EVALUATION OF NEMATODE PROBLEMS (NEMATODE DISEASE DIAGNOSIS).

- ✓ Systematic surveys a soil & various crop types using suitable sampling and array techniques are necessary to determine the general census of plant-parasite nematode communities in an area;
- ✓ It is very essential for nematologists to spend most time in the field to learn which crops are showing symptoms of nematode attack and how they are being damaged.
- ✓ The objective of the survey must be clearly defined before the survey. Generally it is very important to conduct a pilot survey for nematode problem that is regional. Seek the assistance of statistician who would tour the diseased area.
- ✓ In ranking nematode problems according to the economic importance of the crops & yield reduction due to the pathogen you should:

- Consider field and lab works necessary to identify the disease agents and the degree of crop infection
- Identify and qualify losses including yield reduction, loss of crop quality and detrimental residual effects in soil or seed. Economic thresholds have to be determined for each crop.
- Conversion of losses into economic terms
- Consider available mgt options and their degrees of effectiveness.
- Estimate costs & benefits.
- Compare costs & benefits with those incurred under alternative management strategies

2. Vectors of plant pathogens

- ✓ Up to 6% of plant viruses are transmitted by plant-parasitic nematodes particularly those belonging to the order Dorylaimida.
- ✓ For example Tobraviruses are naturally transmitted by plant-parasitic nematodes in the genera *Trichodorus* and *Paratrichodorus*. This group of nematodes possesses long stylets and is ectoparasites.

- ✓ During their feeding activities of these nematodes, they acquire virus particles from the sap of virus-infected root cells.
- ✓ Upon withdrawal of the stylet from root cells, the viruses are retained on the cuticle lining of the nematode Pharyngeal wall. Subsequently upon salivation of pharyngeal secretion the nematode releases the virus particles unto new cells or plant.
- ✓ Other important genera of nematode vectors of soil-borne plant viruses include *Xiphinema Longidorus* and *Paralongidorus*. *X*. index is suspected to be responsible for the transmission of Grapevine fan leaf virus disease while *X. basiri* appears to be a possible vector of cowpea mosaic virus in Nigeria.
- ✓ *Anguina tritici* are involved in the transportation of spores of *Dilophospora alopecuri* (fungus) on cereals.
- ✓ Nematodes can also interact with other pathogens to cause mirage of untold damages and severe loses to crops.

Bio-control agents

- ✓ Some nematodes are useful in biological control of insect pests and other pathogens affecting crop production and food supply.
- ✓ The use of entomophagus nematode to control insects in agriculture is well known throughout the world.
- ✓ E.g. *Aphelenchus avenae* feed extensively on several fungi associated with diseased root.

3. Interactions with other plant pathogens

SYNERGISM.

- ➢ Synergism is a phenomenon, which refers to a combined infection being more serious than individual infection. *Fusarium* wilt is caused by *Fusarium spp*. However, in association with *Meloidogyne spp*. it results in infection more severe than either *Fusarium spp* or

Meloidogyne spp can cause. Plant-parasitic nematodes may serve as mechanical wound agents or breaker of disease resistance sometime they provide necrotic infection court.

- During penetration, plant-parasitic nematode provides entry point on intact surfaces by forth and backward thrusting of the stylet.
- This entry point aids the entrance of other plant pathogens already present. *Pseudomonas solanacearum* are often assisted by *M. incognita* to gain entrance to cause vascular wilt of tomato.

✓ Other examples are: *Pratylenchus penetrans* assists *Verticillium albo-atrum* to enter and to proliferate the roots of eggplants.

✓ *S. bradys* predisposes yam tuber to *Aspergillus niger* which has no potential for self-establishment.

✓ Vascular wilt of tobacco caused by *Pseudomonas* and *Fusarium* wilt of tomato are assisted by *Meloidogyne spp*.

- Nematode-plant-pathogen interaction may also be deterrent to plant disease. Stem rot of rice caused by *Leptosphaeria salvicnii* is restricted by *Aphelenchoides besseyi*.
- Sometimes the interaction may be detrimental to the nematodes. Fungal hyphae have been associated with the destruction of giant cell preventing developing female juvenile from attaining full adult stage.

Terminologies in Nematology

- **Nematology –** study of nematodes
- **Nematodes –** Microscopic, wormlike animals that live saprophytically in water or soil or as plant or animal parasites
- **Principles –** ideology, standard, rule, tenet, assumptions
- **Parasite –** organism which derives part or all its nutrition from another organism called Host
- **Pathogen -** an organism able to cause disease in a particular host or range of hosts
- **Pathogenecity –** Ability to cause disease

- **Perineal pattern –** cuticular folds and annules around the tail, anus, phasmids and vulva in *Meloidogyne* females
- **Annulation -** series of tranverse depressions on the cuticles of a nematode
- **Cuticle –** membraneous on outer/external wall of epidermis made up of wax or cutins for protection of nematodes against chemical and physical dangers
- **Pathogenecity –** Ability to cause disease
- **Perineal pattern –** cuticular folds and annules around the tail, anus, phasmids and vulva in *Meloidogyne* females
- **Annulation -** series of tranverse depressions on the cuticles of a nematode
- **Cuticle –** membraneous on outer/external wall of epidermis made up of wax or cutins for protection of nematodes against chemical and physical dangers
- **Resistance –** Ability to retard or withstand effect of invading pathogen. i.e. prevent reproduction/development of the organism
- **Susceptible –** Inability of the host to defend itself against or to overcome the effects of invasion by pest/pathogen
- **Symptom –** a visible or detectable abnormality arising from disease/infection
- **Sterilisation –** a process of rendering a substrate devoid of devoid of all living organisms
- **Pasteurisation –** Process of selectively killing specific organism leaving others alive

LIFE CYCLE OF PLANT-PARASITIC NEMATODES

Three basic types of reproduction are distinguishable viz;

(1) Amphimixis – This involve cross-fertilization between male and female.

(2) Parthenogenesis : Non-sexual reproduction where male is not required for reproduction.

Most plant-parasitic nematodes exhibit this phenomenon.

(3) Hermaphrodism – male and female organs are both present in an individual.

- Plant-parasitic nematodes have a simple life cycle of six basic stages.
- The life cycle of plant-parasitic nematode begins with egg, followed by four larval or juvenile stages, and an adult.
- Usually the embryo develops within the egg to produce the first juvenile, which upon first molt produces the invasive (infective) second stage juvenile before hatching. Four molts, one each accompany each juvenile stage.
- The nematode is bigger in each successive stage than the preceding stage (Fig. 1.)

Egg J1 M1 J2 (hatch) M2 J3 M3 J4 M4 Adult

Where;

J1 - J4 = Second-stage to 4th stage juveniles

M1 - M4 = 1st molt to 4th molt.

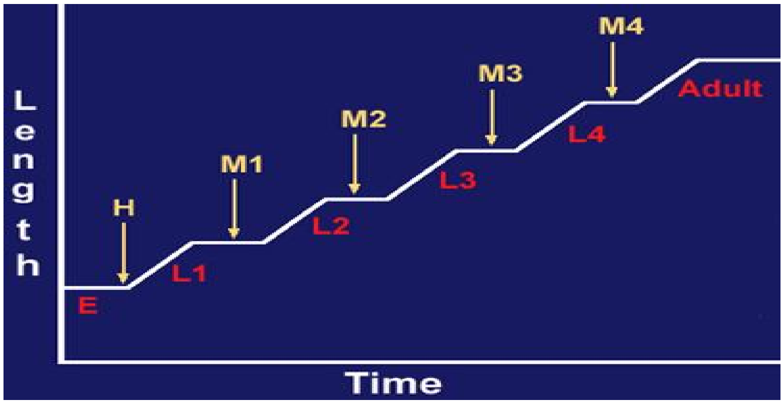

Fig. 1. Life cycle of a typical plant-parasitic nematode.

L1 – L4 = Larval stages 1 to 4 (synonymous with juvenile stages 1 to 4)

- However depending on the host parasite relationship (secondary endoparasite, migratory endoparasite and migratory ectoparasites) there may be possible modifications to the typical life cycle demonstrated above.

1. SEDENTARY ENDOPARASITES.

- Sedentary endoparasitic phytonematodes include *Anguina tritici Tylenchulus semipenetrans Heterodera* spp. and *Meloidogyne* spp.
- Life cycle of *Meloidogyne* spp. reveals that infective second stage juvenile hatches from the egg and find feeding site within the root. J2 will moult to J3, then to J4 and finally adult.
- As the nematode become sessile, plant cells around the head of the invading nematode enlarge to form nurse or giant cells.
- Adult females will begin to lay eggs which will be held in gelatinous matrix at the posterior end of the body. The egg mass may be within the root or partly or wholly exposed on the root surface. The gelatinous matrix will dissolve to release the eggs into the soil and the life cycle begins all over again.
- The eggs are usually oblong in shape and brownish in colour.

- It takes 23 – 30 days to complete its life cycle depending on temperature (27°C). It is takes up to 57 days at 20 °C.
- Reproduction is parthenogenetic.

Two or several generations can occur in the life of the host depending on the span of the crop. Life cycle of a typical sedentary plant-parasitic nematode is as shown on page 18. Note *Meloidogyne* spp. exhibits sexual dimorphism i.e. adult female are permanently immobile and sacchate in shape while adult males are temporally sedentary and vermiform

2. MIGRATORY ENDOPARASITES.

✓ Migratory endoparasitic nematodes include *Aphelenchoides spp, Pratylenchus spp, Ditylenchus*. Except the egg, any stage of life cycle of this group of nematodes can move into, through and out from the host tissues. *Pratylenchus* reproduces by mitotic parthenogenesis. Female usually lay in soil or in root tissue eggs singly. Eggs will hatch to larvae within 4-8 days.

✓ The larva will undergo four molts the first in the egg to become adult within the feeding period, Completion of the one generation varies depending especially on temperature, being 4 weeks at 27 – 30 °C or 14 weeks at 5 – 10 °C on the same crop. The entire life cycle can occur in root.

✓ There may be modifications in some migratory endoparasites where eggs may be laid only in the soil. Since most stages are migratory, it implies that second stage juvenile (J2) to adult can emerge and re-infect the root at any point.

ECTOPARASITES.

✓ Ectoparasitic nematodes are generally migratory. Although some have very long stylets that enable them to feed deeper in the root, most feed superficially at or very near the root tip or even on root hairs. Genera of nematodes belonging to this category include, *Trichodorus, Xiphinema, Longidorus, Helicotylenchus, Paratylenchus, Hemicycliophora* etc.

- ✓ All the six basic stages of development of nematodes are well represented in ectoparasites. However, the female lays egg while free in the soil and not in or on the host. These multiple stages do not initiate feeding as the case with migratory and sedentary endoparasites.

Population dynamics of nematodes and their distribution in space and time

- ❑ Farmers need to know the risk or otherwise of nematode s to their crops. Will low population result in small (or insignificant crop loss) or high (dangerous loss?)
- ❑ Pathogenicity –damage caused by nematode while population growth refers to rate of increase. What factor could cause or influence nematode population growth? Seasonal growth?
- ❑ COMMUNITIES - This refers to the total array (collection/group) of organisms (birds, insects, mammals, etc) living in one type of environment (location/area).
- ❑ Energy pathway – this there is the web of interconnections among organisms in the in which energy flows e.g. when a tree dies it is decomposed to humus in the soil by activities of various organisms. Nematodes play a significant part in the web of energy transfer both as consumers of living plant cytoplasms and as consumer s of fungi, bacteria, mites, insects, and nematodes themselves (each other) and will in turn be consumed by other decomposers and predators.
- ❑ Therefore, they not only are pests but importantly are consumers of fungi and bacteria
- ❑ Plant and animal communities vary from agricultural fields being fewer (with large population of some species) to undisturbed (virgin) land. It should be noted that the diversity of the communities usually reverts back after leaving a cultivated land to fallow for some time.
- ❑ Species types are usually regulated to maintain equilibrium

- **Populations -** Communities are usually complex in nature. However, populations of each species of the interacting organisms behave in a predictable manner. Similarly, nematode population responds to the same forces or organisms. Sometimes it rises other times it reduces
- **Population at a given time depends on the:**
- 1) Biotic Potentials of the species – which is the capacity of the nematode species to reproduce under optimal conditions without restraint imposed by the environment. Similarly, nematode population responds to the same forces or organisms. Sometimes it rises other times it reduces

NEMATODE DISTRIBUTION

IN SPACE (spatial distn) - Over the area/field

- Nematodes are never uniformly distributed in the field but occur in clusters. Several generations occur per growing season and each new generation remains close to the point of origin because of limited movement. They tend to be more in the uppermost layer of the soil except for *Trichodorus* spp.

IN TIME – Seasonal Cycles

- Soil conditions vary from season to season
- Temperature, moisture, hosts (roots) changes seasonally
- Nematodes respond to the changing conditions
- Nematodes are more in rainy season than dry spells

NEMATODE-HOST INTERACTIONS

- After the population rises to the highest level a particular force (another organism antagonostic to it or unfavourable environmental conditions) will act against it to reduce the population.

- Such that an equilibrium is therefore maintained. The exact equilibrium point is dictated by the host, the nematode, and the environment. Different population levels of PPN have different effects on crop growth
- As nematode populations rises crop host will decline until the highest level after which the crop may fail completely for the nematode population to decline. Some hosts may be more severely damaged than the other by certain species and populations of nematodes.

Attributes of host plants:

- Susceptibility to injury
- Efficiency in raising and supporting nematode population