

17 Nematology

TRIMESTER WISE DISTRIBUTION OF COURSES

I TRIMESTER

		L	P
NEMA 501	GENERAL NEMATOLOGY	2	2
NEMA 505	NEMATOLOGICAL TECHNIQUES	2	2
NEMA 503	STRUCTURAL AND FUNCTIONAL ORGANIZATION OF NEMATODES	2	2
NEMA 507	FUNDAMENTALS OF NEMATODE PHYSIOLOGY	2	1
NEMA 604	ADVANCED MOLECULAR NEMATOLOGY	3	0
NEMA 691	SEMINAR	1	0

II TRIMESTER

NEMA 502	FUNDAMENTALS OF NEMATODE BIOSYSTEMATICS	2	2
NEMA 508	NEMATODE ECOLOGY	2	1
NEMA 506	NEMATODE DISEASES OF CROPS	3	2
NEMA 511	NEMATODE PARASITES OF INVERTEBRATES	2	1
NEMA 512	PRINCIPLES OF INTEGRATED NEMATODE MANAGEMENT	2	1
NEMA 513/ AC 512/ PL PATH 521/ ENT 512/ MB 512	NANO TECHNOLOGY IN CROP PROTECTION	2	1
NEMA 691	SEMINAR	1	0

III TRIMESTER

NEMA 504	TAXONOMY OF PLANT PARASITIC NEMATODES	2	1
NEMA 509	INTERACTIONS OF PLANT PARASITIC NEMATODES WITH OTHER MICRO-ORGANISMS	2	1
NEMA 601	ADVANCES IN NEMATODES SYSTEMATICS	2	1
NEMA 510	NEMATODE MANAGEMENT	3	2

NEMA 605/ PLANT HEALTH DIOGNOSTIC AND MANAGEMENT ENT 611	2	2
NEMA 691 SEMINAR	1	0

Core Courses

M.Sc.: NEMA 501, NEMA 502, NEMA 503, NEMA 505, NEMA 507, NEMA 508, NEMA 605/Ento 611

Ph.D.: NEMA 501, NEMA 502, NEMA 503, NEMA 505, NEMA 506, NEMA 507, NEMA 508, NEMA 512, NEMA 601, NEMA 604, NEMA 605/Ento 611

NEMATOTOLOGY

Major Field : Nematology

Minor Fields : Ph.D. student shall take two minors (9 credits of course work in each) from any of the other fields outside his/her own.

M.Sc. student shall take one minor (9 credits of course work) from any of the other fields outside his/her own.

DESCRIPTION OF COURSES

NEMA 501 GENERAL NEMATOTOLOGY

(2L+2P) I

Objective

To project the importance of nematodes in agriculture and impart basic knowledge on broad aspects of plant nematology.

Theory

UNIT I

Characteristics of Phylum Nematoda and its relationship with other related phyla, history and growth of Nematology; nematode habitats and diversity- plant, animal and human parasites; useful nematodes; economic importance of nematodes to agriculture, horticulture and forestry.

UNIT II

Gross morphology of plant parasitic nematodes; broad classification, nematode biology, physiology and ecology.

UNIT III

Types of parasitism; nature of damage and general symptomatology; interaction of plant-parasitic nematodes with other organisms.

UNIT IV

Plant nematode relationships, cellular responses to infection by important phytonematodes; physiological specialization among phytonematodes.

UNIT V

Principles and practices of nematode management; integrated nematode management.

UNIT VI

Emerging nematode problems, Importance of nematodes in international trade and quarantine.

Practicals

Studies on kinds of nematodes- free-living, animal, insect and plant parasites; nematode extraction from soil; extraction of migratory endoparasites, staining for sedentary endoparasites; examination of different life stages of important plant parasitic nematodes, their symptoms and histopathology.

Suggested Readings

- Bridge, J. and Starr, J. 2007. *Plant Nematodes of Agricultural Importance*, Manson Publishing, 128pp.
- Bridge, John S., and Starr, J. 2007. *Plant Nematodes of Agricultural Importance: A Colour Handbook*, Wiley
- Chen, Z.X., Chen, S.Y., and Dickson, D.W. 2004. *Nematology: Advances and Perspectives Vol II: Nematode Management and Utilization*, CABI, October, 2004.
- Dropkin V.H. 1980. *An Introduction to Plant Nematology*. John Wiley & Sons, New York.
- Maggenti AR. 1981. *General Nematology*. Springer-Verlag, New York.
- Mai, W. F. and Lyon, H. H. 1996. *Plant parasitic nematodes: A pictorial key to genera*. Cornell University press, New York.
- Nickle, W.R. 1984. *Plant and insect nematodes*. New York: Marcel Dekker.
- Parvatha Reddy 2009. *Laboratory and Field Manual for Plant Nematology* Stadium press
- Perry RN and Moens M. 2006. *Plant Nematology*. CABI, London.
- Perry RN and Moens M. 2009. *Root Knot Nematodes*. CABI, London.
- Southey, J.F. 1986 *Laboratory manual to work with plant and soil nematodes*
- Swarup, G, Dasgupta, D.R. and Koshy, P.K. 1989. *Plant Diseases*, Anmol Publications.
- Walia R.K. and Bajaj H. K. 2003. *Text Book on Introductory Plant Nematology*. ICAR, New Delhi.

NEM 502 FUNDAMENTALS OF NEMATODE BIOSYSTEMATICS

(2L+2P) II

Objective

To sensitize the students on the theory and practices of classifying organisms with special emphasis on Phylum Nematoda.

Theory

UNIT I

Principles of Nematode systematics

UNIT II

Taxonomic position of nematodes and their relationships with allied groups; Classification and diagnosis of Nematodes upto ordinal rank (Secernentea); Classification and diagnoses of Nematodes upto ordinal rank (Adenophorea).

UNIT III

Nematode parasites of Vertebrates and Invertebrates.

UNIT IV

Classification of Plant Parasitic Nematodes; Classification of order Tylenchida and diagnoses of its Sub-orders, superfamilies, families and important genera; Orders Aphelenchida, Dorylaimida and Triplonchida and diagnosis of their important genera.

UNIT V

Molecular taxonomy

Practicals

Identification of soil nematodes belonging to diverse orders, viz., Tylenchida, Dorylaimida, Aphelenchida, Mononchida, Enoplida, Monhysterida, Araeolaimida, Cephalobida, Rhabditida, Diplogasterida; Processing of nematode specimens and preparation of permanent mount; Processing of animal parasitic nematodes for permanent mounts; Isolation of Thelastomatids from cockroaches and entomopathogenic nematodes from soil; Identification of important plant parasitic nematodes.

Suggested Readings

- Ernst Mayr and Peter DA. 1991. *Principles of Systematic Zoology*. Mc Graw Hill Book Co. New York.
- Maggenti AR. 1981. *General Nematology*. Springer-Verlag, New York.
- Siddiqi M.R. 1980. *Origin of Tylenchida*. In: Nematological Abstracts.
- Siddiqi MR. 1986. *Tylenchida: Parasites of Plants and Insects*. 1st Ed. CABI, Wallingford.
- Siddiqi MR. 2000. *Tylenchida: Parasites of Plants and Insects*. 2nd Ed. CABI, Wallingford.
- Stone AR, Platt HM and Khalil LF. 1983. *Concepts in Nematode Systematics*. Academic press, London and New York.

NEMA 503 STRUCTURAL AND FUNCTIONAL ORGANIZATION OF NEMATODES

(2L+2P) I

Objective

Familiarization with morphology, anatomy, histology, ultra-structure and functions of various organs and systems to enable the students to understand biology, physiology, evolutionary trends and classification of nematodes.

Theory

UNIT I

Introduction and general organization of nematode body; Morphology and anatomy of nematode cuticle, hypodermis, musculature and pseudocoelom.

UNIT II

Digestive system- structural variations of stoma, oesophagus, intestine and rectum in nematodes.

UNIT III

Reproductive system- Variations in female and male reproductive systems, types of reproduction, spermatogenesis and oogenesis

UNIT IV

Types and structure of excretory-secretory systems; nervous system and associated sense organs.

UNIT V

Embryogenesis, Cell lineage and postembryonic development; Process of hatching and moulting.

Practicals

Studies on variations in nematode shapes and sizes, morphological details of cuticle, cuticular markings and ornamentation, variations in stoma, oesophagus, rectum; types and parts of female and male reproductive systems, sense organs, and excretory system.

Suggested Readings

- Bird AF & Bird J. 1991. *The Structure of Nematodes*. Academic Press, New York.
- Chitwood BG & Chitwood MB. 1950. *An Introduction to Nematology*. Univ. Park Press, Baltimore.
- Chen, Z.X., Chen, S.Y., and Dickson, D.W. (2004). *Nematology: Advances and Perspectives Vol I and II: Nematode Management and Utilization*, CABI, October, 2004.
- Maggenti AR. 1981. *General Nematology*. Springer-Verlag, New York.
- Malakhov VV. 1994. *Nematodes: Structure, Development, Classification and Phylogeny*. Smithsonian Institution Press, Washington DC.

NEMA 504 TAXONOMY OF PLANT PARASITIC NEMATODES

(2L+1P) III

Objective

Development of skills in the identification of plant parasitic nematodes up to genera and species levels.

Theory

UNIT I

Classification of Phylum Nematoda- Orders of Class Adenophorea and Secernentea; Diagnosis of Order Tylenchida- Sub order Tylenchina, Hoplolaimina and Criconematina; Infraorders Tylenchata and Anguinata- their families and genera; Diagnosis of Aphelenchida, Dorylaimida and Triplonchida

UNIT II

Diagnosis of genera and families of Suborders Hoplolaimina and Criconematina.

UNIT III

Orders Aphelenchida, Dorylaimida and Triplonchida with emphasis on plant parasitic genera.

Practicals

Identification of common plant parasitic nematodes belonging to Orders Tylenchida, Dorylaimida and Aphelenchida up to generic level; and up to species level for major nematode pests (root-knot, cyst nematodes etc.) of crops.

Suggested Readings

- DeCramer W. 1995. *The Family Trichodoridae: Stubby Root and Virus Vector Nematodes*. Kluwer Academic Press, Dordrecht.
- Geraert E. 2006. *Nematology Homograph and Prospectus*. Brill.
- Hunt DJ. 1993. *Aphelenchida, Longidoridae and Trichodoridae – their Systematics and Bionomics*. CABI, Wallingford.
- Siddiqi MR. 2000. *Tylenchida: Parasites of Plants and Insects*. 2nd Ed. CABI, Wallingford.

NEMA 505 NEMATOLOGICAL TECHNIQUES

(2L+2P) I

Objective

Understanding the principles, theoretical aspects and developing skills in nematological techniques.

Theory

UNIT I

Principles and use of light, scanning and transmission electron microscopes, and other laboratory equipments.

UNIT II

Methods of survey, surveillance and *sampling* for nematodes; Extraction of active and sedentary nematodes from soil and plant tissues; Nematode population estimation.

UNIT III

Principles and techniques of killing, *anaesthetizing*, fixing, clearing and mounting (*temporary or permanent*) of nematodes; preparation of perineal patterns, vulval cones of cyst nematodes, en-face views and body section of nematodes; Sketching and measurement of nematodes using camera Lucida/drawing tube and image analyzer; Microphotography of nematodes.

UNIT IV

Methods for raising of pure culture of plant and insect parasitic and microbivorous nematodes. Experimental techniques for studying pathogenicity. Evaluation of nematicides. Screening of crop varieties for locating sources of resistance. Staining nematodes in plant tissues; microtomy for histopathological studies; collection of plant root exudates and their bioassay; preparation of plant materials for exhibition.

UNIT V

Spectrophotometry, electrophoresis, PCR, Chromatography, Centrifugation

Practicals

Baermann's funnel technique; Cobb's sieving and decanting technique; Oostenbrink elutriation technique ; Cotton wool filter technique, Two flask Technique; Estimation of nematode population in soil; Picking tools and nematode handling; Root incubation method; Centrifugation floatation technique ; Root knot nematode- Eggmass collection and their hatching, Extraction of root knot with NaOCl; Inoculation of nematodes in pots and maintenance of nematode culture; Observation on and extraction of different stages of root knot nematodes from roots; Lactophenol method for staining of nematodes in plants; Byrd's method for staining of nematodes in plants; Microscope Handling and taking photos through microscope; Cyst extraction with Fenwick can; Cyst extraction through Sieve; Cyst population estimation; Drawing and measuring nematodes; Temporary mount preparation; Permanent mount preparation special preparation of nematodes - perineal patterns, vulval cones, en-face and body sections; collection of root exudates, preparation of exhibits of nematode diseased plant material, in vitro culturing techniques of nematodes- callous culture, excised root and carrot disc techniques. Protein extraction and estimation, DNA extraction and estimation, PAGE, Agarose gel electrophoresis, DNA amplification using PCR.

Suggested Readings

Ayoub SM. 1981. *Plant Nematology – An Agricultural Training Aid*. NemaAid Publications.

Barker KR, Carter CC & Sasser JN 1985. *An Advanced Treatise on Meloidogyne*. Vol. II. *Methodology*. International *Meloidogyne* Project, NCSU, Raleigh.

Southey JF. 1986. *Laboratory Methods for Work with Plant and Soil Nematodes*. HMSO, London.

Zuckerman BM, Mai WF & Harrison MB. 1985. *Plant Nematology Laboratory Manual*. Univ. of Massachusetts.

Objective

To know the diseases and their symptoms caused by various plant parasitic nematodes in different field crops, horticultural and plantation crops.

Theory

Causal organism, distribution, host range, biology, nature of damage, symptoms, interaction with other organisms and management of major diseases caused by important nematodes in different crops:

UNIT I

Cereal crops (Rice, wheat, barley, oat, maize, sorghum): Ear-cockle and tundu disease of wheat, molya disease of wheat and barley; rice-root nematode, root-knot and cyst nematodes, ufra and white tip disease of rice; lesion and cyst nematodes of maize and sorghum.

UNIT II

Pulses, oilseed, Cash, and fibre crops (Pigeonpea, mungbean, cowpea, chickpea, groundnut, castor, soybean, sunflower, sesame, Sugarcane, sugarbeet, Cotton, jute): Pigeonpea cyst nematode, root-knot, reniform nematodes, lesion, lance nematodes, sugarbeet cyst and soybean cyst nematode problems.

UNIT III

Vegetable crops (Tomato, brinjal, chillies, carrot, onion, garlic, okra, cucurbits, potato): root-knot disease, reniform nematode, potato cyst nematode; stem and bulb nematode; nematode problems in protected cultivation.

UNIT IV

Horticultural and Ornamental crops (Citrus, grapes, peach, strawberry, papaya, mushroom, rose, chrysanthemum, zinnia, gladiolus, tuberose, crossandra, jasmine): root-knot disease, reniform nematode; slow decline of citrus, Nematode problems in mushroom.

UNIT V

Plantation crops & Medicinal and aromatic plants (Banana, pepper, betelvine, coconut, arecanut, palm, cocoa, tea, coffee, rubber, condiments): burrowing nematode infestation in banana, spices and condiments, root-knot and lesion nematodes of coffee and tea, red ring disease of coconut. pine wilt disease.

Practicals

Study of symptoms of cyst, root-knot, lesion, earcockle, citrus, burrowing, reniform, stem and bulb, white tip, mushroom, leaf and bud, golden nematode damage in different crop plants. Visual field diagnosis of nematode problems through study tours.

Suggested Readings

- Bridge, J. and Starr, J. 2007. *Plant Nematodes of Agricultural Importance*, Manson Publishing, 128pp.
- Bridge, John S., and Starr, J. 2007. *Plant Nematodes of Agricultural Importance: A Colour Handbook*, Wiley February 2007.
- Chen, Z.X., Chen, S.Y., and Dickson, D.W. 2004. *Nematology: Advances and Perspectives Vol II: Nematode Management and Utilization*, CABI, October, 2004.

- Ciancio, A. and Mukerji, K. 2008. *Integrated Management and Biocontrol of Vegetable and Grain Crops Nematodes*, Springer, 2008.
- Kenneth, R.H. and Nelson P.E. 1997. *Compendium of Chrysanthemum Diseases*, APS
- Luc, M. Sikora, R. and Bridge, J. 2005. *Plant Parasitic Nematodes in Subtropical and Tropical Agriculture*, 2nd Edition, CABI May 2005.
- Parvatha, Reddy. P. 2008. *Diseases of Horticultural Crops: Nematode Problems and their Management*, Scientific Publishers, 380pp.
- Perry, R N and Moens, M 2006. *Plant Nematology*, CABI May 2006
- Perry, R. N., Moens, Maurice and Starr, J.L. 2009. *Root-knot Nematodes*, CABI Publishing, 496pp.
- Swarup, G. and Dasgupta, D.R. 1986. *Plant Parasitic Nematodes of India*. Ravi Sachdeva at Allied Publishers Pvt. Ltd., New Delhi.
- Swarup, G., Dasgupta, D.R. and Koshy, P.K. 1989. *Plant Diseases*. Anmol Publishers.

NEM 507 FUNDAMENTALS OF NEMATODE PHYSIOLOGY

(2L+1P) I

Objective

To understand the basic mechanism of host finding, metabolic pathways, growth and development in nematodes.

Theory

UNIT I

Principles of physiology. History and importance of nematode physiology in management of plant parasitic nematodes.

UNIT II

Cell structure, Cell organelles, structure of cell organelles, Physiological functions of cell organelles; Chemical composition of nematodes. Pseudocoelomic fluid and its function.

UNIT III

Host finding mechanism, Feeding mechanisms and physiology, Hydrolytic enzymes of nematodes and their role in physiopathology of host.

UNIT IV

Metabolism of carbohydrates, proteins and fatty acids; Physiology of digestion; Physiology of excretion, osmoregulation, permeation dynamics, steroid and hormonal regulation in nematodes

UNIT V

Physiology of growth, development, reproduction, molting and hatching

Practicals

Solutions, buffers, Isolation of nucleic acids and proteins from plants and nematode juveniles, quantification of nucleic acids and proteins from plants and nematode juveniles, molecular weight estimation of nucleic acids and proteins on agarose and polyacrylamide gels, RFLP of plant and nematode DNA, RAPD of nematode and plant DNA using PCR technique

Suggested Readings

- Fenoll, C, M. W. Grundler, Stephan Ohl 1997. *Cellular and molecular aspects of plant-nematode interactions*. Kluwer Academic, Dordrecht.
- Lee D.L. 2002. *The Biology of Nematodes*, Taylor & Francis, London, UK.
- Nelson, D.L and MM Cox 2008. *Principles of Biochemistry*. W H Freeman and Company, New York, USA.
- Perry, R.N. and D. J. Wright 1998. *The physiology and biochemistry of freeliving and plant parasitic nematodes*. CABI, Wallingford, UK.
- Perry, R.N. and M. Moens 2006. *Plant Nematology*. CABI , Wallingford UK.

NEMA 508 NEMATODE ECOLOGY

(2L +1P) II

Objective

To understand the life of plant parasitic nematodes in their environment; their survival strategies, and how to exploit these for their control.

Theory

UNIT I

Definition and scope; components of environment; evolution of nematodes; ecological classification, prevalence, distribution and dispersal of nematodes.

UNIT II

Role of nematodes in the food web; habitat and niche characteristics; community analysis, ecological indices, population estimation models

UNIT III

Effects of abiotic and biotic factors on nematodes; Environmental extremes and nematode behaviour, survival strategies in nematodes and nematodes as bioindicators.

UNIT IV

Modeling population dynamics and relations with crop performance; ecological considerations in nematode management, data interpretation and systems simulation.

UNIT V

Impact of climate change on nematode pest problem.

Practicals

Study of nematode fauna in varied agro-ecological systems, community analysis of nematode populations, laboratory exercises on influence of abiotic factors on movement and hatching, greenhouse experiments on effect of abiotic factors on nematode populations and plant growth.

Suggested Readings

- Been, Thomas H. and Corrie H. Schomaker 2006. *Distribution patterns and sampling* . p302-324. (In . Plant Nematology , eds. Perry, R.N. and Maurice Moens), CABI Publication.
- Gaur H.S. 1994. Ecology of Plant Parasitic Nematodes (p 31-65) In *:Nematode Pest Management in crops* (Eds. D.S. Bhatti & R.K. Walia) CBS Publishers .

- Chen, Z.X., Chen S.Y. and D.W. Dickson *Nematology Advances and Perspectives Volume I Nematode Morphology, Physiology and Ecology*). CABI Publication
- Jones F.G. W. and R.A. Kempton 1982. *Population dynamics, population models and integrated control*.p. 333-361. (In *Plant Nematology* ed. Southey, J.F).
- Jones F.G. W. 1982. *The soil plant environment* (In *Plant Nematology* ed. Southey, J.F) 46-62.
- Jones F.G.W 1975. *Soil as an environment for Nematodes*. Ann. Appl. Biol.79:113-139.
- Lee DL. 2002. *The Biology of Nematodes*. Taylor & Francis, London.
- Mc Sorley Robert and Larry W. Duncan 2003. *Population dynamics* p 469-486. .(In Chen, Z.X., Chen S.Y. and D.W. Dickson *Nematology Advances and Perspectives Volume I Nematode Morphology, Physiology and Ecology*). CABI Publication
- Michael J. Wilson and Thomas Kakouli Duarte 2009. *Nematodes as environmental indicators* .CABI Publication
- Norton DC. 1978. *Ecology of Plant Parasitic Nematodes*. John Wiley.
- Wallace HR. 1973. *Nematode Ecology and Plant Disease*. Edward Arnold,London.
- Yeates, G.W. and Brian Boag 2003. *Background for nematode ecology in the 21st Century*. p406-429.
- Zuckerman, B.M, Mai, W.F. & Rohde, R.A. 1971. *Plant Parasitic Nematodes*, Vol 1. Academic Press

NEMA 509 INTERACTIONS OF PLANT PARASITIC NEMATODES WITH OTHER MICRO-ORGANISMS (2L + 1P) III

Objective

To understand the interaction of plant-parasitic nematodes with bacteria, fungi, viruses and other organisms.

Theory

UNIT 1

Concepts, importance and types of interactions

UNIT II

Nematode – nematode interactions

UNIT III

Interaction of plant-parasitic nematodes with wilt causing, root rot and other fungal pathogens

UNIT IV

Interaction of plant-parasitic nematodes with bacteria

UNIT V

Plant-parasitic nematodes – virus interactions

UNIT VI

Interaction with other micro organisms.

Practicals

Interaction studies between plant-parasitic nematodes and plant pathogenic fungi or bacteria.

Suggested Readings

- Khan, M.W. 1993. *Nemic Interactions*. Chapman & Hall, New York.
- Lamberti, F; Taylor, C. E and Seinhorst, J.W. 1975. *Nematode Vectors of Plant Viruses*, Plenum Press, London.
- Veech, J.A. and Dickson, D.W. 1987. *Vistas on Nematology: A commemoration of the twenty fifth anniversary of the Society of Nematologists*.
- Trivedi, P.C. 1998. *Plant nematode management*. CBS Publishers and Distributors, New Delhi.

NEMA 510 NEMATODE MANAGEMENT

(3L+2P) III

Objective

Theory and practice of nematode management to prevent yield losses of agricultural crops.

UNIT I

Principles and Concept of nematode management in crops.

UNIT II

Components of nematode management; Cultural: Tillage methods, cropping system and pattern, flooding, solarization, summer ploughing, soil amendments, antagonistic and cover crops; Physical: heat, steam, hot water treatment, irradiation; Biological: Fungi, bacteria and other bioagents with their utilizations; Chemical: Types, formulations, doses, mode of action and fate of nematicides; Host resistance in nematode management.

UNIT III

Factors affecting the nematode management; Integrated nematode management; Novel methods of nematode management.

UNIT IV

Legal aspect of nematode management: Quarantine and disinfections methods

UNIT V

Probit analysis and calculation for LD₅₀ values

Practicals

Calculation of dose of nematicides, Types of chemical nematicides and their application methods, *In vitro* and *In vivo* testing of nematicides against nematodes, observation on mortality of nematodes, application and dosage of organic amendments, application and dosage of bioagents (fungal and bacterial) for nematode management.

Suggested Readings

- Bhatti D.S. and Walia , R.K. 1994. *Nematode Management in Pest crops* CBS, New Delhi.
- Brown R.H. and Kerry B.R. 1987. *Principal and practice in Nematode in Crops*. Academic Press Sydney.
- Chen Z.X., Chen S.Y. and Dickson D.W. 2004. *Nematology Advances and perspectives. Volume II Nematode Management and Utilization* and CABI.
- Perry R.N. and Moen M 2006. *Plant Nematology* CABI.
- White head A.G. 1997. *Plant Nematode Control* CABI.

Objective

To sensitize about the use of nematodes for the biological control of insects, other arthropod and invertebrate pests of crops.

Theory

UNIT I

Beneficial nematode fauna- predators, parasites of insects, molluscs and other pests; Entomophilic nematodes- important groups, types of nematodeinsect associations; taxonomic characteristics of nematode parasites of insects.

UNIT II

Host-parasite relations and life cycle of mermithids, entaphelenchids, thelastomids, sphaerularids, allantonematids and Iotonchids.

UNIT III

Entomopathogenic nematodes- *Steinernematids* and *Heterorhabditids*, their morphological characteristics, taxonomic status, biology, nematode-bacterium symbiosis and virulence mechanism.

UNIT IV

Entomopathogenic nematodes- mass multiplication techniques, formulations, field applications and efficacy, success stories.

UNIT V

Entomopathogenic nematodes- Ecological considerations, compatibility with various agrochemicals and their use in IPM.

Practicals

Isolation of EPN from soil by baiting; Collection of insects and detection of nematodes; General morphology and taxonomic outline of EPN; General microscopic features of Mermithids, Rhabditids, Thelastomatids, Diplogasterids, Tylenchids etc.; Killing, fixing, preparation of permanent mounts of EPN; Isolation and culturing of symbiotic bacteria; Formulation of EPN and symbiotic bacteria; Laboratory bioassay of EPN/bacteria against insects.

Suggested Readings

- Gaugler R & Kaya HK. 1990. *Entomopathogenic Nematodes in Biological Control*. CRC Press, Boca Raton, Florida.
- Gaugler R. 2002. *Entomophilic Nematology*. CABI, Wallingford.
- Grewal PS, Ehlers RU & Shapiro DI. 2005. *Nematodes as Biocontrol Agents*. CABI, Wallingford.
- Jairajpuri MS & Khan MS. 1982. *Predatory Nematodes (Mononchida)*. Associated Publ. Co., New Delhi.
- Woodring JL & Kaya HK. 1988. *Steinernematid and Heterorhabditid Nematodes: A Handbook of Techniques*. Southern Coop. Bull., Ark. Ag. Ext. Sta.

Objective

To familiarize the students with principles of Nematode pest management, including concept and philosophy of Integrated Pest Management (IPM). Train students in computation of ETL, implementing IPM programmes.

Theory

UNIT I

History and growth of IPM

UNIT II

Concept, ecological principles, economic threshold level and consideration of IPM

UNIT III

Tools of pest management and their integration, legislative, cultural, physical and mechanical methods; pest survey and surveillance, forecasting, types of surveys including remote sensing methods, factors affecting surveys; political, social and legal implications of IPM; pest risk analysis; pesticide risk analysis; cost-benefit ratios and partial budgeting; case studies of successful IPM programmes.

Practicals

Characterization of agro-ecosystems; sampling methods and factors affecting sampling; population estimation methods; crop loss assessment-direct losses, indirect losses, potential losses, avoidable losses, unavoidable losses, Computation of EIL and ETL; crop modeling; designing and implementing of IPM system.

Suggested Readings

- Dhaliwal GS & Arora R. 2003. *Integrated Pest Management-Concepts and approaches*. Kalyani publ., New Delhi.
- Dhaliwal GS, Ram Singh & Chillar BS. 2006. *Essentials of Agricultural Entomology*. . Kalyani publ., New Delhi.
- Flint MC & Bosch RV. 1981. *Introduction to Integrated Pest Management*. 1st Ed., Springer, New York.
- Horowitz AR & Ishaaya I. 2004. *Insect Pest Management. Field and Protected Crops* Springer, New Delhi.
- Ignacimuthu SS & Jayaraj S. 2007. *Biotechnology and Insect Pest Management*. Elite publ., New Delhi.
- Metcalf RL & Luckman WH. 1982. *Introduction of Insect Pest Management*. John Wiley & Sons, New York.
- Norris RF, Caswell-Chen EP & Kogan M. 2002. *Concepts in Integrated Pest Management*. Prentice Hall, New Delhi.
- Pedigo RL. 2002. *Entomology and Pest Management* 4th Ed. Prentice Hall, New Delhi.
- Subramanyam B & Hagstrum DW. 1995. *Integrated Management of Insect in Stored Products*. Marcel Dekker, New York.

NEMA 513/AC 512/PL PATH 512/ENT 512/MB 512 NANO TECHNOLOGY IN CROP PROTECTION (2L+1P) II

(Multidisciplinary course to be operated by the Division of Agril.Chemicals)

Objective

To enable students to acquire expertise and skill to develop agrochemical formulations with nanoparticles and to acquaint them with nanotechnology

Thoery

UNIT I

Introduction: History of nanotechnology – Origin, fundamental concepts, and molecular perspective, Nanomaterials: formation, stability and quality. Application of nanotechnology in agricultural chemicals, bio-pesticides, carriers, surfactants, formulation auxiliaries plant nutrients and related materials.

UNIT II

Effect of bioactive nano-materials on insect pests and beneficial insects.

UNIT III

Different types of nano-compounds and their use in the management of plant disease incited by pathogenic fungi , bacteria and viruses with special reference to copper, sulfur etc, Interaction of bioactive nano- materials on plant pathogens including fungi, bacteria, virus etc.

UNIT IV

Nematodes: Plant pathogenic and entomopathogenic nematodes, life cycle, Efficacy of nano chemicals against nematodes, Biotoxins from Xenorhabdus and Photorhabdus. Identification and quantification of biotoxins effective in nano-doses.

UNIT V

Microbes: Microbes of agricultural importance. Life cycle: genesis, growth, reproduction, identification and quantification. Nanotechnological application in microbiology.

UNIT VI

Nanomaterials: size, characterization, formation and stability. Tools for identification and quantitation: Particle size analyzers, nanosizers, scanning microscopes of different types. Development of nano-materials: Bottom-up and top-down approach: Chemical synthesis, sol-gel and emulsion polymerization techniques, wet milling, nano-milling. Stabilization of nanoparticles. Regulations and quality control.

Practicals

Identifications, and quantification of agricultural chemicals in conventional and nano formulations, Size determination, Quality of nano-formulations: Cold test, emulsion stability test, and suspensibility tests

Suggested Reading

Allhoff, Fritz, Lin, Patrick (Eds.) 2009. *Nanotechnology and Society*, ISBN: 978-1-4020- 6208-7, Springer Publications, UK.

Objective

Apprising of ultrastructural, cytogenetical, biochemical and molecular approaches in nematode systematics using SEM and TEM.

Theory

UNIT I

Importance of ultrastructure of nematode body wall- cuticle, hypodermis and muscles; nematode feeding apparatus, and other parts of alimentary canal in nematode systematics.

UNIT II

Importance of ultrastructure of nematode sense organs, reproductive and excretory secretory systems in nematode systematics.

UNIT III

Preparation of illustrations, keys and compendia for nematode species and other taxa.

UNIT IV

Recent advances in nematode identification- molecular, biochemical, immunodiagnostic, molecular characterization and DNA finger-printing techniques.

UNIT V

Databases and computer aided nematode identification programmes - NEMISYS (Nematode Identification SYStem), NEMAID etc.

Practicals

Detailed studies of morphological structures and identification of plant parasitic nematodes up to species level. Drawing and measurements of nematodes, preparation of compendia and keys. Identification of species/races of root-knot and cyst nematodes using PAGE.

Suggested Readings

- Barrington EJW. 1967. *Invertebrate Structure and Function*. Nelson, Nairobi.
- Blackwelder RE. 1967. *Taxonomy - A Text and Reference Book*. John Wiley & Sons, New York.
- Chen ZX, Chen SY & Dickson DW. 2004. *Nematology: Advances and Perspectives. Vol. I. Nematode Morphology, Physiology and Ecology*. CABI, Wallingford.
- Geraert E. 2006. *Nematology Monographs and Perspectives*. Vol. IV. Brill.
- International Commission of Zoological Nomenclature 1999. *International Code of Zoological Nomenclature* 4th Ed. The Natural History Museum, London.
- Kapoor VC. 1983. *Theory and Practice in Animal Taxonomy*. Oxford & IBH, New Delhi.
- Mayr E. 1969. *Principles of Systematic Zoology*. Tata McGraw-Hill, New Delhi.
- Quicke DLJ. 1993. *Principles and Techniques of Contemporary Taxonomy*. Blackie, London.

Objective

To understand the advances in gene expression, plant defense system, host resistance, host recognition survival and ageing of nematodes at molecular level.

Theory

UNIT I

Nucleic acids – structure and functional properties, replication, transcription, translation, protein synthesis

UNIT II

Caenorhabditis elegans – model nematode for nematode genetics, physiology and genomics.

UNIT III

Plant defense systems, cytological and biochemical changes in host plants induced by nematode feeding

UNIT IV

Resistance, genetics of resistance, molecular basis of host resistance, cloned resistance genes against plant parasitic nematodes, molecular changes in nematode feeding cells.

UNIT V

Host recognition, chemoreception, survival and ageing

UNIT VI

RNA interference, promoters for specific gene expression and novel approaches for nematode management

Suggested Reading

Berg, R.H. and Taylor, C.G. 2008. *Cell Biology of Plant Nematode Parasitism*

Chen, Z.X., Chen, S.Y. and Dickson, D.W. 2004. *Nematology: Advances and Perspectives. Vol I Nematode Morphology, Physiology and Ecology*. CABI, Wallingford UK.

Fenoll, C, M. W. Grundler and Stephan Ohl 1997. *Cellular and molecular aspects of plant-nematode interactions*. Kluwer Academic, Dordrecht.

Lee D.L. 2002. *The Biology of Nematodes*, Taylor & Francis, London, UK.

Perry, R.N. and Wright, D.J. 1998. *The physiology and biochemistry of freeliving and plant parasitic nematodes*. CABI, Wallingford, UK.

Perry, R.N. and Moens, M. 2006. *Plant Nematology*. CABI , Wallingford UK.

Riddle, D.L. 1997. *Caenorhabditis elegans* II, Cold Spring Harbor Press, USA.

Series: PLANT CELL MONOGRAPHS 15. Springer-Verlag, Germany.

Starr, J.L., Cook, R. and Bridge, J. 2002. *Plant Resistance to Parasitic Nematodes*. Oxford Press University, UK.

NEMA 605/ENT 611 PLANT HEALTH DIAGNOSTICS & MANAGEMENT

(2L+2P) III

(Multidisciplinary Courses to be Operated by the Division of Entomology)

Objective

To familiarize the students with different abnormalities caused by insect, pathogens, nematodes, weeds and imbalance use of plant nutrients. Also, develop the confidence in them to handle plant protection problems faced by the farmers/growers.

Theory

UNIT I

Introduction to the plant health clinic: concept, importance, infrastructure etc. Identification of important beneficial insects (parasitoids, predators, pollinators and others of economic importance). Principles of pest management; Injury caused by different type of insects to the plants by feeding, oviposition, sheltering or any other means.

UNIT II

Screening of damaged material for establishing the identity of casual agent viz.; insect, microbe, nematode, mites, rodents, vertebrates, competitive plant as well as nutritional or any other physiological disorders.

UNIT III

Important Plant parasitic nematodes and their symptoms produced on major field, fruit, ornamental and plantation crops; Damage caused by important nematodes causing root knot, ear-cockle and other diseases in different crops and their management.

UNIT IV

Molecular approaches for viral, bacterial and fungal diseases with regards to diagnostics and management.

UNIT V

Symptoms of diseases caused by imbalances in plant nutrients

UNIT VI

Identification of problematic weeds and their management.

Practicals

Identification of symptoms caused by important insect pests. Preparation of pesticide stock solution and safe handling of agrochemicals. Disease diagnostic kit and basic facilities. Identification of common diseases. Types of plant parasitic nematodes, demonstration of pathogenicity of root knot nematode on tomato and vegetables, Root knot index calculation. Symptoms of Molya disease and Ear-cockle disease of wheat. Management methods to manage nematode diseases in crop.

Suggested Readings

Swarup, G. and Dasgupta, D.R. 1986. *Plant Parasitic Nematodes of India*. Ravi Sachdeva at Allied Publishers Pvt. Ltd., New Delhi.

Swarup, G., Dasgupta, D.R. and Koshy, P.K. 1989. *Plant Diseases*. Anmol Publishers.