.

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– Economic threshold level

– Crop loss assessment

• Direct (Experimentation & surveys)

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• **Nematode basis**

• **Crop basis**

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• Soybean (40%) } RKN disease caused by *Meloidogyne* spp.

• Cowpea (25%)

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• **Exclusion -** is a principle aimed at preventing the spread of pest/disease

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• **Resistance -** is genetic or innate ability to prevent, reduce or tolerate pest/disease organism

• **Therapy/treatment –** application of treatment to diseased plants

Methods of nematode management

• Cultural

• Physical

• Chemical

• Biological

• Host-Plant resistance

• Integrated nematode management

• Organic protection system, and

• Biotechnology

Cultural Method

• Any agronomic practice adopted consciously or unconsciously by farmers to improve crop yields. Although, its effectiveness on nematodes may be difficult to verify, there are evidence that cultural practices can also achieve good crop protection against nematodes. Examples include:

1. **Nematode-free planting materials**. Infested or infected seeds and plant materials, such as tubers, rootstocks, cutting and grafts, can infect an entire crop. Using healthy and clean seeds or planting materials is the best starting point in nematode management.

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3. **Ploughing the fields and burning stubble.** This method produces good seedbeds or plant beds. Turning the soil exposes nematode larva and eggs

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5**. Intercropping.** The planting of different crops or varieties within the same area diversifies the available habitat and may inhibit the expansion of nematode **especially if resistant varieties are included.**

6.Crop rotation. Varying the annual crop in the same field from year to year interrupts the specific relationship between nematodes and host plants and can prevent the spread the target nematode. For example: (i) cereals can be alternated with beans or groundnuts, sweet potatoes with cotton and cassava. (ii) Another example of crop rotation is growing maize or sorghum for one or two seasons and planting vegetables or a root crop in the third season.

NB: Crop rotation can be an effective measure against nematodes if the rotation cycle is sufficiently long and **resistant host is included**

7. **Plant nutrition-** Well-balanced fertilizer application results in healthy plants. Organic fertilizer, which improves the physical and microbial properties of soils, is better than inorganic fertilizers.

8. **Farm/Tool sanitation/hygiene**. Sanitation in storage areas, farmyards and fields is also a principal means of preventing nemaodes. They aim at reducing initial inocula.

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Chemical Method

• Synthetic nematicides are routinely used to control nematodes

• Quick action- The major advantage is that synthetic pesticides are quick in action. However, they have been found to have the potential to harm humans, livestock and wildlife. They can pollute the environment and destroy beneficial organisms and there is also growing concern about the increasing resistance of pests to pesticides.

• To optimize the timing and efficacy of nematicides against target nematodes and to minimize the potential detrimental effects on beneficial species, other non-target organisms and the natural environment, it is important to know their general mode of action.

Mode of action

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2 Systemic nematicides move through the plant's vascular system. They are absorbed by the nematodes that feed on the leaves, stems, fruits or roots of treated plants.

Biological Control

• Use of natural enemies/other organisms to control nematodes:

(i) *Trichoderma* spp.

(ii) *Dactylella* spp.

(iii) *Mycorryhza*

Host-Plant Resistance

• Resistant varieties are one of the important components of nematode management and can easily be combined with other control methods.

• In the field, however, crop resistance to nematodes can eventually break down.

• Therefore, plant resistance breeding programmes continuously select new varieties to replace older ones.

Nature of resistance:

1. Horizontal resistance is polygenic resistance
2. Vertical resistance is monogenic resistance

Biotechnology

• Biotechnology is the application of molecular biology in agriculture, environment and health.

• This implies improvement of the genetic traits of the cell (of plant, animal, bacterium or fungus) by exploiting recombinant deoxyribonucleic acid (DNA) and other molecular technologies inorder to develop improved methods and modified organisms.

• Biotechnology has already yielded nematode-resistant, plants in developed agriculture.

Organic approach

• Organic nematode management (OPM) describes a system that would mimic and optimise natural processes and products (holistic).

• Encourages growth and diversity of soil fauna and flora with beneficial and/or antagonistic effects on nematode pests.

• OPM is not IPM Integrated Nematode Management

• INM attempts to combine 2 or more methods of nematode managements

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(i) *Trichoderma* spp.

(ii) *Dactylella* spp.

(iii) *Mycorryhza*

Host-Plant Resistance

• Resistant varieties are one of the important components of nematode management and can easily be combined with other control methods.

• In the field, however, crop resistance to nematodes can eventually break down.

• Therefore, plant resistance breeding programmes continuously select new varieties to replace older ones.

Nature of resistance:

1. Horizontal resistance is polygenic resistance
2. Vertical resistance is monogenic resistance

Biotechnology

• Biotechnology is the application of molecular biology in agriculture, environment and health.

• This implies improvement of the genetic traits of the cell (of plant, animal, bacterium or fungus) by exploiting recombinant deoxyribonucleic acid (DNA) and other molecular technologies inorder to develop improved methods and modified organisms.

• Biotechnology has already yielded nematode-resistant, plants in developed agriculture.

Organic approach

• Organic nematode management (OPM) describes a system that would mimic and optimise natural processes and products (holistic).

• Encourages growth and diversity of soil fauna and flora with beneficial and/or antagonistic effects on nematode pests.

• OPM is not IPM Integrated Nematode Management

• INM attempts to combine 2 or more methods of nematode managements