# DEPARTMENT OF AGRIL. ENTOMOLOGY

# COLLEGE OF AGRICULTURE, DAPOLI

The department was established in the year **1965** with the establishment of College of Agriculture, Dapoli with intake capacity of **64 students.** In the year 1996 ICAR modified UG syllabus of B.Sc.( Agri) and ICAR curriculum in the vogue. In the **year 2001**, the intake capacity of this college was increased to **128** and now Department is offering Entomological courses to these students. In addition, this department is also offering the courses to B.Sc. (Hort.) students. M. Sc. (Agri.) programme in Agricultural Entomology has been started in the year **1977** with the earlier intake capacity of 2 students only. But, subsequently, the intake capacity was increased to 8 students including one ICAR student. Presently, the PG courses are offered as per the recommendations of ICAR and those courses are being offered from the year 2004-05. Ph.D programme was started in the year **2002** with the intake capacity of 2 students. Presently 4 students are undergoing Ph.D. and 4 have already completed their studies.

**STAFF POSITION**

**1 Faculty strength sSanctioned & in position**

| Sr. No. | Name of Post | Sanctioned Posts | Present Position | Vacancies |
|---|---|---|---|---|
| 1 | Head | 1 | 1 | 0 |
| 2 | Professor | 1 | 0 | 1 |
| 3 | Associate Professor | 2 | 2 | 0 |
| 4 | Assistant Professor | 4 | 1 +1 (Study leave) | 2 |
| 5 | Agril. Assistant | 2 | 2 | - |
| 6 | Lab boy | 1 | 1 | - |
| 7 | Clerk | 1 | 1 | - |
| 8 | Peon | 2 | 0 | 2 |
| 9 | Majoor | 2 | 1 | 1 |

# Academic programmes

a) **Doctoral programme Ph. D. (Agril. Entomology)**

| Code | Course Title | Credits |
|---|---|---|
| ENT 601 | Advance Insect Systematics | 1+2 |
| ENT 602 | Immature Stages of Insects | 1+1 |
| ENT 603 | Advance Insect Physiology | 2+0 |
| ENT 604 | Advance Insect Ecology | 1+1 |
| ENT 605 | Insect Behaviour | 1+1 |
| ENT 606 | Recent Trends in Biological Control | 1+1 |
| ENT 607 | Advanced Insecticide Toxicology | 2+1 |
| ENT 608 | Advanced Host Plant Resistance | 1+1 |
| ENT 609 | Advanced Acarology | 1+1 |
| ENT 610 | Agricultural ornithology | 1+1 |
| ENT 611 ** | Molecular Approaches in Entomological Research | 2+1=3 |
| ENT 612 ** | Advanced Integrated Pest Management | 2+0 |
| ENT 691 | Doctoral Seminar I | 1+0 |
| ENT 692 | Doctoral Seminar II | 1+0 |
| ENT 699 | Doctoral Research | 45 |

b) ** Compulsory for Ph. D. Programme

**ENT 601 ADVANCED INSECT SYSTEMATICS 1+2**

**Objective**

To familiarize the students with different schools of classification, phylogenetics, classical and molecular methods, evolution of different groups of insects. International Code of Zoological Nomenclature. Ethics and procedure for taxonomic publications.

**Theory**

UNIT I

Detailed study of three schools of classification- numerical, evolutionary and cladistics. Methodologies employed. Development of phenograms, cladograms, molecular approaches for the classification of organisms. Methods in identification of homology. Species concepts and speciation processes and evidences. Zoogeography.

UNIT II

Study of different views on the evolution of insects- alternative phylogenies of insects: Kukalova Peck and Kristensen. Fossil insects and evolution of insect diversity over geological times.

UNIT III

Detailed study of International Code of Zoological Nomenclature, including appendices to ICZN- Ethics.

UNIT IV

Concept of Phylocode and alternative naming systems for animals. A detailed study of selected representatives of taxonomic publications – small publications of species descriptions, revisionary works, monographs, check lists, faunal volumes, etc. Websites related to insect taxonomy and databases. Molecular Taxonomy, barcoding species.

**Practical**

Collection, curation and study of one taxon of insects- literature search, compilation of a checklist, study of characters, development of character table, construction of taxonomic keys for the selected group. Development of descriptions, photographing, writing diagrams, and preparation of specimens for "type like" preservation. Submission of the collections made of the group. Multivariate Analysis techniques for clustering specimens into different taxa, and development of phenograms. Rooting and character polarisation for developing cladograms and use of computer programmes to develop cladograms.

**Suggested Readings**


CSIRO 1990. *The Insects of Australia: A Text Book for Students and Researchers.* 2nd Ed. Vols. I & II, CSIRO. Cornell Univ. Press, Ithaca.

Dakeshott J & Whitten MA. 1994. *Molecular Approaches to Fundamental and Applied Entomology.* Springer-Verlag, Berlin.

Freeman S & Herron JC. 1998. *Evolutionary Analysis*. Prentice Hall, New Delhi.

Hennig W. 1960. *Phylogenetic Systematics*. Urbana Univ. Illinois Press, USA.

Hoy MA. 2003. *Insect Molecular Genetics: An Introduction to Principles and Applications*. 2nd Ed. Academic Press, New York.

Mayr E & Ashlock PD. 1991. *Principles of Systematic Zoology.* 2nd Ed.McGraw Hill, New York.

Mayr E.1969. *Principles of Systematic Zoology.* McGraw-Hill, New York.

Quicke DLJ. 1993. *Principles and Techniques of Contemporary Taxonomy.*Blackie Academic and Professional, London.

Ross HH. 1974. *Biological Systematics.* Addison Wesley Publ. Co.,London.

Wiley EO. 1981. *Phylogenetics: The Theory and Practices of Phylogenetic Systematics for Biologists*. Columbia Univ. Press, USA.

**ENT 602 IMMATURE STAGES OF INSECTS 1+1**

**Objective**

To impart knowledge on morphology of immature stages of different groups of insects. Train students in identification of common pest species during their immature stages.

**Theory**

UNIT I

Types of immature stages in insect orders, morphology of egg, nymph/larva and pupa, identification of different immature stages of crop pests and stored product insects

UNIT II

Comparative study of life history strategies in hemi-metabola and holometabola, immature stages as ecological and evolutionary adaptations, significance of immature stages for pest management.

**Practical**

Types of immature stages; their collection, rearing and preservation. Identification of immature insects to orders and families, in endopterygote orders viz., Diptera, Lepidoptera, Hymenoptera and Coleoptera using key.

**Suggested Readings**

Chu HF. 1992. *How to Know Immature Insects*. William Brown Publ., Iowa.
Peterson A. 1962. *Larvae of Insects*. Ohio University Press, Ohio.
Stehr FW. 1998. *Immature Insects*. Vols. I, II. Kendall Hunt Publ., Iowa.

**ENT 603 ADVANCED INSECT PHYSIOLOGY 2+0**

**Objective**

To impart knowledge to the students on detailed physiology of various secretory and excretory systems, moulting process, chitin synthesis, physiology of digestion, transmission of nerve impulses, nutrition of insects, pheromones etc.

**Theory**

UNIT I

Physiology and biochemistry of insect cuticle and moulting process. Biosynthesis of chitin, chitin-protein interactions in various cuticles, types of sclerotization.

UNIT II

Digestive enzymes, digestive physiology in phytophagous, wood boring and wool feeding insects, efficiency of digestion and absorption, role of endosymbionts in insect nutrition, nutritional effects on growth and development; physiology of excretion and osmoregulation, water conservation mechanisms.

UNIT III

Detailed physiology of nervous system, transmission of nerve impulses, neurotransmitters and modulators. Production of receptor potentials in different types of sensilla, pheromones and other semiochemicals in insect life, toxins and defense mechanisms.

UNIT IV

Endocrine system and insect hormones, physiology of insect growth and development-metamorphosis, polyphenism and diapause. Energetics of muscle contractions.

**Suggested Readings**

Kerkut GA & Gilbert LI. 1985. *Insect Physiology, Biochemistry and Pharmacology*. Vols. I-XIII. Pergamon Press, Oxford, New York.

Muraleedharan K. 1997. *Recent Advances in Insect Endocrinology*. Assoc. for Advancement of Entomology, Trivandrum, Kerala.

**ENT 604 ADVANCED INSECT ECOLOGY 1+1**

**Objective**

To impart advanced practical knowledge of causal factors governing the distribution and abundance of insects and the evolution of ecological characteristics.

**Theory**

UNIT I

Characterisation of distribution of insects- Indices of Dispersion, Taylor's Power law. Island Biogeography. Population dynamics- Life tables, Leslie Matrix, Stable age distribution, Population projections. Predator-Prey Models- Lotka-Volterra and Nicholson-Bailey Model. Crop Modeling- an introduction.

UNIT II

Insect Plant Interactions. Fig-figwasp mutualism and a quantitative view of types of Associations. Role of insects in the environment. Adaptations to terrestrial habitats. Evolution of Insect diversity and role of phytophagy as an adaptive zone for increased diversity of insects. Evolution of resource harvesting organs, resilience of insect taxa and the sustenance of insect diversity- role of plants. Herbivory, pollination, predation, parasitism. Modes of insect-plant interaction, tri-trophic interactions. Evolution of herbivory, monophagy vs polyphagy. Role of plant secondary metabolites. Host seeking behaviour of parasitoids. Meaning of stress- plant stress and herbivory. Consequences of herbivory to plant fitness and response to stress. Constitutive and induced plant defenses.

UNIT III

Biodiversity and Conservation- RET species, Ecological Indicators. Principles of Population genetics, Hardy Weinberg Law, Computation of Allelic and Phenotypic frequencies, Fitness under selection, Rates of Evolution under selection. Foraging Ecology- Optimal foraging theory, Marginal Value Theorem, and Patch departure rules, central place foraging, Mean-variance relationship and foraging by pollinators, Nutritional Ecology.

UNIT IV

Reproductive ecology- Sexual selection, Mating systems, Reproductive strategies - timing, egg number, reproductive effort, sibling rivalry and parent-offspring conflict. Agro-ecological vs Natural Ecosystems – Characterisation, Pest Control as applied ecology- case studies.

**Practical**

Methods of data collection under field conditions. Assessment of distribution parameters, Taylor's power law, Iwao's patchiness index, Index of Dispersion, etc. Calculation of sample sizes by different methods. Fitting Poisson and Negative Binomial distributions and working out the data transformation methods. Hardy-Weinberg Law, Computation of

Allelic and Phenotypic Frequencies - Calculation of changes under selection, Demonstration of genetic drift. Assessment of Patch Departure rules. Assessment of Resource size by female insects using a suitable insect model, fruit flies/*Goniozus*/Female Bruchids etc.- A test of reproductive effort and fitness. Construction of Life tables and application of Leslie Matrix – population projections, Stable age distribution. Exercises in development of Algorithms for crop modeling.

**Suggested Readings**

Barbosa P & Letourneau DK. (Eds.). 1988. *Novel Aspects of Insect-Plant Interactions*. Wiley, London.

Elizabeth BA & Chapman RF. 1994. *Host-Plant Selection by Phytophagous Insects.* Chapman & Hall, New York.

Freeman S & Herron JC.1998. *Evolutionary Analysis*. Prentice Hall, New Delhi.

Gotelli NJ & Ellison AM. 2004. *A Primer of Ecological Statistics*. Sinauer Associates, Sunderland, MA.

Gotelli NJ. 2001. *A Primer of Ecology*. 3rd Ed., Sinauer Associates, Sunderland, MA, USA.

Krebs C. 1998. *Ecological Methodology.* 2nd Ed. Benjamin-Cummings Publ. Co., New York.

Krebs CJ. 2001 *Ecology: The Experimental Analysis of Distribution and Abundance*. 5th Ed. Benjamin-Cummings Publ. Co., New York.

Magurran AE. 1988. *Ecological Diversity and its Measurement*. Princeton University Press, Princeton.

Real LA & Brown JH. (Eds.). 1991. *Foundations of Ecology: Classic Papers with Commentaries.* University of Chicago Press, USA.

Southwood TRE & Henderson PA. 2000. *Ecological Methods.* 3rd Ed.Wiley Blackwell, London.

Strong DR, Lawton JH & Southwood R. 1984. *Insects on Plants:Community Patterns and Mechanism*. Harward University Press, Harward.

Wratten SD & Fry GLA. 1980. *Field and Laboratory Exercises in Ecology*. Arnold Publ., London.

**ENT 605 INSECT BEHAVIOUR 1+1**

**Objective**

To acquaint the students with a thorough understanding of how natural selection has led to various survival strategies manifested as behaviour in insects.

**Theory**

UNIT I

Defining Behaviour**-** Concept of umwelt, instinct, fixed action patterns, imprinting, complex behaviour, inducted behaviour, learnt behaviour and motivation. History of Ethology- development of behaviorism and ethology, contribution of Darwin, Frisch, Tinbergen and Lorenz; Studying behaviour- Proximate and Ultimate approaches, behavioural traits under natural selection, genetic control of behaviour and behavioural polymorphism.

UNIT II

Orientation- Forms of primary and secondary orientation including taxes and kinesis; Communication- primary and secondary orientation, responses to environmental stimuli,

role of visual, olfactory and auditory signals in inter- and intra-specific communication, use of signals in defense, mimicry, polyphenism; evolution of signals.

UNIT III

Reproductive behaviour- mate finding, courtship, territoriality, parental care, parental investment, sexual selection and evolution of sex ratios; Social behaviour- kin selection, parental manipulation and mutualism; Selforganization and insect behaviour.

UNIT IV

Foraging- Role of different signals in host searching (plant and insects) and host acceptance, ovipositional behaviour, pollination behaviour, coevolution of plants and insect pollinators. Behaviour in IPM**-** Concept of super-normal stimuli and behavioural manipulation as potential tool in pest management, use of semio-chemicals, auditory stimuli and visual signals in pest management.

**Practical**

Quantitative methods in sampling behaviour; training bees to artificial feeders; sensory adaptation and habituation in a fly or butterfly model, physical cues used in host selection in a phytophagous insect, chemical and odour cues in host selection in phytophagous insect (DBM or gram pod borer), colour discrimination in honey bee or butterfly model, learning and memory in bees, role of self-organization in resource tracking by honeybees. Evaluation of different types of traps against fruit flies with respect to signals; Use of honey bees/*Helicoverpa armigera* to understand behavioural polymorphism with respect to learning and response to pheromone mixtures, respectively.

**Suggested Readings**

Ananthkrishnan TN. (Ed.). 1994. *Functional Dynamics of Phytophagous Insects*. Oxford & IBH, New Delhi.

Awasthi VB. 2001. *Principles of Insect Behaviour*. Scientific Publ.,Jodhpur.

Bernays EA & Chapman RF. 1994. *Host-Plant Selection by Phytophagous Insects*. Chapman & Hall, London.

Brown LB. 1999. *The Experimental Analysis of Insect Behaviour.* Springer,Berlin.

Krebs JR & Davies NB. 1993. *An Introduction to Behavioural Ecology.* 3rd Ed. Chapman & Hall, London.

Manning A & Dawkins MS. 1992. *An Introduction to Animal Behaviour*. Cambridge University Press, USA.

Mathews RW & Mathews JR. 1978. *Insect Behaviour.* A Wiley- InterScience Publ. John Wiley & Sons, New York.

## ENT 606 RECENT TRENDS IN BIOLOGICAL CONTROL 1+1

**Objective**

To appraise the students with advanced techniques in handling of different bioagents, modern methods of biological control and scope in cropping system-based pest management in agro-ecosystems.

**Theory**

UNIT I

Scope of classical biological control and augmentative biocontrol; introduction and handling of natural enemies; nutrition of entomophagous insects and their hosts, dynamics of biocontrol agents *vis-à-vis* target pest populations.

UNIT II

Mass culturing techniques, insectary facilities and equipments, basic standards of insectary, viable mass-production unit, designs, precautions, good insectary practices.

UNIT III

Colonization, techniques of release of natural enemies, recovery evaluation, conservation and augmentation of natural enemies, survivorship analysis and ecological manipulations, large-scale production of biocontrol agents, bankable project preparation.

UNIT IV

Scope of genetically engineered microbes and parasitoids in biological control, genetics of ideal traits in biocontrol agents for introgressing and for progeny selections, breeding techniques of biocontrol agents.

**Practical**

Mass rearing and release of some commonly occurring indigenous natural enemies; assessment of role of natural enemies in reducing pest populations; testing side effects of pesticides on natural enemies; effect of semiochemicals on natural enemies, breeding of various biocontrol agents, performance of efficiency analyses on target pests; project document preparation for establishing a viable mass-production unit /insectary.

**Suggested Readings**

Burges HD & Hussey NW. (Eds.). 1971. *Microbial Control of Insects and Mites.* Academic Press, London.

Coppel HC & James WM. 1977. *Biological Insect Pest Suppression.* Springer Verlag, Berlin.

De Bach P. 1964. *Biological Control of Insect Pests and Weeds.* Chapman & Hall, London.

Dhaliwal, GS & Koul O. 2007. *Biopesticides and Pest Management*. Kalyani Publ., New Delhi.

Gerson H & Smiley RL. 1990. *Acarine Biocontrol Agents – An Illustrated Key and Manual*. Chapman & Hall, New York.

Huffakar CB & Messenger PS. 1976. *Theory and Practices of Biological Control.* Academic Press, London.

## ENT 607 ADVANCED INSECTICIDE TOXICOLOGY 2+1

**Objective**

To acquaint the students with the latest advancements in the field of insecticide toxicology, biochemical and physiological target sites of insecticides, and pesticide resistance mechanisms in insects.

**Theory**

UNIT I

Penetration and distribution of insecticides in insect systems; insecticide selectivity; factors affecting toxicity of insecticides.

UNIT II

Biochemical and physiological target sites of insecticides in insects; developments in biorationals, biopesticides and newer molecules; their modes of action and structural – activity relationships; advances in metabolism of insecticides.

UNIT III

Joint action of insecticides; activation, synergism and potentiation.

UNIT IV

Problems associated with pesticide use in agriculture: pesticide resistanceresistance mechanisms and resistant management strategies; pest resurgence and outbreaks; persistence and pollution; health hazards and other side effects.

UNIT V

Estimation of insecticidal residues- sampling, extraction, clean-up and estimation by various methods; maximum residue limits (MRLs) and their fixation; insecticide laws and standards, and good agricultural practices.

**Practical**

Sampling, extraction, clean-up and estimation of insecticide residues by various methods; calculations and interpretation of data; biochemical and biological techniques for detection of insecticide resistance in insects.

**Suggested Readings**

Busvine JR. 1971. *A Critical Review on the Techniques for Testing Insecticides.* CABI, London.

Dhaliwal GS & Koul O. 2007. *Biopesticides and Pest Management*. Kalyani Publ., New Delhi.

Hayes WJ & Laws ER. 1991. *Handbook of Pesticide Toxicology.* Academic Press, New York.

Ishaaya I & Degheele (Eds.). 1998. *Insecticides with Novel Modes of Action.* Narosa Publ. House, New Delhi.

Matsumura F. 1985. *Toxicology of Insecticides.* Plenum Press, New York.

O' Brien RD. 1974. *Insecticides Action and Metabolism.* Academic Press, New York.

Perry AS, Yamamoto I, Ishaaya I & Perry R. 1998. *Insecticides in Agriculture and Environment.* Narosa Publ. House, New Delhi.

Prakash A & Rao J. 1997. *Botanical Pesticides in Agriculture.* Lewis Publ., New York.

## ENT 608 ADVANCED HOST PLANT RESISTANCE 1+1

**Objective**

To familiarize the students with recent advances in resistance of plants to insects and acquaint with the techniques for assessment and evaluation of resistance in crop plants.

**Theory**

UNIT I

Importance of plant resistance, historical perspective, desirable morphological, anatomical and biochemical adaptations of resistance; assembly of plant species - gene pool; insect sources – behaviour in relation to host plant factors.

UNIT II

Physical and chemical environment conferring resistance in plants, role of trypsin inhibitors and protease inhibitors in plant resistance; biochemistry of induced resistance – signal transduction pathways, methyl jasmonate pathways, polyphenol oxidase pathways, salicylic acid pathways; effects of induced resistance; exogenous application of elicitors.

UNIT III

Biotechnological approaches in host plant resistance- genetic manipulation of secondary plant substances; incorporation of resistant gene in crop varieties; marker-aided selection in resistance breeding.

UNIT IV

Estimation of plant resistance based on plant damage- screening and damage rating; evaluation based on insect responses; techniques and determination of categories of plant resistance; breakdown of resistance in crop varieties.

**Practical**

Understanding mechanisms of resistance for orientation, feeding, oviposition *etc.*, allelochemical bases of insect resistance; macroculturing of test insects like aphids, leaf/plant hoppers, mites and stored grain pests; field screening- microplot techniques, infester row technique, spreader row technique and plant nurseries; determination of antixenosis index, antibiosis index, tolerance index, plant resistance index.

**Suggested Readings**

Panda N. 1979. *Principles of Host Plant Resistance to Insects*. Allenheld, Osum & Co., New York.

Rosenthal GA & Janzen DH. (Eds.). 1979. *Herbivores – their Interactions with Secondary Plant Metabolites*. Vol. I, II. Academic Press, New York.

Sadasivam S & Thayumanavan B. 2003. *Molecular Host Plant Resistance to Pests*. Marcel Dekker, New York.

Smith CM, Khan ZR & Pathak MD. 1994. *Techniques for Evaluating Insect Resistance in Crop Plants*. CRC Press, Boca Raton, Florida.

## ENT 609 ADVANCED ACAROLOGY 1+1

**Objective**

To acquire a good working knowledge of identification of economically important groups of mites up to the species level, a detailed understanding of the newer acaricide molecules and utilization of predators.

**Theory**

UNIT I

Comparative morphology of Acari, phylogeny of higher categories in mites, knowledge of commonly occurring orders and families of Acari in India. Diagnostic characteristics of commonly occurring species from families Tetranychidae, Tenuipalpidae, Eriophyidae, Tarsonemidae, Phytoseiidae, Bdellidae, Cunaxidae, Stigmaeidae, Pymotidae, Cheyletidae, Acaridae, Pyroglyphidae, Orthogalumnidae, Argasidae, Ixodidae, Sarcoptidae. Soil mites in India.

UNIT II

Management of economical important species of mites in agriculture, veterinary and public health; storage acarology.

UNIT III

Mites as vectors of plant pathogens; mode of action, structure-activity relationships of different groups of acaricides; problem of pesticide resistance in mites, resurgence of mites.

UNIT IV

Predatory mites, their mass production and utilization in managing mite pests, acaropathogenic fungi- identification, isolation and utilization.

**Practical**

Identification of commonly occurring mites up to species, preparation of keys for identification. Collection of specific groups of mites and preparing their identification keys. Rearing phytoseiid mites and studying their role in suppression of spider mites. Management of mite pests of crops using acaricides, phytoseiid predators, fungal pathogens *etc.*

**Suggested Readings**

Evans GO.1992. *Principles of Acarology.* CABI, London.

Gerson H & Smiley RL. 1990. *Acarine Biocontrol Agents- An Illustrated Key and Manual*. Chapman & Hall, New York.

Gupta SK. 1985. *Handbook of Plant Mites of India.* Zoological Survey of India, Calcutta.

Krantz GW. 1970. *A Manual of Acarology.* Oregon State University Book Stores, Corvallis, Oregon.

Sadana GL. 1997. *False Spider Mites Infesting Crops in India.* Kalyani Publ. House, New Delhi.

## ENT 610 AGRICULTURAL ORNITHOLOGY 1+1

**Objective**

To expose the students to the prevalence of birds in agricultural fields, their habitat associations and the beneficial and harmful role played by birds in crop fields and management of pest situations.

**Theory**

UNIT I

Status of agricultural ornithology in India, groups of birds associated with agro-ecosystems. Habitat associations of birds in both wet and dry agricultural systems. Association of birds with different cultivation practices and crop stages, their seasonality and succession. Pestiferous and beneficial birds associated with different crops, their general biology and ecology. Food and feeding habits of birds in crop fields.

UNIT II

Nature of damage caused by birds in different crops. Foraging ecology of birds in agricultural fields. Birds affecting stored grains in houses and godowns. Beneficial role of birds in agriculture and attracting them to field. Use of bird excreta in agriculture. Management of bird pests in agriculture: physical, cultural, ecological and chemical methods.

**Practical**

Study of different groups of birds associated with agriculture, their morphology and field identification. Field visits to different agroecosystems. Study of bird associations with different crop stages. Study of nesting and roosting habits of birds in agricultural habitats.

Study of the feeding habits, nature and types of damage caused by birds in selected crops. Visits to godowns. Analysis and study of the use of bird excreta in agriculture at a bird sanctuary. Field visits to paddy growing command areas to study birds in crop fields. Assignments on assessing bird damage, estimation of populations etc.

**Suggested Readings**

Dhindsa SR & Parasharya BM. 1998. *Birds in Agricultural Ecosystem.* Society for Applied Ornithology, Hyderabad.

Mehrotra KN & Bhatnagar RK. 1979. *Status of Economic Ornithology in India- Bird Depredents, Depredations and their Management.* ICAR, New Delhi.

Vasudeva Rao & Dubey OP. 2006. Grainivorous Pests and their Management. In: *Vertebrate Pests in Agriculture*, *The Indian Scenario* (Ed: Sridhara, S.), Scientific Publ., Jodhpur.

**ENT 611 MOLECULAR APPROACHES IN ENTOMOLOGICAL RESEARCH 1+1**

**Objective**

To familiarize the students with DNA recombitant techonology, marker genes, transgenic plants, biotechnology in sericulture and apiculture.

**Theory**

UNIT I

Introduction to molecular biology; techniques used in molecular biology.

UNIT II

DNA and RNA analysis in insects- transcription and translocation mechanisms. DNA recombinant technology, identification of genes/nucleotide sequences for characters of interest. Genetic improvement of natural enemies. Cell lines, genetic engineering in baculoviruses, *Bt* and entomopathogenic fungi.

UNIT III

Genes of interest in entomological research- marker genes for sex identification, neuropeptides, JH esterase, St toxins and venoms, chitinase, CPTI; lectins and proteases. Peptides and neuropeptides, JH esterase, St toxins and venoms, chitinase, Bt toxin, CPTI; trypsin inhibitors, lectins and proteases, neuropeptides. Transgenic plants for pest resistance and diseases.

UNIT IV

Insect gene transformation; biotechnology in relation to silkworms and honey bees; introduction of lectin genes for pest suppression; DNA finger printing for taxonomy and phylogeny. Genetic improvement of inebriate tolerance of natural enemies.

UNIT V

DNA-based diagnostics; insect immune systems in comparison to vertebrates; molecular basis of metamorphosis; Sf transgenic technology and implications; molecular biology of baculoviruses; insecticide resistance. Resistance management strategies in transgenic crops.

**Practical**

Isolation of DNA/RNA; purity determinations; base pair estimation; agarose gel electrophoresis; restriction mapping of DNA; demonstration of PCR, RFLP and RAPD techniques.

**Suggested Readings**

Bhattacharya TK, Kumar P & Sharma A. 2007. *Animal Biotehnology*. 1st Ed., Kalyani Publ., New Delhi.

39

Hagedon HH, Hilderbrand JG, Kidwell MG & Law JH. 1990. *Molecular Insect Science.* Plenum Press, New York.

Oakeshott J & Whitten MA.. 1994. *Molecular Approaches to Fundamental and Applied Entomology.* Springer Verlag.

Rechcigl JE & Rechcigl NA. 1998. *Biological and Biotechnological Control of Insect Pests.* Lewis Publ., North Carolina.

Roy U & Saxena V. 2007. *A Hand Book of Genetic Engineering*. 1st Ed. Kalyani Publ., New Delhi.

Singh BD. 2008. *Biotechnology (Expanding Horizons)*. Kalyani Publ., New Delhi.

Singh P. 2007. *Introductory to Biotechnology*. 2nd Ed. Kalyani Publ., New Delhi.

## ENT 612 ADVANCED INTEGRATED PEST MANAGEMENT 2+0

**Objective**

To acquaint the students with recent concepts of integrated pest management. Surviellance and data base management. Successful national and international case histories of integrated pest management, non conventional tools in pest management.

**Theory**

UNIT I

Principles of sampling and surveillance; database management and computer programming, simulation techniques and system analysis and modeling.

UNIT II

Case histories of national and international programmes, their implementation, adoption and criticisms, global trade and risk of invasive pests.

UNIT III

Genetic engineering and new technologies- their progress and limitations in IPM programmes, deployment of benevolent alien genes for pest management- case studies; scope and limitations of bio-intensive and ecological based IPM programmes. Application of IPM to farmers' realtime situations.

UNIT IV

Challenges, needs and future outlook; dynamism of IPM under changing cropping systems and climate; insect pest management under protected cultivation; strategies for pesticide resistance management.

**Suggested Readings**

Dhaliwal GS & Arora R. 2003. *Integrated Pest Management – Concepts and Approaches.* Kalyani Publ., New Delhi.

Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essentials of Agricultural Entomology.* Kalyani Publ., New Delhi.

Flint MC & Bosch RV. 1981. *Introduction to Integrated Pest Management.* Springer, Berlin.
Koul O & Cuperus GW. 2007. *Ecologically Based Integrated Pest Management.* CABI, London.
Koul O, Dhaliwal GS & Curperus GW. 2004. *Integrated Pest Management Potential, Constraints and Challenges.* CABI, London.
Maredia KM, Dakouo D & Mota-Sanchez D. 2003. *Integrated Pest Management in the Global Arena.* CABI, London.
Metcalf RL & Luckman WH. 1982. *Introduction of Insect Pest Management.* John Wiley & Sons, New York.
Norris RF, Caswell-Chen EP & Kogan M. 2002. *Concept in Integrated Pest Management.* Prentice Hall, New Delhi.
Pedigo RL. 1996. *Entomology and Pest Management.* Prentice Hall, New Delhi.
Subramanyam B & Hagstrum DW. 1995. *Integrated Management of Insects in Stored Products.* Marcel Dekker, New York.

**M. Sc. (Agri.)**

**Semester – I**

| **Sr. No.** | **Course No** | **Course Title** | **Credits** |
|---|---|---|---|
| **Major Courses : 11 Credits** | | | |
| 1 | ENT -501 | Insect Morphology | 1+1=2 |
| 2 | ENT -502 | Insect Anatomy, Physiology and Nutrition | 2+1=3 |
| 3 | ENT –505 | Insect Ecology | 1+1+2 |
| 4 | ENT –512 | Pest of Field Crops | 1+1=2 |
| **Minor Courses : 9 Credits** | | | |
| 5 | MICRO -501 | Introductory Mycology | 2+1=3 |
| 6 | NEMA - 501 | Agro-meteorology and Crop Weather Forecasting | 2+1=3 |
| **Supporting Course : 3 Credits** | | | |
| 7 | Biochem –501 | Basic Biochemistry | 2+1=3 |
| | | **Total** | **13+5=18** |

**Semester – II**

| | | | |
|---|---|---|---|
| **Major Courses : 10 Credits** | | | |
| 1 | ENT –507 | Biological Control of Crop Pests and Weed | 1+1=2 |
| 2 | ENT –504 | Classification of Insects | 2+1=3 |
| 3 | ENT –508 | Toxicology of Insecticides | 2+1=3 |
| 4 | ENT –512 | Pest of Horticultural and Plantation Crops | 1+1=2 |
| **Minor Courses : 6 Credits** | | | |
| 5 | PL Path -506 | Principle of Plant Disease Management | 2+1=3 |
| 6 | Micro -505 | Microbial Biotechnology | 2+1=3 |
| **Supporting Course : 3 Credits** | | | |
| 7 | Stat -507 | Design of Experiment for Plant Protection | 2+1=3 |
| | | **Total** | **12+6=18** |

**Semester – III**

| | | | |
|---|---|---|---|
| **Major Courses : 1 Credits** | | | |
| 1 | ENT –518 | Technique in Plant Protection | 0+1=1 |
| **Minor Courses : 2 Credits** | | | |
| 2 | PL Path -505 | Detection and Diagnosis of Plant Diseases | 0+2=2 |
| **Supporting Course : 8 Credits** | | | |
| 3 | Stat -506 | Insect Pathology | 1+1=2 |
| 4 | ENT -509 | Plant Resistance to Insects | 1+1=2 |
| 5 | ENT -513 | Storage Entomology | 1+1=2 |
| 6 | ENT -515 | General Acarology | 1+1=2 |
| | | **Total** | **4+7=11** |

**Semester – IV**

| **Seminar : 1 Credits** | | | |
|---|---|---|---|
| 1 | ENT –591 | Masters Seminar | 0+1=1 |
| | | Total | 0+1=1 |
| **Grand Total** | | | **31+22=53** |

**Syllabus**

**ENT 501 Insect Morphology 1+1**

Objective

To acquaint the students with external morphology of the insect's body i.e., head, thorax and abdomen, their appendages and functions.

Theory

UNIT I

Principle, utility and relevance: insect body wall structure, cuticular outgrowths, colouration and special integrumentary structures in insects, body tagmata, sclerites and segmentation.

UNIT II

Head- Origin, structure and modification: types of mothparts and antennae, tentorium and neck sclerites.

UNIT III

Thorax- Areas and sutures of tergum, sternum and pleuron, pterothorax; wings: structure and modifications, venation. Wing coupling apparatus and mechanism of flight: legs: structure and modifications.

UNIT IV

Abdomen- Segmentation and appendages: Genitalia and their modifications: Embryonic and post-embryonic development: types of metamorphosis. Insect sense organs (mechano- photo and chemoreceptors).

Practical

Study of insect segmentation, various tagmata and their appendages: preparation of permanent mounts of different body parts and their appendages of taxonomic importance including male and female genitalia. Sense organs.

Suggested Reading

Chapman RF. 1998. The Insects: Structure and Function. Cambridge univ, Press, Cambridge.

David BV & Ananthkrishnan TN 2004. General and Applied Entomolgy. Tata-MCGraw Hill, New Delhi.

Dunston PA 2004. The Insects: Structure and Function and Biodiversity. Kalyani Publ., New Delhi.

Evans JW 2004. Outlines of Agricultural Entomology, Asiatic Publ. New Delhi.

Richards OW & Davies RG1977. Imm's General Text Book of Entomology. 10th Ed. Chapman and Hall. London.
Saxena RC & Srivastava RC 2007. Entomology: At a Glance Agrotech Pub. Academy, Jodhpur.
Snodgross RE. 1993. Principles of Insect Morphology. Cornell Univ. Press, Ithaca.

**ENT -502 Insect Anatomy, Physiology and Nutrition 2+1=3**

Objective

To important knowledge to the students on basic aspects of anatomy of different systems. Elementary physiology, nutritional physiology and their application in entomology.

Theory

UNIT I

Scope and importance of insect anatomy and physiology.

UNIT II

Structure, modification and physiology of different systems- digestive. Circulartory, respiratory, excretory, nervous, sensory, reproductive, musculature, endocrine and exocrine glands.

UNIT III

Thermodynamics: physiology of integument, moulting, growth, metamorphosis and diapauses.

UNIT IV

Insect nutrition- role of vitamins, proteins, amino acids, carbohydrates, lipids, minerals and other food constituents: extra and intra-cellular micro-organisms and their role in physiology artificial diets.

Practical

Dissection of different insects to study comparative anatomical details of different systems; preparation of permanent mounts of internal systems; chromatographic analysis of free amino acids of haemolymph; determination of chitin in insect cuticle' examination of insect haemocytes; determination of respiratory quotient' preparation and evaluation of various diets; consumption, utilization and digestion of natural and artificial diets.

Suggested Reading

Chapman RF. 1998. The Insects: Structure and Function. ELBS ED., London.
Dunston PA 2004. The Insects: Structure and Function and Biodiversity. Kalyani Publ., New Delhi
Kerkut GA & Gilbert LI. 1985. Comprehensive Insect Physiology, Biochemistry and Pharamacology. Vols. I-XIII. Pergamon Press. New York.
Patnaik BD 2002. Physiology of Insects. Dominant, New Delhi.
Richards OW & Davies RG1977. Imm's General Text Book of Entomology. 10th Ed. Vol. 1. Structure, physiology and Development Chapman and Hall. New York.
Saxena RC & Srivastava RC 2007. Entomology: at a Glance Agrotech Pub. Academy, Jodhpur.
Wigglesworth VB. 1984. Insect Physiology, 8th Ed. Chapman & Hall, New York.

**ENT 505 INSECT ECOLOGY 1+1**

**Objective**

To teach the students the concepts of ecology, basic principles of distribution and abundance of organisms and their causes. Study life tables, organization of communities, diversity indicies. Train students in sampling methodology, calculation of diversity indicies, constructing life tables, relating insect population fluctuations to biotic and/or abiotic causes.

**Theory**

UNIT I

History and Definition. Basic Concepts. Organisation of the Biological world. Plato's Natural Balance vs Ecological Dynamics as the modern view. Abundance and diversity of insects, Estimates and Causal factors. Study of abundance and distribution and relation between the two. Basic principles of abiotic factors and their generalised action on insects. Implications for abundance and distribution of organisms including insects- Law of the Minimum, Law of Tolerance, and biocoenosis, Systems approach to ecology.

UNIT II

Basic concepts of abundance- Model vs Real world. Population growth basic models – Exponential vs Logistic models. Discrete vs Continuous growth models. Concepts of Carrying capacity, Environmental Resistance and Optimal yield. Vital Statistics- Life Tables and their application to insect biology. Survivorship curves. Case studies of insect life tables. Population dynamics- Factors affecting abundance- Environmental factors, 15 dispersal and migration, Seasonality in insects. Classification and mechanisms of achieving different seasonality- Diapause (Quiescence) - aestivation, hibernation.

UNIT III

Biotic factors- Food as a limiting factor for distribution and abundance, Nutritional Ecology. Food chain- web and ecological succession. Interspecific interactions- Basic factors governing the interspecific interactions- Classification of interspecific interactions - The argument of cost-benefit ratios. Competition- Lotka-Volterra model, Concept of nicheecological homologues, competitive exclusion. Prey-predator interactions- Basic model- Lotka-Volterra Model, Volterra's principle. Functional and numerical response. Defense mechanisms against predators/parasitoids-Evolution of mimicry, colouration, concept of predator satiation; evolution of life history strategies.

UNIT IV

Community ecology- Concept of guild, Organisation of communities- Hutchinson Ratio, May's *d/w*, Relation between the two and their association with Dyar's Law and Przibram's law. Relative distribution of organisms, Concept of diversity- the Wallacian view. Assessment of diversity. Diversity- stability debate, relevance to pest management. Pest management as applied ecology.

**Practical**

Types of distributions of organisms. Methods of sampling insects, estimation of densities of insects and understanding the distribution parameters- Measures of central tendencies, Poisson Distribution, Negative Binomial Distribution. Determination of optimal sample size. Learning to fit basic population growth models and testing the goodness of fit. Fitting Holling's Disc equation, Assessment of prey-predator densities from natural systems and understanding the correlation between the two. Assessing and describing

niche of some insects of a single guild. Calculation of niche breadth, activity breadth and diagrammatic representation of niches of organisms. Calculation of some diversity indices- Shannon's, Simpson's and Avalanche Index and understanding their associations and parameters that affect their values. Problem solving in ecology. Field visits to understand different ecosystems and to study insect occurrence in these systems.

**Suggested Readings**


Chapman JL & Reiss MJ. 2006. *Ecology: Principles & Applications*. 2nd Ed. Cambridge Univ. Press, Cambridge.

Gotelli NJ & Ellison AM. 2004. *A Primer of Ecological Statistics.* Sinauer Associates, Inc., Sunderland, MA.

Gotelli NJ. 2001. *A Primer of Ecology.* 3rd Ed. Sinauer Associates, Inc., Sunderland, MA

Gupta RK. 2004. *Advances in Insect Biodiversity*. Agrobios, Jodhpur.

Krebs CJ. 1998. *Ecological Methodology*. 2nd Ed. Benjamin-Cummings Publ. Co., New York.

Krebs CJ. 2001. *Ecology: The Experimental Analysis of Distribution and Abundance.* 5th Ed. Benjamin-Cummings Publ. Co., New York.

Magurran AE. 1988. *Ecological Diversity and its Measurement.* Princeton Univ. Press, Princeton.

Price PW. 1997. *Insect Ecology*. 3rd Ed. John Wiley, New York.

Real LA & Brown JH. (Eds). 1991. *Foundations of Ecology: Classic Papers with Commentaries*. University of Chicago Press, Chicago.

Southwood TRE & Henderson PA. 2000. *Ecological Methods.* 3rd Ed. Methuen & Co. Ltd., London.

Speight MR, Hunta MD & Watt AD. 2006. *Ecology of Insects: Conceptsand Application*. Elsevier Science Publ., The Netherlands.

Wilson EO & William H Bossert WH. 1971. *A Primer of Population Biology*. Harvard University, USA.

Wratten SD & Fry GLA.1980. *Field and Laboratory Exercises in Ecology*. Arnold, London.


## ENT 507 BIOLOGICAL CONTROL OF CROP PESTS AND WEEDS 1+1

**Objective**

To train the students with theory and practice of biological control, mass production techniques and field evaluation of various biological control agents like parasitoids, predators and various entomopathogenic microorganisms.

**Theory**

UNIT I

History, principles and scope of biological control; important groups of parasitoids, predators and pathogens; principles of classical biological control- importation, augmentation and conservation.

UNIT II

Biology, adaptation, host seeking behaviour of predatory and parasitic groups of insects. Role of insect pathogenic nematodes, viruses, bacteria, fungi, protozoa etc., their mode of action. Biological control of weeds using insects.

UNIT III

Mass production of quality biocontrol agents- techniques, formulations, economics, field release/application and evaluation.

UNIT IV

Successful biological control projects, analysis, trends and future possibilities of biological control. Importation of natural enemies- Quarantine regulations, biotechnology in biological control. Semiochemicals in biological control.

**Practical**

Identification of common natural enemies of crop pests (parasitoids, predators, microbes) and weed killers. Visits (only where logistically feasible) to bio-control laboratories to learn rearing and mass production of egg, egg-larval, larval, larval-pupal and pupal parasitoids, common predators, microbes and their laboratory hosts, phytophagous natural enemies of weeds. Field collection of parasitoids and predators. Hands-on training in culturing, identification of common insect pathogens. Quality control and registration standards for biocontrol agents.

**Suggested Readings**

Burges HD & Hussey NW. (Eds). 1971. *Microbial Control of Insects and Mites.* Academic Press, London.

De Bach P. 1964. *Biological Control of Insect Pests and Weeds.* Chapman & Hall, New York.

Dhaliwal GS & Arora R. 2001. *Integrated Pest Management: Concepts and Approaches.* Kalyani Publ., New Delhi.

Gerson H & Smiley RL. 1990. *Acarine Biocontrol Agents – An Illustrated Key and Manual.* Chapman & Hall, New York.

Huffaker CB & Messenger PS. 1976. *Theory and Practices of BiologicalControl.* Academic Press, London.

Ignacimuthu SS & Jayaraj S. 2003. *Biological Control of Insect Pests*. Phoenix Publ., New Delhi.

Saxena AB. 2003. *Biological Control of Insect Pests*. Anmol Publ., New Delhi.

Van Driesche & Bellows TS. Jr. 1996. *Biological Control*. Chapman & Hall, New York.

## ENT 504 CLASSIFICATION OF INSECTS 2+1

**Objective**

To introduce the students to the classification of insects up to the level of families with hands-on experience in identifying the families of insects.

**Theory**

UNIT I

Brief evolutionary history of Insects- introduction to phylogeny of insects and Major Classification of Superclass Hexapoda – Classes – Ellipura (Collembola, Protura), Diplura and Insecta- Orders contained.

UNIT II

Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them. Collembola, Protura, Diplura. Class Insecta: Subclass Apterygota – Archaeognatha, Thysanura. Subclass: Pterygota, Division

Palaeoptera – Odonata and Ephemeroptera. Division: Neoptera: Subdivision: Orthopteroid and Blattoid Orders (=Oligoneoptera: Plecoptera, Blattodea, Isoptera, Mantodea, Grylloblattodea, Dermaptera, Orthoptera, Phasmatodea, Mantophasmatodea, Embioptera, Zoraptera), Subdivision: Hemipteroid Orders (=Paraneoptera): Psocoptera, Phthiraptera, Thysanoptera and Hemiptera.

UNIT III

Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them (Continued). Division Neoptera – Subdivision Endopterygota, Section Neuropteroid- Coleopteroid Orders: Strepsiptera, Megaloptera, Raphidioptera, Neuroptera and Coleoptera, Section Panorpoid Orders Mecoptera, Siphonaptera, Diptera, Trichoptera, Lepidoptera, and Section Hymenopteroid Orders: Hymenoptera.

**Practical**

Study of Orders of insects and their identification using taxonomic keys. Keying out families of insects of different major Orders: Odonata, Orthoptera, Blattodea, Mantodea, Isoptera, Hemiptera, Thysanoptera, Phthiraptera, Neuroptera, Coleoptera, Diptera, Lepidoptera and Hymenoptera. Field visits to collect insects of different orders.

**Suggested Readings**

CSIRO 1990. *The Insects of Australia: A Text Book for Students and Researchers*. 2nd Ed. Vols. I & II, CSIRO. Cornell Univ. Press, Ithaca.

Freeman S & Herron JC. 1998. *Evolutionary Analysis*. Prentice Hall, New Delhi.

Richards OW & Davies RG. 1977. *Imm's General Text Book of Entomology.* 10th Ed. Chapman & Hall, London.

Ross HH.1974. *Biological Systematics.* Addison Wesley Publ. Co.Triplehorn CA & Johnson NF. 1998. *Borror and DeLong's Introduction to the Study of Insects.* 7th Ed. Thomson/ Brooks/ Cole, USA/Australia.

## ENT 508 TOXICOLOGY OF INSECTICIDES 2+1

**Objective**

To orient the students with structure and mode of action of important insecticides belonging to different groups, development of resistance to insecticides by insects, environmental pollution caused by toxic insecticides and their toxicological aspects.

**Theory**

UNIT I

Definition and scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in India.

UNIT II

Classification of insecticides and acaricides based on mode of entry, mode of action and chemical nature. Structure and mode of action of organochlorines, organophosphates, carbamates, pyrethroids, tertiary amines, neonicotinoids, oxadiazines, phenyl pyrozoles, insect growth regulators, microbials, botanicals, new promising compounds, etc.

UNIT III

Principles of toxicology; evaluation of insecticide toxicity; joint action of insecticides-synergism, potentiation and antagonism; factors affecting toxicity of insecticides; insecticide compatibility, selectivity and phytotoxicity.

UNIT IV

Insecticide metabolism; pest resistance to insecticides; mechanisms and types of resistance; insecticide resistance management and pest resurgence.

UNIT V

Insecticide residues, their significance and environmental implications. Insecticide Act, registration and quality control of insecticides; safe use of insecticides; diagnosis and treatment of insecticide poisoning.

**Practical**

Insecticide formulations and mixtures; quality control of pesticide formulations; laboratory and field evaluation of bioefficacy of insecticides; bioassay techniques; probit analysis; evaluation of insecticide toxicity and joint action. Toxicity to beneficial insects. Pesticide appliances. Working out doses and concentrations of pesticides; visit to toxicology laboratories.Good laboratory practices.

**Suggested Readings**

Chattopadhyay SB. *1985. Principles and Procedures of Plant Protection.* Oxford & IBH, New Delhi.

Gupta HCL.1999. *Insecticides: Toxicology and Uses.* Agrotech Publ., Udaipur.

Ishaaya I & Degheele (Eds.). 1998. *Insecticides with Novel Modes of Action.* Narosa Publ. House, New Delhi.

Matsumura F. 1985. *Toxicology of Insecticides.* Plenum Press, New York.

Perry AS, Yamamoto I, Ishaaya I & Perry R. 1998. *Insecticides in Agriculture and Environment.* Narosa Publ. House, New Delhi.

Prakash A & Rao J. 1997. *Botanical Pesticides in Agriculture.* Lewis Publ., New York.

## ENT 512 PESTS OF HORTICULTURAL AND PLANTATION CROPS 1+1

**Objective**

To impart knowledge on major pests of horticultural and plantation crops regarding the extent and nature of loss, seasonal history, their integrated management.

**Theory**

Systematic position, identification, distribution, host range, bionomics and seasonal abundance, nature and extent of damage and management of insect pests of various crops.

UNIT I

Fruit Crops- mango, guava, banana, jack, papaya, pomegranate, litchi, grapes, *ber*, fig, citrus, *aonla*, pineapple, apple, peach and other temperate fruits.

UNIT II

Vegetable crops- tomato, potato, radish, carrot, beetroot, cole crops, french beans, chow-chow, brinjal, okra, all gourds, gherkin, drumstick, leafy vegetables etc.

UNIT III

Plantation crop- coffee, tea, rubber, coconut, arecanut, cashew, cocoa etc.; Spices and Condiments- pepper, cardamom, clove, nutmeg, chillies, turmeric, ginger, beetlevine etc.

UNIT IV

Ornamental, medicinal and aromatic plants and pests in polyhouses/protected cultivation.

**Practical**

Collection and identification of important pests and their natural enemies on different crops; study of life history of important insect pests and noninsect pests.

**Suggested Readings**

Atwal AS & Dhaliwal GS. 2002. *Agricultural Pests of South Asia and their Management.* Kalyani Publ., New Delhi.

Butani DK & Jotwani MG. 1984. *Insects and Vegetables.* Periodical Expert Book Agency, New Delhi.

Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essential of Agricultural Entomology.* Kalyani Publ., New Delhi.

Srivastava RP.1997. *Mango Insect Pest Management.* International Book Distr., Dehra Dun.

Verma LR, Verma AK & Goutham DC. 2004. *Pest Management in Horticulture Crops : Principles and Practices.* Asiatech Publ., New Delhi.

**ENT 518 TECHNIQUES IN PLANT PROTECTION 0+1**

**Objective**

To acquaint the students with appropriate use of plant protection equipments and techniques related to microscopoy, computation, pest forecasting, electrophoresis etc.

**Theory**

UNIT I

Pest control equipments, principles, operation, maintenance, selection, application of pesticides and biocontrol agents, seed dressing, soaking, root-dip treatment, dusting, spraying, application through irrigation water.

UNIT II

Soil sterilization, solarization, deep ploughing, flooding, techniques to check the spread of pests through seed, bulbs, corms, cuttings and cut flowers.

UNIT III

Use of light, transmission and scanning electron microscopy.

UNIT IV

Protein isolation from the pest and host plant and its quantification using spectrophotometer and molecular weight determination using SDS/PAGE.

UNIT V

Use of tissue culture techniques in plant protection. Computer application for predicting/forecasting pest attack and identification.

**Suggested Readings**

Alford DV. 1999. *A Textbook of Agricultural Entomology.* Blackwell Science, London.

Crampton JM & Eggleston P. 1992. *Insect Molecular Science.* Academic Press, London.

## ENT 506 INSECT PATHOLOGY 1+1

**Objective**

To teach the students about various microbes that are pathogenic to insects, factors that affect their virulence; provide hands-on training in identification, isolation, culturing various pathogens and assessing pathogenicity.

**Theory**

UNIT I

History of insect pathology, infection of insects by bacteria, fungi, viruses, protozoa, rickettsiae, spiroplasma and nematodes.

UNIT II

Epizootiology, symptomatology and etiology of diseases caused by the above and the factors controlling these. Defense mechanisms in insects against pathogens.

UNIT III

Examples of successful instances of exploitation of pathogens for pest management and mass production techniques of pathogens. Safety and registration of microbial pesticides. Use of insect pathogens in integrated management of insect pests.

**Practical**

Familiarization with equipment used in insect pathology laboratory. Identification of different groups of insect pathogens and symptoms of infection. Isolation, culturing and testing pathogenicity of different groups of pathogens. Testing Koch's postulates. Estimation of pathogen load. Extraction of pathogens from live organisms and soil. Bioassays to determine median lethal doses.

**Suggested Readings**

Boucias DG & Pendland JC. 1998. *Principles of Insect Pathology.* Kluwer Academic Publisher, Norwel.

Burges HD & Hussey NW. (Eds). 1971. *Microbial Control of Insects and Mites.* Academic Press, London.

Steinhaus EA. 1984. *Principles of Insect Pathology.* Academic Press, London.

## ENT 509 PLANT RESISTANCE TO INSECTS 1+1

**Objective**

To familiarize the students with types, basis, mechanisms and genetics of resistance in plants to insects and role of plant resistance in pest management.

**Theory**

UNIT I

History and importance of resistance, principles, classification, components, types and mechanisms of resistance.

UNIT II

Insect-host plant relationships; theories and basis of host plant selection in phytophagous insects.

UNIT III

Chemical ecology, tritrophic relations, volatiles and secondary plant substances; basis of resistance. Induced resistance - acquired and induced systemic resistance.

UNIT IV

Factors affecting plant resistance including biotypes and measures to combat them.

UNIT V

Screening techniques; breeding for insect resistance in crop plants; exploitation of wild plant species; gene transfer, successful examples of resistant crop varieties in India and world.

UNIT VI

Role of biotechnology in plant resistance to insects.

**Practical**

Screening techniques for measuring resistance; measurement of plant characters and working out their correlations with plant resistance; testing of resistance in important crops; bioassay of plant extracts of susceptible/resistant varieties; demonstration of antibiosis, tolerance and antixenosis.

**Suggested Readings**

Dhaliwal GS & Singh R. (Eds). 2004. *Host Plant Resistance to Insects - Concepts and Applications.* Panima Publ., New Delhi.

Maxwell FG & Jennings PR. (Eds). 1980. *Breeding Plants Resistant to Insects.* John Wiley & Sons, New York.

Painter RH.1951. *Insect Resistance in Crop Plants*. MacMillan, London.

Panda N & Khush GS. 1995. *Plant Resistance to Insects.* CABI, London.

Smith CM. 2005. *Plant Resistance to Arthropods – Molecular and Conventional Approaches.* Springer, Berlin.

## ENT 513 STORAGE ENTOMOLOGY 1+1

**Objective**

To focus on requirement and importance of grain and grain storage, to understand the role of stored grain pests and to acquaint with various stored grain pest management techniques for avoiding losses in storage.

**Theory**

UNIT I

Introduction, history of storage entomology, concepts of storage entomology and significance of insect pests. Post-harvest losses *in toto visà- vis* total production of food grains in India. Scientific and socio-economic factors responsible for grain losses.

UNIT II

Important pests namely insects, mites, rodents, birds and microorganisms associated with stored grain and field conditions including agricultural products; traditional storage structures; association of stored grain insects with fungi and mites, their systematic position, identification, distribution, host range, biology, nature and extent of damage, role of field and cross infestations and natural enemies, type of losses in stored grains and their effect on quality including biochemical changes.

UNIT III

Ecology of insect pests of stored commodities/grains with special emphasis on role of moisture, temperature and humidity in safe storage of food grains and commodities. Stored grain deterioration process, physical and biochemical changes and consequences.

Grain storage- types of storage structures i.e., traditional, improved and modern storage structures in current usage. Ideal seeds and commodities' storage conditions.

UNIT IV

Important rodent pests associated with stored grains and their non-chemical and chemical control including fumigation of rat burrows. Role of bird pests and their management. Control of infestation by insect pests, mites and microorganisms. Preventive measures- Hygiene/sanitation, disinfestations of stores/receptacles, legal methods. Curative measures- Non-chemical control measures- ecological, mechanical, physical, cultural, biological and engineering. Chemical control- prophylactic and curative- Characteristics of pesticides, their use and precautions in their handling with special emphasis on fumigants. Integrated approaches to stored grain pest management.

**Practical**

Collection, identification and familiarization with the stored grains/seed insect pests and nature of damage caused by them; detection of insect infestation in stored food grains; estimation of losses in stored food grains; determination of moisture content in stored food grains; familiarization of storage structures, demonstration of preventive and curative measures including fumigation techniques; treatment of packing materials and their effect on seed quality. Field visits to save grain campaign, central warehouse and FCI warehouses and institutions engaged in research or practice of grain storage like CFTRI, IGSMRI, Hapur etc. (only where logistically feasible).

**Suggesting Readings**

Hall DW. 1970. *Handling and Storage of Food Grains in Tropical and Subtropical Areas.* FAO. Agricultural Development Paper No. 90 and FAO, Plant Production and Protection Series No. 19, FAO, Rome.

Jayas DV, White NDG & Muir WE. 1995. *Stored Grain Ecosystem.*Marcel Dekker, New York.

Khader V. 2004. *Textbook on Food Storage and Preservation*. Kalyani Publ., New Delhi.

Khare BP. 1994. *Stored Grain Pests and Their Management.* Kalyani Publ., New Delhi.

Subramanyam B & Hagstrum DW. 1995. *Interrelated Management of Insects in Stored Products.* Marcel Dekker, New York.

**ENT 515 GENERAL ACAROLOGY 1+1**

**Objective**

To aquaint the students with external morphology of different groups of mites, train in identification of commonly occurring families of plant associated mites, provide information about important mite pests of crops and their management.

**Theory**

UNIT I

History of Acarology; importance of mites as a group; habitat, collection and preservation of mites.

UNIT II

Introduction to morphology and biology of mites and ticks. Broad classification- major orders and important families of Acari including diagnostic characteristics.

UNIT III

Economic importance, seasonal occurrence, nature of damage, host range of mite pests of different crops, mite pests in polyhouses, mite pests of stored products and honeybees.

Management of mites using acaricides, phytoseiid predators, fungal pathogens *etc*. Culturing of phytophagous, parasitic and predatory mites.

**Practical**

Collection of mites from plants, soil and animals; extraction of mites from soil, plants and stored products; preparation of mounting media and slide mounts; external morphology of mites; identification of mites up to family level using keys; studying different rearing techniques for mites.

**Suggested Readings**


Chhillar BS, Gulati R & Bhatnagar P. 2007. *Agricultural Acarology*. Daya Publ. House, New Delhi.

Gerson U & Smiley RL. 1990. *Acarine Biocontrol Agents - An Illustrated Key and Manual*. Chapman & Hall, NewYork.

Gupta SK. 1985. *Handbook of Plant Mites of India.* Zoological Survey of India, Calcutta.

Gwilyn O & Evans GO. 1998. *Principles of Acarology*. CABI, London.

Jeppson LR, Keifer HH & Baker EW. 1975. *Mites Injurious to Economic Plants*. University of California Press, Berkeley.

Krantz GW. 1970. *A Manual of Acarology.* Oregon State Univ. Book Stores, Corvallis, Oregon.

Qiang Zhiang Z. 2003. *Mites of Green Houses- Identification, Biology and Control*. CABI, London.

Sadana GL. 1997. *False Spider Mites Infesting Crops in India.* Kalyani Publ.House, New Delhi.

Walter DE & Proctor HC. 1999. *Mites- Ecology, Evolution and Behaviou*r. CABI, London**.**


**Bachelor's programme**

**B.Sc (Ag.)**

| **Semester** | **Course No.** | **Course Title** | **Credits** |
|---|---|---|---|
| III | ENT-231 | Insect Morphology and Systematics | 2+1=3 |
| IV | ENT-242 | Insect Ecology and Integrated Pest Management including Beneficial Insects | 2+1=3 |
| V | ENT-353 | Crop Pest and Stored Grain Pests and their Management | 2+1=3 |
| VI | ENT-364 | Introductory Nematology | 1+1=2 |
| | | **Total** | **11** |
| VII | ENT-475 | RAWE- Crop Protection (Agril Entomology) | 4 credits |

**B.Sc (Hort.)**

| Semester | Course No. | Course Title | Credits |
|---|---|---|---|
| II | ENT-121 | Fundamentals of Entomology | 2+1=3 |
| V | ENT-352 | Insect Pest Management of Fruit, Plantation and Aromatic Crops. | 2+1=3 |
| V | ENT-353 | Insect Pest Management of Vegetables, Ornamentals and Spice Crops | 2+1=3 |
| VI | ENT-364 | Nematode Pest of Horticultural Crops and their Management | 1+1=2 |
| VI | ENT-365 | Apiculture | 0+1=1 |
| | | **Total** | **7+15=12** |
| VII | ENT -476 | RAWE | 0+2=2 |

**Laboratories**

The department is having two under graduate laboratories and one post graduate laboratory which is utilized for the students. Along with these laboratories one biological control laboratory and one sericulture unit is there. Both the laboratories are used by the post graduate students for conducting research. The department has developed one insect museum for farmers as well as students.

Insect museum and sericulture unit

Insect museum

Bio control laboratory

| **Name of the equipments available in the department** |
|---|
| Student dissenting microscope |
| LCD projector |
| Microscope Image projection system |
| Olympus make anti fungus microscope |
| Autoclave |

| |
|---|
| Electric Top pan balance |
| Environmental test chamber model CH -125 |
| Micro imaging device catcam |
| Micro imaging analysis software |

Autoclave

Environmental test chamber

**Faculty**

1. **Dr Anand Lalaba Narangalkar**

   **Head,**

| | | | |
|---|---|---|---|
| 1 | Name in Full | Dr. Anand Lalba Narangalkar | |
| 2 | Date of Birth | 23/01/1961 | |
| 3 | Sex- Male / Female | Male | |
| 4 | Nationality and state of Domicile | Indian (Maharashtra) | |
| 5 | Name of Agricultural university | Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli | |
| 6 | Present Designation and Date of Joining | Head, 29/01/2013 | |
| 7 | Present office / Department and place of work | Department of Agril. Entomology, College of Agriculture, Dapoli. | |
| 8 | Address for correspondence | Department of Entomology, College of Agriculture, Dapoli | |
| | A) Telephone no. | Office | 02358-282415 extn 223 |
| | | Residence | |
| | B) Mobile No. | 9422431681 | |
| 9 | Permanent Hone address | At Post Narangal Taluka Deglur, Dist. Nanded | |
| 10 | Married / Unmarried | Married | |
| 11 | If married No. of Children | Son – One | Daughter – One |
| 12 | Cast Category | SC | |

**13 Academic Qualification**

| Sr. No. | Degree / Diploma certificate pass | Board / University | Year | Percentage of marks obtained | Grade | Major Subject |
|---|---|---|---|---|---|---|
| 1 | B. Sc. (Agri) | Marathwada Krishi Vidyapeeth, | 1985 | 59.80 | II Class | Agriculture |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | Prabhani | | | | |
| 2 | M. Sc. (Agri) | Marathwada Krishi Vidyapeeth, Prabhani | 1988 | 67.40 | II Class | Agril. Entomology |
| 3 | Ph. D | Gujarat Krishi Vidyapeeth, Anand | 2003 | 68.20 | II Class | Agril. Entomology |

**14 Service details and experience (first appointment, till present post)**

| Sr. No. | Designation | Place of Work and organization | Mode of Recruitment | | Date of Joining from – to | Nature of Job |
|---|---|---|---|---|---|---|
| | | | Nomination | Promotion | | |
| 1 | Assistant Professor | Deptt. of Agril. Entomology, College of Agriculture, Dapoli | Nomination | - | 10/01/1992 to 03/03/2004 | Teaching, Research & Extension |
| 2 | Associate Professor | Deptt. of Agril. Entomology, College of Agriculture, Dapoli | Nomination | - | 03/03/2004 to 14/05/2008 | Teaching, Research & Extension |
| 3 | Professor | Deptt. of Agril. Entomology, College of Agriculture, Dapoli | - | Promotion | 14/05/2008 to 28/01/2013 | Teaching, Research & Extension |
| 4 | Head | Deptt. of Agril. Entomology, College of Agriculture, Dapoli | 11 monthly | | 29/01/2013 | Administration, Teaching, Research & Extension |

**15 Training Attended National :**

1. Biological Pest Suppression in Coconut 1993
2. Pest disease and Nematode Management 1993
3. 21 days on “Biological Suppression of Crops and Weeds 2004
4. 21 days training on Beekeeping, Ludhiana
5. National Conference on beekeeping.

**16 Important Research Findings : Nil**

**17 Awards and prizes :**

1. Best citizen of India – 2007
2. Shiksha Rattan Award -2007

3. Dr. Babasaheb Ambedkar fellowship

**18 Special work done (if any) ; Nil**

**2. Dr Sarjerao Krishna Godase**
**Associate Professor (Charge- Professor)**

| | | | |
|---|---|---|---|
| 1 | Name in Full | Dr. Sarjerao Krishna Godase | |
| 2 | Date of Birth | 01/06/1955 | |
| /3 | Sex- Male / Female | Male | |
| 4 | Nationality and state of Domicile | Indian (Maharashtra) | |
| 5 | Name of Agricultural university | Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli | |
| 6 | Present Designation and Date of Joining | Associate Professor, 03/08/1981 | |
| 7 | Present office / Department and place of work | Department of Agril. Entomology, College of Agriculture, Dapoli. | |
| 8 | Address for correspondence | Department of Entomology, College of Agriculture, Dapoli | |
| | A) Telephone no. | Office | 02358-282415 extn 223 |
| | | Residence | |
| | B) Mobile No. | 9423804578 | |
| 9 | Permanent Hone address | At Post Dolegaon Taluka Dist. Satara | |
| 10 | Married / Unmarried | Married | |
| 11 | If married No. of Children | Son – One | Daughter – One |
| 12 | Cast Category | Maratha | |

**13 Academic Qualification**

| Sr. No. | Degree / Diploma certificate pass | Board / University | Year | Percentage of marks obtained | Grade | Major Subject |
|---|---|---|---|---|---|---|
| 1 | B. Sc. (Agri) | Mahatama Phule Krishi Vidyapeeth, Rahuri | 1976 | | I Class | Agriculture |
| 2 | M. Sc. (Agri) | Mahatama Phule | 1978 | | I Class | Agril. |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | Krishi Vidyapeeth, Rahuri | | | | Entomology |
| 3 | Ph. D | Gujarat Krishi Vidyapeeth, S. K. Nagar, Gajarat | 2003 | 68.20 | I Class | Agril. Entomology |

**14 Service details and experience (first appointment, till present post)**

| Sr. No. | Designation | Place of Work and organization | Mode of Recruitment | | Date of Joining from – to | Nature of Job |
|---|---|---|---|---|---|---|
| | | | Nomination | Promotion | | |
| 1 | Junior Entomologist | Cashew Research Station, Vengurla | Nomination | - | 03/08/1981 to 31/12/1995 | Research & Extension |
| 2 | Junior Entomologist | Mango Research Station, Vengurla | Nomination | - | 01/01/1996 to 30/12/2004 | Research & Extension |
| 3 | Associate Professor | Deptt. of Agril. Entomology, College of Agriculture, Dapoli | Nomination | - | 31/12/2004 to till date | Teaching, Research & Extension |

**15 Training Attended National :**

1. Advance training on Insect ecology 16/03/1998 to 31/03/1998
2. Commercial production and utilization of Tropical fruits 19/09/1997 to 18/10/1997
3. Management of Agriculture Education 17/11/1998 to 16/12/1998
4. Gas Chromatography 02/06/2003 to 16/06/2003

**16 Important Research Findings :**

1. Recommendation for the control of tea mosquito and flower thrips of cashew.
2. A new species of the phoridae parasitoid of the mango shoot borer
3. Prophylactic and curative control of stem and root borer of cashew
4. Imidacloprid pesticide was recommended for control of mango hopper.
5. Thiamethoxam pesticide was recommended for control of mango hopper
6. Synthetic pyrathroids were recommended for control of mango hopper
7. Nimbicidin was recommended for control of mango hopper
8. Clothianidin was recommended for control of mango hopper
9. Involved in release of cashew variety Vengurla -7
10. Involved in release of mango variety Konkan Ruchi
11. Recommended pesticicdes lambda cyhalothrin and profenophos for control of tea mosquito and flower thrips of cashew.
12. For uniform vegetative shoots, flowering, fruiting and to reduce incidence of mango hopper light pruning during rest period is recommended.

**17 Awards and prizes :**

1.Abasaheb Kubal Horticulture Awards 2002 for Horticulture crop

2. Anantrao Randive Amba Lekhan Purskar 2002 for "Hapus Amba Bageche Varshik Velaptrak"

**18 Special work done (if any) :**

Worked as PI/ Co-PI / scientists in Seven Research Projects.

**3. Dr. (Mrs.) Kumud Vitthal Naik**
**Associate Professor**

| | | | |
|---|---|---|---|
| 1 | Name in Full | Mrs. Kumud Vitthal Naik | |
| 2 | Date of Birth | 26/10/1964 | |
| 3 | Sex- Male / Female | Female | |
| 4 | Nationality and state of Domicile | Indian (Maharashtra) | |
| 5 | Name of Agricultural university | Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli | |
| 6 | Present Designation and Date of Joining | Associate Professor, 18/06/2013 | |
| 7 | Present office / Department and place of work | Department of Agril. Entomology, College of Agriculture, Dapoli. | |
| 8 | Address for correspondence | At. Gimhavane, Post. Tal. Dapoli, Dist. Ratnagiri | |
| | A) Telephone no. | Office | 02358-282415 extn 223 |
| | | Residence | 02358-283228 |
| | B) Mobile No. | 9421229878 | |
| 9 | Permanent Hone address | At. Gimhavane, Post. Tal. Dapoli, Dist. Ratnagiri | |
| 10 | Married / Unmarried | Married | |
| 11 | If married No. of Children | Son – One | Daughter - |
| 12 | Cast Category | Brahmin | |

**13 Academic Qualification**

| Sr. No. | Degree / Diploma certificate pass | Board / University | Year | Percentage of marks obtained | Grade | Major Subject |
|---|---|---|---|---|---|---|
| 1 | B. Sc. (Agri) | Konkan Krishi Vidyapeeth, Dapoli | 1985 | 84.38 | First class with distinctions | All required for B. Sc.(Agri) degree |
| 2 | M. Sc. (Agri) | Konkan Krishi Vidyapeeth, Dapoli | 1987 | 89.20 | First class with distinctions | Agril. Entomology |

**14 Service details and experience (first appointment, till present post)**

| Sr. No. | Designation | Place of Work and organization | Mode of Recruitment | | Date of Joining from – to | Nature of Job |
|---|---|---|---|---|---|---|
| | | | Nomination | Promotion | | |
| 1 | Technical Assistant (Agri. Officer) | Deptt. of Agril. Extension, College of Agriculture, Dapoli | Nomination | - | 08/2/1990 to 14/12/1995 | Research & Extension |
| 2 | Assistant Professor | Deptt. of Agril. Entomology, College of Agriculture, Dapoli | | Promotion | 15/12/1995 to till date | Teaching, Research & Extension |

**15 Training Attended National**

| | | |
|---|---|---|
| 1. | Training for Rural Development : Prospects & Retrospect | 22/11/1991 to 23/11/1991 |
| 2. | Summer School: Commercial production & utilization of Tropical fruits | 19/09/1997 to 18/10/1997 |
| 3. | Winter School: Management of Agricultural Education: Teachers Training in Educational Technology. | 17/11/1998 to 16/12/1998 |
| 4. | Management Programme for women scientists at NAARM, Hyderbad | 19/03/2001 to 24/03/2001 |

**16 Important Research Findings**

1. Guided four post graduate students for their research work as Major Advisor/ Research Guide

**17 Awards and prizes**

1. Best Teacher Award, 2002
2. First prize for best paper presentation in the National Level Seminar Training for Rural Development : Prospects & Retrospect during 22/11/1991 to 23/11/1991

**18 Special work done (if any)**

1 Worked as Hostel Monitor for Girls Hostel from 1995 to 2001

**13 Academic Qualification**

| Sr. No. | Degree / Diploma certificate pass | Board / University | Year | Percentage of marks obtained | Grade | Major Subject |
|---|---|---|---|---|---|---|
| 1 | B. Sc. (Agri) | Konkan Krishi Vidyapeeth, Dapoli | 1985 | 84.38 | First class with distinctions | All required for B. Sc.(Agri) degree |
| 2 | M. Sc. (Agri) | Konkan Krishi Vidyapeeth, Dapoli | 1987 | 89.20 | First class with distinctions | Agril. Entomology |

**4. Dr. Vijaykumar Sitaram Desai**
**Assistant Professor**

| | | | |
|---|---|---|---|
| 1 | Name in Full | Dr. Vijaykumar Sitaram Desai | |
| 2 | Date of Birth | 21/04/1967 | |
| 3 | Sex- Male / Female | Male | |
| 4 | Nationality and state of Domicile | Indian (Maharashtra) | |
| 5 | Name of Agricultural university | Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli | |
| 6 | Present Designation and Date of Joining | Assistant Professor, 18/06/1992 | |
| 7 | Present office / Department and place of work | Department of Agril. Entomology, College of Agriculture, Dapoli. | |
| 8 | Address for correspondence | Department of Entomology, College of Agriculture, Dapoli | |
| | A) Telephone no. | Office | 02358-282415 Extn 223 |
| | | Residence | |
| | B) Mobile No. | 9422630389 | |

| | | | |
|---|---|---|---|
| 9 | Permanent Hone address | Department of Entomology, College of Agriculture, Dapoli | |
| 10 | Married / Unmarried | Married | |
| 11 | If married No. of Children | Son – One | Daughter – One |
| 12 | Cast Category | Hindu Maratha | |

**13 Academic Qualification**

| Sr. No. | Degree / Diploma certificate pass | Board / University | Year | Percentage of marks obtained | Grade | Major Subject |
|---|---|---|---|---|---|---|
| 1 | B. Sc. (Agri) | Konkan Krishi Vidyapeeth, Dapoli | 1988 | 76.50 | 3.10 | Agriculture |
| 2 | M. Sc. (Entomology) | Konkan Krishi Vidyapeeth, Dapoli | 1990 | 81.20 | 3.34 | Agril. Entomology |
| 3 | Ph. D | Gujarat Krishi Vidyapeeth, Junagad | 2003 | | 8.00 | Agril. Entomology |

**14 Service details and experience (first appointment, till present post)**

| Sr. No. | Designation | Place of Work and organization | Mode of Recruitment | | Date of Joining from – to | Nature of Job |
|---|---|---|---|---|---|---|
| | | | Nomination | Promotion | | |
| 1 | Technical Assistant (Agri. Officer) | Dept. of Agronomy. College of Agriculture, Dapoli | Nomination | - | 18/6/1992 to 17/10/1996 | Research & Extension |
| 2 | Assistant Professor | Dept. of Agril. Entomology, College of Agriculture, Dapoli | Nomination | - | 18/10/1996 to till date | Teaching, Research & Extension |

**15 Training Attended National**

1. Completed 21 days training on ' Pesticide Residue Analysis' held at HAU, Hissar
2. Completed 8 days training on ‘Biological suppression of coconut pests’ held at PDBC, Bangalore
3. Completed 21 days training on 'Integrated Pest Management on important field cops' held at NCIPM, New Delhi
4. Completed 6 days training on ‘ In vitro production of host insects and predators using artificial diet’ held at DBC, Bangalore
5. Completed 21 days training on ‘Recent advances in Microbial control of crop pests’ held at Tamil Nadu Agricultural University, Coimbatore.

6. Completed 21 days training on " Production protocol and quality control of microbial pesticides" at National Integrated Plant Health management, Hyderabad

**16 Important Research Findings**

1. For the control of coconut black headed caterpillar, release of larval parasite *Goniozus nephantidis* at the rate of 20.5 per cent of the pest population (3500 per hectare) was recommended in **Joint AGRESCO 1999.**
2. The innermost 2nd and 3rd leaf axils may be filled with phorate 10G @ 25 g., methyl parathion 2% @ 50 g., endosulfan 4% @ 50 g., endosulfan 12.5 g. and lindane 1.3% @ 12.5 g. plus equal quantity of sand at the interval of three months was recommended for prophylactic control of rhinoceros beetle by Joint AGRESCO 2004.
3. Integrated pest management technology for rhinoceros beetle *Oryctes rhinoceros.* A recommendation was approved in Joint AGRESCO 2004.
5. Integrated Pest Management of Coconut Black headed caterpillar.
   A recommendation was approved by Joint AGRESCO 2004.
6. Associated with the recommendation, grafting of nutmeg on myphal, a wild stalk. A recommendation was approved in Joint AGRESCO 2006.
7. Associated with development of coconut variety 'D X T'. A variety was released in Joint AGRESCO 2004**.**
8. Associated with development of nutmeg variety 'Konkan Swad'. A variety was released in Joint AGRESCO 2004**.**
9. Associated with development of kokum variety 'Konkan hatis'. A variety was released in Joint AGRESCO 2006**.**

**17 Awards and prizes**

1. Regional Fruit Research Station Acclamation Award in 2010

**18 Special work done (if any)**

1. Worked as a Research Guide for 9 M.Sc. (Agri.) students and member of 16 M.Sc.(Agri.)
2. Working as Hostel Monitor since 2007
3. Handled charge of Hostel Rector, Agronomist, Technical officer to Dean etc.
4. Conducted 9 agency trials
5. Established Bio control laboratory at RCRS, Bhatye and Department of Agril. Entomology, BSKKV,Dapoli
6. Working as a Member, Placement Cell, College of Agriculture, Dapoli
7. Working as Associated Scientists, Indo Israel Project, BSKKV, Dapoli

## Research recommendations

1. Integrated Pest Management of Coconut Black headed Caterpillar. (2004)

   The integrated pest management strategy to be adopted in endemic areas of the pest consists of:

- Mechanical control : Cutting and burning of badly infested dried leaves reduce the pest infestation.
- Biological control : A larval parasite *Goniozus nephantidia* should be released at the rate 3,500 adult parasites per hectare.
- Chemical control : (i) Spraying with 0.1% carbaryl or 0.05% endosulfan or 0.5% dimethoate or 0.05% DDVP during severe outbreaks of the pest would give satisfactory control. Care should be taken to spray lower surfaces of the leaves so as to get effective control. If chemical control is necessary even after release of parasitoids, spraying should be done 15 days after release.

2. Integrated Pest Management of Rhinoceros beetle (*Oryctes rhinoceros*) : (2004)

   An Integrated Pest Management for effective and economical control of Rhinoceros beetle consist of:

   - Sanitation method : The dead and decaying organic debris in the coconut gardens may be properly disposed off since these act as a prolific breeding sites for the beetle.
   - Mechanical method : Removal of beetles with iron or aluminum hook from the holes / wounds made by rhinoceros beetle and their destruction without causing injury to the growing point, particularly during peak period of population build up.
   - Attraction and trapping : (False breeding material trap): Digging out ten pits per hectare of the size 20 x 20 x 20 cm. and filling with breeding material (dung) should be done in coconut garden. These pits should be sprayed with 0.1 per cent carbaryl 50 WDP at the interval of two months.
   - Organic debris may be treated with 0.1 per cent carbaryl 50 WDP at interval of three months.
   - Biological control: Release of baculovious infected beetles in the orchard at the rate of 10 to 15 beetles per acre.

3. For the control of Sapota seed borer spraying of Profenophos 40 EC @ 1 ml/lit. by the end of monsoon, Deltamethrin 2.8 EC 1 ml/lit. one month after first spray, Lambda-cyhalothrin 5 EC 1 ml/lit. one month after second spray and Deltamethrin 2.8 EC 1 ml/lit. one month after third spray is recommended. (2008)

4. Equation for Forecasting of Thrips on cashew (2008)

| | |
|---|---|
| $Y_4$=0.015271 $X_1$ 0.093 $X_2$ + 0.030321 $X_3$ + 0.030019 $X_4$ 0.16478 $X_5$ 0.21634 $X_6$ 0.09379 $X_7$ + 10.31713 | R square = 0.891 |

$Y_4$ = Predicted population of thrips on cashew variety Vengurla -4.

$X_1$ = Rainfall (mm)

$X_2$ = Afternoon humidity (%)

$X_3$ = Forenoon humidity (%)

$X_4$ = Minimum temperature ($^0$C)

$X_5$ = Maximum temperature ($^0$C)

$X_6$ = Wind speed (Km/Hr.)

$X_7$ = Sunshine hours

5. As a curative treatment for the cashew trees infested by cashew stem and root borer, application of 10 ml. chloropyriphos + 50 ml kerosene or 10 ml DDVP + 50 ml Kerosene or 10 ml DDVP + 50 ml Kerosene through entry hole (after removing frass) with the help of plastic pipe and plugging the hole by moist soil is recommended. (2008)

6. For the control of Red Palm Weevil (RPW) in coconut, two Rakshak – 2 traps be installed per hectare at East and West wind direction sides with changing lure after every 3 months and for more weevil catch, use synthetic pineapple flavour 5 ml per trap soaked in cotton. (2008)

7. Equation for Forecasting of Tea mosquito bug on cashew

| | |
|---|---|
| $Y_4$=0.090095 $X_1$ 0.00359 $X_2$ + 0.70137 $X_3$ + 0.84672 $X_4$ 2.68176 $X_5$ 2.87401 $X_6$ 0.41121 $X_7$ + 173.2185 | R square = 0.891 |

$Y_4$ = Predicted population of thrips on cashew variety Vengurla -4.

$X_1$ = Rainfall (mm)

$X_2$ = Afternoon humidity (%)

$X_3$ = Forenoon humidity (%)

$X_4$ = Minimum temperature ($^0$C)

$X_5$ = Maximum temperature ($^0$C)

$X_6$ = Wind speed (Km/Hr.)

$X_7$ = Sunshine hours

8 Growing of Yam bean as a border crop 15 days before the sowing of Amorphophallus and spraying

of yam been seed + soap nut water extract at the rate of 50 g each per liter of water as prophylactic spray is recommended for the control of snails in Amorphophallus. (2008)

9. It is recommended to spray clothianidin 50 WDG @ 1.2 gm/10 lit. of water is recommended for the control of mango hoppers. The precaution should be taken that this insecticide is to be used only once before flowering. (2009)

10. Three sprays of Emamectin benzoate 5 SG @ 0.45 g/lit. or Deltamethrin 2.8 EC @ 1 ml/lit. are recommended for control of sapota bud borer. The first spray should be given at the fifty per cent flowering i.e. March and subsequent two spray should be given at an interval of one month. The precaution should be taken that there should not be immediate repetition of any insecticide in the subsequent spray. All mature fruits should be harvested before each spray. (2009)

11. Drenching of eriophyid smash (Azadirachtin 0.03 per cent plus micro nutrients) at the rate of 250 ml in 20 lit. of water per palm at the interval of three months is recommended for the management of coconut eriophyid mite. (2011)

| | |
|---|---|
| 12. | The use of pheromone trap for the management of coconut red palm weevil. (2011) |
| 13. | For the management of sweet potato weevil, planting of sweet potato and marigold in the proportion of 2:1 rows. (2012) |
| 14. | For the management of chilli thrips alternate spray of 10 per cent cow urine and azadirachtin 10000 PPM @ 3 ml/lit at 7 days interval. The first spray should be given at 15 days after transplanting and subsequent sprays should be given application at 7 days interval up to 3.5 months. (2012) |

Hooking out of rhinoceros beetle

Leaf axil filling of insecticidal dust

A larval parasitoid *Goniozus nephantidis* feeding on larva of coconut leaf eating caterpillar

Infestation of coconut eriophyid mite

Root feeding of azadirachtin for management of coconut eriophyid mite

Spraying of acaricide for eriophyid mite  Drenching of azadirachtin for eriophyid mite

Pheromone trap (Rakshak II)for coconut red palm weevil

Pheromone trap (Rakshak I) for fruit fly

On going research project

1. Crop pest surveillance and advisory project on Mango
2. Crop pest surveillance and advisory project on Rice

Abstract of the thesis

| | | |
|---|---|---|
| Title of thesis | : | "Studies On Coconut Eriophyid Mite In Konkan Region" |
| Name of the Student | : | Abhaykumar Sadashivrao Bagde |
| Regd. No. | : | 52 |
| Year of Award of Degree | : | 2010 |

## THESIS ABSTRACT

Coconut is an important plantation crop grown on coastal area of India. India is the third largest producer of the coconut in the world contributing 12148 million nuts from an area of 1.93 million ha. with the average annual productivity of 13516 nuts per ha, (Anonymous, 2004). In Maharashtra it is grown on 26,884 ha, area with production of 193.8 million nuts and productivity of 7,208 nuts per ha, (Khan *et al*., 2003). Coconut is infested by number of pests like red palm weevil, rhinocerous beetle, black headed caterpillar and recently added with eriophyid mite. Eriophyid mite (*Aceria guerreronis* K.) is microscopic having elongated worm like body, two pairs of legs and needle like mouthparts. They are infesting to the nut surface below perianth. First time it was observed by Keifer in Mexico in 1965 (Keifer, 1965). As result of damage it reduces in size, Murlidharan *et al.* (2001) reported 30.94% and 41.71% losses in terms of copra and husk, respectively in Kerala. As pest recently observed in Konkan region of Maharashtra, no information was available on extent of incidence and management practices. So the present study was undertaken. The survey was conducted as per the method given by Murlidharan *et al.* (2001).

The egg and mite counts were recorded by as 4 sq.mm. window method. The nuts were classified in to different grades and mean damage Grade Index and severity of infestation was calculated as per the method given by Julia and Mariau (1979).

The investigation on survey of eriophyid mite in Konkan region was carried out during 2004-05 to 2007-08. The field experiments were conducted on evaluation of the efficacy of certain biopesticides and development of IPM modules for management of eriophyid mite during 2006-07 on Asond Farm, CES, Wakawali, Dr. B. S. K. K. V., Dapoli (M.S.).

During the survey maximum infestation was observed in Thane district followed by Sindhudurg, Ratnagiri and Raigad districts as per the severity of infestation. On the basis of grade wise, the nut infestation in Thane district was mostly belongs to Grade III, where as in Sindhudurg, Ratnagiri and Raigad districts, most of the infested nuts belongs to Grade II. However, in some villages the per cent infestation in Grade III was found to be increasing.

In the evaluation of biopesticides, the treatment T5 (Neemazal 5% + Neemazal 5% spraying and root feeding) was found most effective (45.88 and 52.51 %) in reducing eggs of mite followed by the treatment T4 (Neemazal 1% + Neemazal 5% spraying and root feeding) (41.63 and 46.91 %) at 7 and 14 days after treatment.

The efficacy of biopesticides against eriophyid mite found that the treatment T5 (Neemazal 5% + Neemazal 5% spraying and root feeding) was most effective (53.24 and 57.51 %) followed by treatment T4 (Neemazal 1% + Neemazal 5% spraying and root feeding) (45.20 and 48.36 %) in reduction of mite at 7 and 14 days after treatment.

The various modules were tested against eriophyid mite management, among them module 9 (Recommended dose of fertilizers + micronutrients + Neemazal 5% root feeding ) with 2.62 mean damage Grade Index was observed to be effective in management of eriophyid mite followed by module 8 (Recommended dose of fertilizers + micronutrients + Neemazal 1% root feeding) with 2.66 mean damage Grade Index and module 7 (Recommended dose of fertilizers + Neem cake + Neemazal 5% root feeding) with 2.70 mean damage Grade Index.

Among the 26 coconut genotypes screened for their reaction to the coconut eriophyid mite, the genotypes Jamica, BSI, Lono, Guwam and Orange dwarf, Kalpwangi found to be moderately resistant and the genotypes Sanrayman, Pratap, Banawali green long were found to be highly susceptible.

Impact of coconut eriophyid mite on yield parameters studied under Konkan conditions indicated that as the severity of eriophyid mite infestation increases the total weight, dehusked nut weight, husk weight, kernel weight, shell weight, length, circumference, water content losses.

| | | |
|---|---|---|
| Title of thesis | : | "Management of *Helicoverpa armigera* (Hubner) infesting chickpea." |
| Name of the Student | : | Jadhav Swapnali Prakash |
| Regd. No. | : | 1963 |
| Year of Award of Degree | : | 2010 |

## THESIS ABSTRACT

The chickpea pod borer, *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) is one of the most important polyphagous and widely distributed pests of grain legumes causing sometimes as high as 90-95 per cent damage.

Studies on screening of genotypes against *H. armigera* infesting chickpea indicated that out of 21 genotypes screened, none of the genotype was found resistant to chickpea pod borer. The minimum mean per cent pod damage of 8.48 was noticed in genotype Phule G-105-14-1 followed by Phule G-12 (9.37), Phule G-7104 (9.61). The maximum mean per cent pod damage of 33.06 was observed in genotype local kabuli followed by Phule G-06302 which recorded mean per cent pod damage of 30.04. Out of 21 genotypes only one genotype Phule G-06302 was found moderately susceptible, while all remaining genotypes were least susceptible.

Yield of genotypes indicated that genotypes Phule G-105-14-1 and Phule G-7104 were found to give maximum yield of 41.39 q/ha and 40.74 q/ha, respectively. The genotype Virat recorded the lowest yield of 12.08 q/ha.

The treatment comprising hand collection and destruction of larvae; alternate sprays of NSKE 5 per cent, *Bt* var. *kurstaki* and *HaNPV* 250 LE/ha at 15 days interval starting from 50 per cent initiation of flowering; growing marigold all along border as trap crop; installation of pheromone trap @ 1 trap/plot; installation of bird perches @ 1 perch/plot was found more effective in checking the larval population of pod borer as evidenced by the data recorded 15$^{th}$ day after II$^{nd}$ and III$^{rd}$ spray of pesticides 1.40 and 0.60 respectively. This treatment also shows that minimum mean per cent pod damage (8.49) and significantly highest yield of 28.09 q/ha. This treatment was most economical giving maximum incremental income (Rs 30598/ha), highest total income (Rs 62921/ha), highest net income (Rs 54971/ha) and highest ratio of incremental cost to incremental returns (1: 3.84).

| | | |
|---|---|---|
| Title of thesis | : | Biology and predatory potential of *Mallada boninensis* (Okamoto) on mango hopper and mealy bugs. |
| Name of the Student | : | Misal Laxman Shahadeo |
| Regd. No. | : | 1969 |
| Year of Award of Degree | : | 2010 |

## THESIS ABSTRACT

A laboratory experiment were conducted, during September 2009 to December 2009 study the **"**Biology and predatory potential of *Mallada boninensis* (Okamoto) on mango hopper and mealy bugs.**"** at Bio-control Laboratory, Department of Agril. Entomology and mango orchards of the Department of Horticulture, College of Agriculture,Dapoli, (M.S.). The cultureof *Mallada boninensis* (Okamoto), mealy bugs were multiplied in the laboratory while mango hopper collected from the mango tree during the investigation.

The results of the present investigation revealed that the *M. boninensis* found predominant thoughout the mango growing areas of Konkan region. The developmental period of all instars on different prey species was in the order of mealy bugs and mango hoppers and The larval period of the *M.boninensis* fed mealy bugs and mango hoppers.The breadth and length varied in different instars of *M. boninensis* when reared on different host insects. The maximum pupal period *of M. boninensis* is 10.13 ±0.52 days when larva fed with mango hoppers nymphs, 9.48 ±0.62 days when larva fed with mealy bugs.. The pupal weight was 9.06 ± 0.067 and 8.18 ± 0.53 mg when larva reared on mealy bugs.and and mango hoppers , respectively. The adult female longetivity was recorded as 30.47 and 27.69 days while male survived for 27.50, and 26.00 days, respectively when larva was mealy bugs and mango hoppers. In general, in respective prey species adult female survived longer than male. The average pre oviposition period *of M. boninensis* after feeding on mealy bugs and mango hoppers was 10.96 ± 1.51 and 10.98 ±

1.58days, respectively, while the average oviposition period was 15.08±2.71 and 15.69±2.76 days ,respectively. The average post oviposition period was recorded as 1.65± 1.60 and 4.79 ± 3.32days when reared on mealy bugs and mango hoppers.The sex ratio (M/F) of adults was 1:1.38 and 1:2.08, respectively on mealy bugs and mango hoppers. The fecundity *of M. boninensis* was also influenced due to food variation at larval stage besides age.

The feeding potential of *M. boninensis* is 4.18, 12.63and 19.91 nymphs of mealy bugs and 8.3, 21.79 and 34.o6 nymphs of mango hoppers. during its first, second and third larval instar.

From all the above results, it can be concluded that the *M.boninensis* can be efficiently reared in laboratory under climatic conditions.The chrysopa are naturally available in the mango ecosystem in this region. Among two species, *M. boninensis* was found to be predominant in this region.

| | | |
|---|---|---|
| Title of thesis | : | "Chrysopids in mango ecosystem of Konkan region" |
| Name of the Student | : | More Santoshkumar Amnaji |
| Regd. No. | : | 91 |
| Year of Award of Degree | : | 2010 |

## THESIS ABSTRACT

Mango (*Mangifera indica* Linnius), belonging to the family Anacardiaceae, is universally considered as the finest tropical fruit of the world. Konkan is the major and famous mango producing region of Maharashtra and this fruit crop is heavily attacked by different sucking insect pests. Use of biological agents has proved as an alternative to the chemical pesticides. In India the chrysopid species viz., *M. boninensis*, *C. lacciperda* and Chrysopa sp. are reported to be the well-defined potential predators feeding on immature and adult stages of hoppers, mealybugs of mango (Fasih and Srivastava, 1990 & Herting and Simmonds, 1972). The chrysopid, *M. boninensis* has been found naturally occurring in the mango ecosystem of the Konkan region of Maharashtra, India. However, their predatory role has not been properly studied for mango pest management. Therefore, the present investigation was undertaken to study the species of chrysopid, biology, feeding potential, safety to insecticides to predominant species and seasonal abundance of chrysopids.

The survey of mango orchards was conducted during the year 2007 and 2008 indicated the prevalence of chrysopid in four districts of Konkan region. The species *M. boninensis* of chrysopid was recorded in all the tahsils of four districts while the species *C. carnea* was noticed

in five tahsils. *M. boninensis* was found predominant in mango ecosystem of Konkan region. Therefore the species *M. boninensis* was considered for further studies viz., biology, feeding potential and safety against recommended insecticides.

The eggs of *M. boninensis* took slightly less incubation period when reared on C. *cephalonica* than natural hosts *viz., F. virgata* and *I. niveosparsus.*

The larva of *M. boninensis* complete its development in a short period when fed with C. cephalonica eggs. The length and breadth of various instars of *M. boninensis did not show any significant differences* when reared on different host insect. The longest pupal period of *M. boninensis* was recorded on on *I. niveosparsus* while maximum weight of pupa was recorded on C. *cephalonica* and the female survived longer than male irrespective of food supplied during the larval stage of *M. boninensis.* But the fecundity was influenced due to food variation at larval stage and the maximum fecundity of 294.00 eggs per female was noticed when the larvae of *M. boninensis* were fed with the eggs of *C. cephalonica.*

The larva of *M. boninensis* feed maximum on the eggs of *Corcyra* which consumed on an average 496.75 eggs during its developments.

The insecticides viz., endosulfan and nimbecidine were found to be safer to the larvae of M. boninensis as minimum larval mortality was noticed. On the other hand, cypermethrin, thiamethoxam and imidacloprid were found toxic to the larvae of *M. boninensis* as maximum mortality was observed. The larval period, pupal period, pupal weight and fecundity of *M. boninensis* were found to be not significantly affected in all the insecticidal treatments.

The adult emergence of *M. boninensis* was found to be affected due to various insecticidal treatments. The insecticides endosulfan and phenthoate were found safer as most of the adult of *M. boninensis* were emerged from pupa. The emergence was significantly reduced and found to be toxic due to the treatments like cypermethrin, diamethoate and thiamethoxam, where the adult emergence was comparatively less while the insecticides like nimbecidine, endosulfan and methyl demeton were found safe and having less ovicidal action on the eggs of *M. boninensis*. On the other hand, the insecticides viz., diamethoate, cypermethrin, thiamethoxam and phenthoate were found toxic as maximum number of eggs of *M. boninensis* did not hatch when treated with these insecticides.

The population of chrysopids was found maximum during first fortnight of November and December when the temperature were low and relative humidity was high at the same time the natural population of insects viz., mango hoppers, mealy bugs, scales and thrips were higher on mango trees. The activity of predator remained low during high temperature in the month of April to August. The different parasites and predators were recorded in mango eco-system include predators viz., Mantids*, M. boninensis, Coccinella septumpunctata, Cheilonens sexmaculata, Spider marpissa dhakurensis, Eris sp., Salticus sp., Neoscona lagleizei, Nephila*

*maculata, Parasite – Dryinid wasp., Pupal parasite* on fruit fly, *Syrphid sp., Bracon greeni* and *entomopathogenic fungi Veticillium leccani.*

| | | |
|---|---|---|
| Title of thesis | : | Eco-Friendly Management of Okra Shoot and Fruit Borer Earias Vittella Fab. |
| Name of the Student | : | Miss. Neha T. Chorage |
| Regd. No. | : | 1964 |
| Year of Award of Degree | : | 2010 |

## THESIS ABSTRACT


The experiment was conducted to study the efficacy of various biopesticides, in comparison with synthetic insecticide against okra shoot and fruit borer. Data on mean fruit infestation after first spray on number basis indicated that among the treatments, Endosulfan 0.06 per cent recorded significantly lowest fruit infestation of about 13.40 per cent and found as most effective treatment. The treatments *B. thuringiensis* var. *kurstaki* @ 1.5 g $L^{-1}$, Neemazal @ 4ml $L^{-1}$, *B. bassiana* @ 5 g $L^{-1}$ and NSKE 5 per cent recorded 16.72, 17.38, 18.07 and 19.05 per cent fruit infestation and were at par with each other.

Mean fruit infestation after second spray (on number basis) by fruit borer indicated that the treatment endosulfan 0.06 per cent recorded lowest per cent fruit infestation (9.15) and was found to be the best treatment. The treatment *B.t.k* @ 1.5 g $L^{-1}$ was next in the order of efficacy by recording 12.11 per cent fruit damage and was at par with endosulfan 0.06 per cent. The next best treatments were *B. bassiana* @ 5 g $L^{-1}$ , Neemazal @ 4ml $L^{-1}$, NSKE 5 per cent and Garlic and Chilli extract @ 10 ml aqueous extract $L^{-1}$ which recorded 14.00, 15.64, 15.71 and 17.25 per cent fruit infestation, respectively.

Mean fruit infestation of okra shoot and fruit borer *E.vittella* after third spray on number basis revealed that the treatment endosulfan 0.06 per cent was found best among all other treatments by reducing the fruit damage upto 6.16 per cent. The next treatments in the order of efficacy were *B .thuringiensis* var. *kurstaki* @ 1.5 g $L^{-1}$ , *B. bassiana* @ 5 g $L^{-1}$, Neemazal @ 4ml $L^{-1}$ and NSKE 5 per cent which recorded 11.63, 13.78, 14.71 and 15.53 per cent fruit damage, respectively and were at par with each other.

The relative efficacy of different treatments after three sprays on number basis indicated that endosulfan 0.06 per cent recorded less per cent fruit infestation (9.57%) followed by *B. thuringiensis* var. *kurstaki* @ 1.5 g $L^{-1}$ , *B. bassiana* @ 5 g $L^{-1}$, Neemazal @ 4ml $L^{-1}$ and NSKE 5 per cent which recorded 13.49, 15.28, 15.91 and 16.76 per cent fruit infestation, respectively and were at par with each other. This indicated that biopesticides and botanicals can effectively control okra shoot and fruit borer, *E. vittella.*

| | | |
|---|---|---|
| Title of thesis | : | Biology and Comparative Performance of Eri Silkworm on Different Host Plants |
| Name of the Student | : | Shivanjali K. Patankar |
| Regd. No. | : | 1968 |
| Year of Award of Degree | : | 2010 |

## THESIS ABSTRACT


Laboratory studies on biology of eri silkworm revealed that mating lasted for a day. A female laid 450-525 eggs. Freshly laid eggs were creamy white in colour which changed to black prior to hatching. An egg was oval, 1.87 mm long and 1.37 mm broad. Oviposition period lasted for 5 to 6 days. Incubation period ranged from 9 to 10 days. Hatching percentage was 90 to 100 with an average of 96.5.

Performance of *Samia cynthia ricini* Boisduval on six different host plants (castor, tapioca, umbar, chafa, shivan and adulsa) revealed a notable difference amongst them. Except on adulsa, where the larvae did not survive for more than two days after hatching, the larvae reached maturity on all other hosts tested.

Castor recorded minimum incubation period, larval period, pupal period and total duration of life cycle from egg to adult. On the other hand, shivan registered higher developmental periods when compared to tapioca, umbar and chafa.

The average incubation period was found more on shivan (11.19 days) followed by chafa (10.80 days), umbar (10.65 days), tapioca (9.74 days) and was less on castor (9.33 days). Hatching percentage was highest in case of castor (94.42 %) followed by tapioca (89.69%), chafa (84.45%), umbar (79.29%) and was lowest on shivan (74.60%). The variation in hatching percentage was due to the effect of host plants.

The larval period was maximum on shivan (27.73 days) and was minimum on castor (19.46 days). It was 25.20, 24.23 and 21.07 days on chafa, umbar and tapioca, respectively. There was no much more variation in duration of pupal period among the hosts.

Eri silkworms fed on leaves of castor recorded the highest mature larval weight (8.602 g) and lowest weight was observed in shivan (6.873 g). The weight increased gradually during early instars and sudden increase was observed during fifth instar. Mean growth rate was maximum on castor (0.196) and minimum on shivan (0.144).

Survival percentage was maximum on castor (98) and minimum on chafa (75). Percentage survival on tapioca, umbar and shivan was 94, 92 and 87, respectively. A maximum cumulative growth index was recorded on castor (5.04) and was minimum on chafa (2.98).

The cocoon weight, pupal weight and shell weight were found to be maximum on castor followed by tapioca. Chafa was found superior to umbar in these parameters. The silk ratio was maximum on castor (15.06%) followed by tapioca (14.89%), chafa (14.78%), umbar (14.21%) and shivan (13.48%).

| | | |
|---|---|---|
| **Name of student** | : | **Kumud Vitthal Naik** |
| **Title of thesis** | : | Host Plant Resistance and Efficacy of Pesticides against Brinjal Shoot and Fruit Borer, *Leucinodes orbonalis* Guenee (Lepidoptera : Pyralidae) |
| **Name of Research Guide** | : | Dr. P. D. Patil |

The studies on field screening of different brinjal cultivars revealed that the per cent shoot and fruit borer infestation during *rabi* 2008-09 ranged between 27.41 to 78.11 and 23.35 to 74.66 in *rabi* 2009-10. The per cent infestation in *rabi* 2008-09 was minimum in the cultivar BB-64 (27.41 %) and maximum (78.11%) in Suvarna Pratibha. While, in *rabi* 2009-2010, the lowest (23.35%) per cent infestation was recorded in the cultivar Lanja Local and highest (74.66%) in CHES-309. The reaction of different brinjal cultivars against infestation by shoot and fruit borer revealed that no any cultivar was found to be fairly resistant as well as highly resistant and even in immune category.

The infestation of the pest was started in 7$^{th}$ meteorological week i.e. 3$^{rd}$ week of February (6.24%) and remained up to 2$^{nd}$ week of April. Among the various meteorological parameters, the morning relative humidity, wind speed, rainfall and pan evapotranspiration were significantly and positively correlated with borer infestation. Other factors were either positively or negatively but non significantly correlated with fruit infestation.

In the present investigation the fruit characters *viz*., colour, shape, pedicel, calyx character and pulp of fruit did not have any direct relation with borer infestation. Whereas, the length of pedicel, calyx, total seed area, distance of seed from pedicel and weight of fruit showed

positive non significant correlation with fruit infestation. The thickness of rind of fruit and number of seeds showed non significant negative correlation with borer infestation.

The biochemical attributes of the brinjal fruits *viz*., phenol and iron were having positive correlation, while sugars, protein, ascorbic acid, phosphorus, potassium, copper, manganese and zinc were negatively correlated with fruit infestation.

The overall efficacy of pesticides from all the four sprays in *rabi* 2008-2009 and 2009-2010 revealed that the treatment of emamecitn benzoate 0.0033 per cent was effective (17.21%) in reducing the fruit damage and was at par with carbaryl 0.1 per cent (17.76%), endosulfan 0.05 per cent (20.26%), methomyl 0.06 per cent (21.84%) and indoxacarb 0.02 per cent (23.77%). The next best treatments were econeem plus 0.004 per cent (26.39%), spinosad 0.0035 per cent (26.67%), novaluron 0.015 per cent (27.07%), cypermethrin 0.0075 per cent (27.58%), *B bassiana* @ 5 g $L^{-1}$ (28.19%) and lambda cyhalothrin 0.003 per cent (31.80%).

---

| | | |
|---|---|---|
| **Name of student** | : | **Mr. Lad Sunil Keraba** |
| **Title of thesis** | | "Mealy bugs infesting some major fruit crops of the Konkan region of Maharashtra (India)" |
| **Name of Research Guide** | : | Dr. P. D. Patil |

---

During survey of mealy bug, five species were recorded on fruit crops *viz,* mango, cashew, coconut, sapota and arecanut from different areas of Konkan region of Maharashtra (India). The species *Ferrisia virgata* (Cockerell) and *Planococcus* spp. were observed on mango, whereas *Ferrisia virgata* (Cockerell), *Maconellicoccus hirsutus* (Green) *and Planococcus* spp. were observed on cashew. On coconut as well as on arecanut *Icerya aegyptiaca* (Douglas) was noticed. The species *Maconellicoccus hirsutus* (Green) observed predominantly in sapota as well as in cashew orchards.

The life cycle from egg to adult emergence in case of male and female mealy bugs were 23.93 ± 2.96 and 32.79 ± 3.92 days in winter season as against those of 21.12 ± 2.92 and 24.19 ± 2.62 days, respectively in summer season. During winter**,** adult male survived for an average of 4.53 ± 0.52 days while female for 18.53 ± 0.99 days whereas, in summer adult male survived with an average of 3.53 ± 1.13 days and female for 9.93 ± 1.16 days. The temperature had a marked effect on sex ratio of the *M. hirsutus*. The male to female sex ratio was 1:1.86

during winter and in summer it was 1:3, respectively. It indicated that the high temperature induces female population.

During the present investigation, different parasites and predators were recorded on mealy bugs included predators *viz., Chrysoperla carnea* (Stephens), *Mallada boninensis* (Okamato), *Cheilomenes sexmaculata* (Fabricius), *Cryptolaemus montrouzieri* (Mulsant) and *Coccinella septumpunctata* (Linnaeus), *Syrphid* spp. and entomopathogenic fungi *Verticillium leccani.*

*C. montrouzieri*, being a potential predator of mealy bugs, the studies on its biology and feeding potential were carried out. During winter the development of first, second, third and fourth instar grub of *C. montrouzieri* took 5 to 7 days, 3 to 5 days, 4 to 6 days and 5 to 8 days, respectively. While in summer the development of first, second, third and fourth instar grub of *C. montrouzieri* was completed in 5 to 8, 3 to 7, 4 to 6 and 5 to 9 days, respectively. During winter the average pre pupal period was 1.5 ± 0.52 days and the pupal period was 10.3 ± 1.63 days. While in summer, the average pre pupal period was 1.6 ± 0.52 days and the pupal period was 11.4 ± 2.72 days. There was not much variation observed in sex ratio, it was 1: 1.08 in winter and 1: 1.17 in summer.

The overall results of the feeding potential of the *C. montrouzieri* revealed that, the Australian lady beetles consumed more number of nymphs (306.6 ± 10.79 nymphs in winter where 315.1 ± 12.91 nymphs in summer) as compared to adults (27.70 ± 7.72 adults in winter where 26.8 ± 4.88 adults in summer) of *M. hirsutus*. Similarly, the result showed that, feeding potential of *C. montrouzieri* was higher in summer than in winter. The study revealed that, the predator *C. montrouzieri* was very good potential predator of mealy bug, *M. hirsutus*

---

| | | |
|---|---|---|
| **Name of student** | **:** | **Miss. Maske Sheetal Vishwas** |
| **Title of thesis** | | Effect of artificial diets on the longevity and fecundity of *Chrysoperla zastrowi arabica* (Henry) |
| **Name of Research Guide** | **:** | Dr. S.K. Mehendale |

---

The results of present investigation revealed that the weight of female and male *Chrysoperla* was maximum in diet T4 (0.016g and 0.0092g, respectively) which contained egg

yolk + milk powder + honey. Female lived longer (28.33 days) when fed on diet T5 (egg white + milk powder + honey).

Maximum life time fecundity (636.07eggs) and per day fecundity (28.98 eggs) was observed when fed on egg yolk (T4). Shortest pre-oviposition period was reported in T7 (3.67 days) which contain honey and water solution. Oviposition period of females from diet T2 (Honey + Proteinex + Fructose + Yeast powder + Vitamin E + Milk powder + Distilled water) was much longer (19.53 days). Post oviposition period was higher in T7. As far as the incubation period is concerned it was shorter in case of eggs obtained from females fed on diets T1 (standard diet) and T5. Results on hatching percentage revealed that 100 per cent egg hatching was recorded in T4, T5 and T6. 100 eggs weight was recorded maximum in case of the eggs laid by the *Chrysoperla* females fed on diet T5 (0.018 g).

Thus, based on over all above results the suitability of different artificial diets for mass production of *C.zastrowi arabica*, diets containing egg parameters like egg yolk, egg white and egg mixed were better for longevity and higher fecundity of female and also next generation of *C.zastrowi Arabica.*

| | | |
|---|---|---|
| **Name of the student** | **:** | **Mr. Ganesh Aaba Gejage** |
| **Title of thesis** | **:** | Life fecundity table studies of rice moth,*Corcyra cephalonica* (Stainton) on different rearing media. |
| **Name of Research Guide** | **:** | Dr. V.S. Desai |

The experiment on the Life fecundity table studies of rice moth, *Corcyra cephalonica* (Stainton) on different rearing media was conducted in laboratory during the year 2010 to 2011 at Department of Agricultural Entomology, College of Agriculture, Dapoli (Maharashtra) with a view to find out an alternate and cheap rearing media to sorghum, as it is costly and not available throughout year in Konkan region. Further the bionomics of *Corcyra cephalonica* (Stainton) was also studied

The results of the present investigation revealed that the rearing media composed of T6 (Maize + Nagli + Groundnut +Yeast) or T1 (Sorghum + Tapioca + Rice germ +Milk powder) or T5 (Bajara + Nagli + Groundnut + Yeast) were found equally effective to standard media T7 (Sorghum + Groundnut + Yeast) for the mass production of the rice moth in the laboratory. The (sorghum + groundnut + yeast) are now a day commonly used for the mass production of *C. cephalonica*. The sorghum is costly and not amply available in the area. As the effective rearing media consists of waste products from milling industry and other locally available ingredients, the cost of the mass production of factitious host may be reduced as well as the local ingredients can be utilized for the mass production. It is therefore recommend that the locally available ingredients like rice germ, nagli, may be used instead of sorghum or to reduce the quantity of sorghum. Also the milk powder or small quantity of sugar may be substituted instead of yeast to reduce the cost of the rearing media.

| | | |
|---|---|---|
| **Name of student** | **:** | **Ms. Sharda Kashinath Nadekar.** |
| **Title** | **:** | Biology and chemical control of *Ferrisia virgata*, cockerell infesting mango. |
| **Name of Research Guide** | **:** | Dr. S. K. Godase |

The studies on biology of *F. virgata*, revealed that the preoviposition, oviposition and postoviposition period lasted for 7.7, 5.2 and 1.7 days, respectively. On an average female laid 59.3 eggs. Incubation period ranged from 0.46 to 0.56 hours with an average of 0.51 hours. The hatching percentage varied from 60 to 100 with an average of 79 per cent. The male nymph moulted three times passed through four nymphal instars whreras, female nymph moulted two times and passed through three nymphal instars. In case of male the average durations of I, II, III and IV instars were 7.3, 5.0, 2.3, 3.3 days, respectively whreras, in female the average durations of I, II and III instars were 7.7, 5.8 and 7.1 days, respectively. A total nymphal period in male varied from 16 to 19 days with an average of 17.6 days whereas, in female total nymphal period varied from 19 to 23 days with an average of 20.7 days. The average longevity of male and

female was observed 16.9 and 16.9 days, respectively with 1:1.32 male to female sex ratio. The total life cycle period in male and female was 17.69 and 20.73 days, respectively. The generation from egg to death of adult completed within 32.02 to 37.02 days with an average of 34.59 days in case of male whereas, 37.02 to 47.02 days with an average of 42.33 days in female.

As regarding evaluation of pesticides. The treatments imidachloprid (0.009%) observed to be the most effective as it gave knock down effect with more than 90 per cent nymphal mortality after three day after application. However, considering the overall cumulative mortality ten days after application, the treatments imidachloprid (0.009%), polytrin-C (0.05%) and spinosad (0.018%) were emerged as the most effective treatments for the control of *F.virgata*.

| | | |
|---|---|---|
| **Name of the student** | **:** | **Mr. Khapare Deepak Dhondiram** |
| **Title of thesis** | **:** | Varietal screening and evaluation of pesticides against okra shoot and fruit borer, *Earias vittella* Fab. (Lepidoptera: Noctuidae). |
| **Name of Research Guide** | **:** | Dr. A.L. Narangalkar |

Varietal screening of twelve cultivars against shoot and fruit borer, *Earias vittella* Fab. indicated that none of the screened cultivar were infested by shoot borer. While, the cultivars screened against fruit borer showed that, PB-236 (30.54 q $ha^{-1}$), Phule Kirti (31.47 q $ha^{-1}$) and Evergreen (27.82 q $ha^{-1}$) were graded as fairly resistant to fruit borer and produced higher yield. Similarly Cultivars *viz.,* DSN-1, Arka Abhay, Varsha Uphar, HRB-107-1, DSU-1 and PB-266-1 were categorized as tolerant by producing 27.39, 25.23, 24.30, 25.05 and 21.99 q $ha^{-1}$ marketable okra fruit, respectively. The cultivars *viz.,* Parbhani Kranti (21.77 q $ha^{-1}$), Bhendi Go-2 (19.03 q $ha^{-1}$) and Karishma (17.82 q $ha^{-1}$) were found as susceptible.

The investigation of evaluation of different pesticides after three sprays showed that, emamectin benzoate 5 SG @ 0.0033 per cent (6.90%) and spinosad 45 SC @ 0.0035 per cent (7.5%) recorded low per cent fruit infestation and produced 43.31 and 42.73 q $ha^{1}$ yield, which is

superior over other treatments. Whereas, in insecticides along with sticker @ 1ml $l^{1}$, the treatments emamectin benzoate 5 SG (@ 75% of 0.0033% conc.), spinosad 45 SC (@ 75% of 0.0035% conc.) and profenofos 40% + cypermethrin 4% (@ 75% of 0.07% conc.) which recorded 10.70, 11.52 and 12.82 per cent fruit infestation and produced 38.26, 37.32 and 36.33 q $ha^{-1}$ marketable okra fruit, respectively.

| | | |
|---|---|---|
| **Name of student** | **:** | **Miss. Madhuri Vijay Pawar** |
| **Title** | **:** | Effect of *Corcyra cephalonica* (Stainton) eggs reared on different media on *Chrysoperla zastrowi arabica* (Henry) |
| **Name of Research Guide** | **:** | Dr. S.K. Mehendale |

Effect of different rearing media on *C. cephalonica* revealed significantly the lowest incubation period (2.3 days) in T4 (Sorghum (750 g) + Gram (250 g) + Yeast (5 g). Similarly, the fastest total larval development period (17.7 days) was observed in T7 (Sorghum (750 g) + Groundnut (250 g) + Yeast (5 g) while minimum pupal period (8.9 days) was observed in T7. However, average larval development was found in T7. As far as weight of fifth instar larva and pupae of *C. cephalonica* was concerned medium T6 (Sorghum (750 g) + Kidney bean (250 g) + Yeast (5 g) recorded significantly the highest values.

Medium T7 was the best medium with highest per cent adult emergence (46.15) and remained at par with T6. Fecundity and longevity was highest in T7 (401.53eggs) and (5.80 days for female and 11.13 days for male), respectively.

Effect of *Corcyra* eggs on *C. zastrowi arabica,* indicated that there was negligible difference in case of feeding potential, developmental period and per cent adult emergence of *Chrysopids.* However, weight of larvae, pupae and adult was somewhat affected by quality of eggs. Maximum weight of larva was 1.83mg in first instar, 6.40mg in second instar and 8.17mg in third instar, as observed in T7, T3 (Sorghum (750 g)+ Cowpea (250 g) + Yeast (5 g) and T7, respectively. Similarly, the maximum weight of pupa of *Chrysoperla* was observed in T6 (7.39mg) followed by T3 (7.35mg). Sex ratio of *Chrysoperla* (M: F) revealed female

preponderance (1: 1.53) in T1 followed by T2 (Sorghum (750 g) + Black gram (250 g) + Yeast (5 g) (1: 1.5). Effect of *Corcyra* eggs on next generation *Chrsoperla* adults revealed that maximum weight of female and male was observed in T3 (3.87 and 3.59mg respectively) followed by T7 (3.86 and 3.48mg respectively).

| | | |
|---|---|---|
| **Name of student** | **:** | **Navale Narayan Raosaheb** |
| **Title** | **:** | Seasonal incidence and ecofriendly management of pod borer complex of pigeon pea |
| **Name of Research Guide** | **:** | Dr. V.S. Desai |

The incidence of *E. atomosa* was started in 46$^{th}$ meteorological week i.e. second week of November and remained up to 3$^{rd}$ meteorological week i.e. third week of January. The incidence was in the range of 0.7 to 1.5 larvae per plant and it was maximum (1.5 larvae / plant) in 3$^{rd}$ meteorological week.The infestation of *H. armigera* started in 49$^{th}$ meteorological week and continued till the end of January (5$^{th}$ meteorological week).

Among the various meteorological (Weather) parameters, the minimum temperature positively influenced the per cent bud infestation of tur plume moth, *E. atomosa* in pigeon pea. Whereas, only sunshine hours have positive correlation with per cent bud infestation of *H. armigera* in pigeon pea.

The cumulative effect of all the three sprays indicated that the module $M_9$ composed of Endosulfan 35 EC (0.07%) followed by Quinalphos 25EC 0.04 per cent followed by Phosalone 35 EC 0.07 per cent recorded lowest bud/pod infestation (5.47%) and found to be best module for the management of tur plume moth, *E. atomosa*.

As regarding *H. armigera* the cumulative effect of all the sprays indicated that the module $M_9$ composed of Endosulfan 35 EC (0.07%) followed by Quinalphos 25EC 0.04 per cent followed by Phosalone 35 EC 0.07 per cent recorded lowest bud/pod infestation (2.01%) and found to be best module for the management of tur pod borer, *H. armigera*.

The yield data on marketable grains recorded in various treatments revealed that highest yield of 11.36 q ha $^{-1}$ was recorded in module $M_9$ (Endosulfan 35EC 0.07per cent followed by Quinalphos 25EC 0.04 per cent and Phosalone 35 EC 0.07 per cent) and was significantly superior over all other treatments.

| | | |
|---|---|---|
| **Name of student** | **:** | **Miss. Pallavi Baburao Salunkhe** |
| **Title of thesis** | : | Relative performance of different races of mulberry silkworm *Bombyx mori* Linn. under Konkan condition. |
| **Name of the Research Guide** | : | Prof. M.S.Karmarkar |

The present study conducted at Sericulture Research Unit, Department of Agricultural Entomology, College of Agriculture, Dapoli. The silkworm DFL's were procured from Sericulture Center, Gadhinglaj, Dist. Kolhapur. The selected races were Pure Mysore (PM-1), bivoltine $CSR_2$ and Kolar Gold.

During study it was observed that hatching and survival percentage were highest in Kolar Gold. Minimum days of larval duration were observed in $CSR_2$. In growth rate, Kolar Gold showed best performance. Weight of mature larva was highest in Pure Mysore. As per market point of view, Kolar Gold showed superiority in economic traits such as green cocoon weight and shell weight among all three races. In morphomatrix, Kolar Gold showed highest length and width of cocoon. But Silk percentage was highest in Pure Mysore. It is due to less weight of pupa in Pure Mysore.

$CSR_2$ showed highest food requirement as compared to other races but highest total yield of cocoon/DFL was reported in Kolar Gold.

It is concluded from present study that Kolar Gold is the best suitable hybrid for Konkan condition in mulberry silk production.

## THESIS ABSTRACTS

| | | |
|---|---|---|
| **Title of thesis** | **:** | Evaluation of entomopathogenic fungi and botanicals for the management of mealybug and scale insect. |
| **Name of the student** | **:** | Mr. Chaudhari Vishal Vilas |
| **Name of the Research Guide** | **:** | Dr. V. S. Desai |


The present investigation on "Evaluation of entomopathogenic fungi and botanicals for the management of mealybug and scale insect" was carried out at Biological control Laboratory, Department of Agril. Entomology, College of Agriculture, Dapoli.

Mealybugs are called as hard to kill pest. For the management of mealybugs and scales, higher concentration of insecticides has to be used that may pose various problems. Use of biopesticides may become safer option. The efficacy of different entomopathogenic fungi and botanicals on mealybugs ten days after treatment revealed that the maximum mean mortality of 90.00 per cent was recorded in the treatment (T3), *V. lecanii* @ $10^9$ cfu/ml followed by treatment (T2) *V. lecanii* @ $10^8$ cfu/ml and (T7)*V. lecanii* @ 5 gm/lit. water which recorded 85.00 and 80.00 per cent mean mortality, respectively and were at par with each other.

The results of the entomopathogenic fungi and botanicals on scale insect ten days after application revealed that the maximum mortality of 41.67 per cent was recorded in the treatment (T6), *B. bassiana* @ $10^9$ cfu/ml. The treatments *V. lecanii* @ $10^9$ cfu/ml (T3), *B. bassiana* @ 5 gm/lit. water (T9), *V. lecanii* @ 5 gm/lit. water (T7), *B. bassiana* @ $10^8$ cfu/ml (T5) and *V. lecanii* @ $10^8$ cfu/ml (T2) recorded 36.67, 35.00, 26.67, 26.67 and 25.00 per cent mortality respectively and were statistically at par with the treatment T6.

It can be concluded that for the management of mealybugs *V. lecanii* @ $10^8$ cfu/ml as well as talc formulation of *V. lecanii* @ 5gm/lit produced at the University can be used effectively. Also for the first instar crawlers of scale insects, *B. bassiana* @ $10^8$ cfu/ml, *V. lecanii* @ $10^8$ cfu/ml as well as talc formulation of *B. bassiana* @ 5 gm/lit. and *V. lecanii* @ 5gm/lit. produced at the University can be used effectively.

| | | |
|---|---|---|
| **Title of thesis** | : | Relative performance of different hybrids of mulberry silkworm *Bombyx mori* Linn. under Konkan condition. |
| **Name of student** | : | Mr. Nikhil Ankush Gawade |
| **Name of the Research Guide** | : | Dr. S. K. Mehendale |

The present study conducted at Sericulture Research Unit, Department of Agricultural Entomology, College of Agriculture, Dapoli. The silkworm DFL's were procured from Central Sericultural Research and Training Institute, Mysore. The hybrids selected were $CSR_3 \times CSR_6$,$CSR_{16} \times CSR_{17}$, $PM \times CSR_2$ and $CSR_2 \times CSR_4$. The reeling was done at Government Reeling Centre, Islampur, Tal. Walwa, Dist. Sangli.

During study it was observed that hatching and survival percentage were highest in $CSR_{16} \times CSR_{17}$. Minimum days of larval duration were observed in $PM \times CSR_2$. In growth rate, $CSR_{16} \times CSR_{17}$ showed best performance. Weight of mature larva was highest in $CSR_{16} \times CSR_{17}$. As per market point of view, $CSR_{16} \times CSR_{17}$ showed superiority in economic traits such as green cocoon weight and shell weight among all four hybrids. In morphomatrix,$CSR_{16} \times CSR_{17}$ showed highest length and width of cocoon. Due to all above parameters silk percentage was highest in $CSR_{16} \times CSR_{17}$. While quality parameters like filament length, single cocoon denier and renditta was highest in $CSR_{16} \times CSR_{17}$.

$CSR_{16} \times CSR_{17}$ showed highest food requirement as compared to other hybrids and also showed highest total yield of cocoon/DFL.

It is concluded from present study that $CSR_{16} \times CSR_{17}$ is the best suitable hybrid for Konkan condition in mulberry silk production.

| | |
|---|---|
| **Title of thesis** | : "Survey of predatory coccinellids, biology and feeding potential of *Chilomenes sexmaculata* (Fab.)" |
| **Name of Student** | : Miss. Walawalkar Namrata Pradip |
| **Name of research guide** | : Dr. A. L. Narangalkar |

Aphids are important pests of various cultivated crops and their populations are kept in check under natural conditions by one of their predators, the coccinellids. The indiscriminate use of pesticides has resulted into several adverse effects. Hence, the situation demands the bio-intensive integrated pest management approach for managing the pests of agricultural importance.*Chilomenes sexmaculata* (Fab.) is an effective predator to be used as a bio-control

agent but the major challenge is it's mass rearing and augmentation. Hence,present studies were undertaken to survey the predatory coccinellids, biology and feeding potential of *C. sexmaculata*during 2010-12 at College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli.

The survey of coccinellids conducted in Department of Agronomy and Horticulture, College of Agriculture, Dapoli during December, 2010 to November, 2011 revealed five species of aphidivorous coccinellids *viz., Chilomenes sexmaculata* (F.)*,Coccinella septempunctata* (L.)*, Coccinella transversalis*(F.), *Chilocorus nigritus*(F.) and *Illeis cincta*(F.).

Studies on the biology of *C. sexmaculata* on *Aphis craccivora* (K.) and artificial diet revealed that the total developmental period was 10.8 and 13.2 days, respectively. The pre-oviposition, oviposition and fecundity was recorded on an average of 1.35 ± 0.50 days, 27.8 ± 5.38 days and 276.4 ± 25.63 when predator reared on aphids. While these bio stages were not observed on artificial diet. The longevity of male and female on aphids was 26.7 and 29.5 days, respectively while on artificial diet it was 12.6 and 13.7 days, respectively.

The study on feeding potential of predator on aphid-nymphs of *Aphis craccivora* (Koch.) revealed that, the grub consumed a total of 118.01 ± 3.2 aphid-nymphs during its developmental period. The male beetle devoured on an average 53.5±1.25 aphid-nymphs while female beetle consumed on an average 58.3±1.32 aphid-nymphs.

From the data, it is concluded that, *C. sexmaculata* was the most abundant species in Konkan region. The *C. sexmaculata*can be reared very well on *Aphis craccivora* (K.) than on artificial diet. As *A. craccivora* is serious pest on field crops in Konkan region of the Maharashtra, beetle can be utilized in the field for its management.

| | | |
|---|---|---|
| **Title of thesis** | **:** | Evaluation of entomopathogenic fungi and botanicals for the management of mango hoppers and thrips. |
| **Name of the student** | **:** | Mr. Prashant Kisan Gurav |
| **Name of the Research Guide** | **:** | Dr. V. S. Desai |

The present investigation on "Evaluation of entomopathogenic fungi and botanicals for the management of mango hopper and thrips" was carried out at Biological Control Laboratory, Department of Agril. Entomology, College of Agriculture, Dapoli.

Mango hoppers are major pest of mango and thrips are polyphagous pest. For the management of mango hoppers and thrips, number of insecticides has to be used that may pose various problems. Use of biopesticides may become safer option.

The efficacy of different entomopathogenic fungi and botanicals on mango hoppers ten days after treatment revealed that the maximum mean mortality 93.34 per cent was recorded in treatment (T3), *V. lecanii* @ $10^9$cfu/ml and was found to be the best treatment. The treatments *V.*

*lecanii* @ 5 g/l (T7), *B. bassiana* @ 5g/l water (T9), *V. lecanii* @ $10^8$ cfu/ml (T2), *B. bassiana* @ $10^9$ cfu/ml (T6), *B. bassiana* @ $10^8$ cfu/ml (T5) and Ritha extract @10 per cent (T14) recorded 90.00, 83.33, 81.67, 81.67, 80.00 and 80.00 per cent mortality of mango hoppers respectively and were statistically at par with the treatment T3.

The results of the entomopathogenic fungi and botanicals on thrips ten days after application revealed that the maximum mortality mean mortality of 90.00 per cent was recorded in treatment (T3), *V. lecanii* @ $10^9$ cfu/ml and was found to be the best treatment. The treatments *V. lecanii* @ 5 g/l (T7), *B. bassiana* @ $10^9$ cfu/ml (T6), *B. bassiana* @ 5g/l water (T9), *V. lecanii* @ $10^8$ cfu/ml (T2), *B. bassiana* @ $10^8$ cfu/ml (T5) and Ritha extract @10 per cent (T14) recorded 86.67, 83.33, 81.67, 80.00, 78.33 and 76.67 per cent mortality of thrips respectively and were statistically at par with the treatment T3.

From the above studies it can be concluded that for the management of mango hoppers and thrips, *V. lecanii* @ $10^8$ cfu/ml, *B. bassiana* @ $10^8$ cfu/ml, talc formulation of *V. lecanii* @ 5g/l, *B. bassiana* @ 5g/l water both prepared at Biological Control Laboratory, Department of Agril. Entomology, and Ritha extract @10 per cent can be used effectively.

| | | |
|---|---|---|
| **Title of thesis** | : | Efficacy of *Sl*NPV by using adjuvants against, *Spodoptera litura* Fab. (Lepidoptera: Noctuidae) |
| **Name of the student** | : | Mr. Bhandvalkar Dipak Shivaji |
| **Name of the Research Guide** | : | Dr. S. K. Mehendale |

*Spodoptera litura* (Fab.) (Lepidoptera: Noctuidae), commonly known as tobacco caterpillar in India is a major polyphagous pest which attacks variety of economically important crops such as cotton, groundnut, rice, tomato, tobacco, citrus, cocoa, potato, rubber, castor, millets, sorghum, maize and many other vegetables. The experiments were conducted to evaluate the efficacy of *Sl*NPV along with adjuvants against, *S. litura* in laboratory during period 2011-2012 at the Department of Entomology, College of Agriculture, Dapoli, with a view to find out a cheap adjuvant for *Sl*NPV.

The results of the present investigation revealed that *Sl*NPV if combined with phagostimulants like coconut oil 0.5 per cent increased the mortality within short period and maximum relative efficacy (RE) against 2$^{nd}$ instar larvae of *S. litura.* Further, phagostimulants like soya flour (2%), egg whole (2%) and molasses (2%) were found to be highly effective in creating significant larval mortality within short period. The studies regarding the role of UV-

Protectants in reducing the photodegradation of *Sl*NPV in the field revealed that the UV-Protectant *viz*; boric acid (0.2% and 0.5 %) checked the photodegradation of *Sl*NPV upto 2 days after spraying along with higher mortality.

| | | |
|---|---|---|
| **Title of thesis** | **:** | "Performance of egg parasitoid *Trichogramma chilonis* (Ishii) under laboratory conditions" |
| **Name of the student** | **:** | Mr. Dileep, R.C. |
| **Name of the Research Guide** | **:** | Dr.(Mrs.) K. V. Naik |

The present investigations were undertaken to study the performance of egg parasitoid *Trichogramma chilonis* (Ishii) under laboratory conditions.

The results of development of *Trichogramma chilonis* (Ishii) on *Corcyra cephalonica* (Stainton) and *Spodoptera litura* (Fab.) revealed that the development of *T. chilonis* was found superior over eggs of *S. litura* except in per cent parasitization on eggs of *C. cepholonica.*

Effect of host egg age on the performance of *T. chilonis* revealed that egg age from 0 - 1 to 24 - 25 h old were highly preferred for parasitization.

For mass production of the parasitoid in the laboratory trichocard of green colour was most suitable.

Effect of cold storage at $15^0$C temperature for varying period on already parasitized egg cards, 4 day after parasitization revealed that parasitized trichocards after 4 days of parasitization can effectively stored up to 30 days without much effect on adult emergence.

Insecticide safeties to egg parasitization revealed that based on ranking, acephate 75 SP (0.1 %), imidachloprid17.5 SL (0.005 %), emamectin benzoate 5 SG (0.0033 %) and novaluron 10 EC (0.0035 %) as harmless (Score 1 = < 30 % reduction in egg parasitization over control) azadirachtin 10000 ppm (0.004 %), spinosad 45 EC (0.0035 %) and cypermethrin 25 EC (0.0075 %) as slightly harmful (Score 2 = 30-79% reduction in egg parasitization over control) while, triazophos 40 EC (0.05 %) and lambda cyhalothrin 5 EC (0.003 %) as moderately harmful (Score 3 = 80-99% reduction in egg parasitization over control). Whereas for adult emergence azadirachtin 10000 ppm (0.004 %) was found safe and acephate 75 SP (0.1 %), emamectin benzoate 5 SG (0.0033 %), novaluron 10 EC (0.0035 %), triazophos 40 EC (0.05 %) and cypermethrin 25 EC (0.0075 %) were slightly harmful, imidachloprid17.5 SL (0.005 %) and lambda cyhalothrin 5 EC (0.003 %) as moderately harmful and spinosad 45 EC (0.0035 %) recorded as harmful.

| | | |
|---|---|---|
| **Title of Thesis** | : | Biology and chemical control of *Orthaga euadrusalis* Walker infesting mango. |
| **Name of student** | : | Mr. Kalpesh Asaram Dabhade. |
| **Name of the Research Guide** | : | Dr. S. K. Godase |

The studies on biology of mango leaf webber, *Orthaga euadrusalis* Walker revealed that the average preoviposition, oviposition and postoviposition periods lasted for 3.1, 4.3 and 1.9 days, respectively. Incubation period ranged from 4 to 8 days with an average of 5.35 days. The hatching percentage varied from 70 to 100 per cent with an average of 82.

The average durations of first, second, third, fourth, fifth, sixth and seventh instars were 4.2, 3.6, 3.5, 4.1, 3.3, 5.8 and 5.6 days, respectively. A total larval period varied from 26 to 35 days with an average of 30.10 days. The average duration of the male and female pupae was 15.2 and 16.8 days, respectively.

The male adults measured on an average 12.36 mm in length and 18.67 mm in breadth at wing expanse, while female adults measured on an average 13.58 mm in length and 21.68 mm in breadth at wing expanse. The average longevity of male and female was observed 4.00 days and 7.60 days, respectively. The total life cycle completed in 55.85 days in male and 57.45 in female whereas, the generation from egg to death of adult completed within 47 to 75 days with an average of 59.85 days. The study conducted on efficacy of insecticides indicated that the treatment of 0.1 per cent carbaryl, 0.015 per cent spinosad, 0.01 per cent cypermethrin, 0.0016 per cent emamectin benzoate, 0.05 per cent DDVP showed comparatively less spread of the leaf webber infestation. The treatment of 0.0025 per cent azadirachtin was also found effective. However, the biopesticide *Bt* was not found effective in the management of *O. euadrusalis* infesting mango.

**Extension activities**

## विस्तार शिक्षण कार्यक्रम

कार्यालय : कृषि कीटकशास्त्र विभाग, कृषि महाविद्यालय, दापोली.

वर्ष : एप्रिल २०१२ ते मार्च २०१३

| अ. क्र. | विस्तार शिक्षण कार्यक्रम | कार्यक्रमांची संख्या | लाभार्थी/सहभागी लोकांचा प्रकार व संख्या | एकूण |
|---|---|---|---|---|

| | | | शेतकरी | | शासकीय अधिकारी | | इतर | |
|---|---|---|---|---|---|---|---|---|
| | | | स्त्री | पुरूष | अधिकारी | विस्तार कार्यकर्ते | | |
| | | १ | २ | ३ | ४ | ५ | ६ | ७ |
| १. | जिल्हा मासिक चर्चासत्र | ०३ | — | २० | १० | — | — | ३० |
| २. | निदान चमू भेटी | — | — | — | — | — | — | — |
| ३. | प्रशिक्षकांचे प्रशिक्षण | — | — | — | — | — | — | — |
| | • अखिल भारतीय स्तरावरील (Trainers training on structural pest control) | १ | — | — | — | — | — | १०० |
| | • राज्य स्तरावरील | १ | — | ५० | १० | — | — | ६० |
| | • कोकण विभाग स्तरावरील | १ | — | — | २५ | ७५ | ९७५ | १०० |
| | • विद्यापीठ स्तरावरील | १ | — | — | — | — | — | ५० |
| ४. | व्यावसायिक प्रशिक्षण | — | — | — | — | — | — | — |
| | • ग्रामीण युवक | — | — | — | — | — | — | — |
| | • ग्रामीण महिला | — | — | — | — | — | — | — |
| | • ग्रामीण कारागीर | — | — | — | — | — | — | — |
| ५. | शेतकरी मेळावे | १० | — | — | — | — | — | २३०० |
| ६. | विशेष दिन (दिनांक आणि दिनाचे नाव)<br>१. महिला कृषि दिन | १ | ३०० | — | — | — | — | ३०० |
| ७. | कृषि प्रदर्शन | १ | — | — | — | — | — | — |
| ८. | मेहिमा | — | — | — | — | — | — | — |
| | • आंबा —काजू मोहोर संरक्षण मोहिम | — | — | — | — | — | — | — |
| | • वृक्षारोपण मोहिम (झाडांची संख्या द्यावी) | ०१ | | ०९ | ०१ | — | — | १० |
| | • जलसंधारण मोहिम (बंधाऱ्यांची संख्या द्यावी) | — | — | — | — | — | — | — |
| ९. | कृती प्रात्यक्षिके | — | — | — | — | — | — | — |
| १०. | परिणाम /पीक प्रात्यक्षिके | — | — | — | — | — | — | — |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ११. | प्रथमदर्शी पीके प्रात्यक्षिके | — | — | — | — | — | — | — |
| १२. | शेतकऱ्यांच्या शेतावर चाचणी | — | — | — | — | — | — | — |
| १३. | चर्चासत्र /कार्यशाळा | — | — | — | — | — | — | — |
| | • अधिकारी/विस्तार कार्यकर्ते | ०२ | — | — | — | — | — | — |
| | • शेतकऱ्यांकरिता | ०४ | १० | ३०० | १५ | — | — | ३२५ |
| १४. | गटचर्चा | — | — | — | — | — | — | — |
| १५. | फिरती कृषि प्रदर्शनी | — | — | — | — | — | — | — |
| १६. | फिरते पीक चिकित्सालय (दिलेल्या निदान सेवाची संख्या द्यावी) | — | — | — | — | — | — | — |
| १७. | आकाशवाणी कार्यक्रम | ०६ | — | — | — | — | — | — |
| १८. | दूरदर्शन कार्यक्रम | — | — | — | — | — | — | — |
| १९. | प्रक्षेत्र सहल | ०२ | — | — | — | — | — | — |
| २०. | तंत्रज्ञान प्रसिध्दी /लेख | ०३ | — | — | — | — | — | — |
| २१. | शेतकरी व कृषि विस्तार कर्मचाऱ्यांकरिता एस.एम.एस सेवा पुरविणे (संदेश संख्या देण्यात यावी) | — | — | — | — | — | — | — |
| २२. | शेतकरी —शास्त्रज्ञ मंच बैठक | ०२ | — | — | — | — | — | — |
| २३. | पत्राद्वारे शेतकऱ्यांना मार्गदर्शन | २० | — | — | — | — | — | — |
| २४. | वैयक्तिक संपर्क | ०६ | — | — | — | — | — | ०६ |
| २५. | शेतकरी प्रशिक्षण वर्ग | ०१ | — | — | — | — | — | ७५ |

**Publications**

| Sr. No. | Name of Faculty | Research Publication | Technical Publication | Extension Publication | Books Published | Bulletin Published |
|---|---|---|---|---|---|---|
| 1 | Dr. A. L. Narangalkar | 20 | 13 | 18 | - | 1 |
| 2 | Dr. S. K. Godase | 40 | 28 | 56 | 1 | 4 |
| 3 | Prof. (Mrs) K. V. Naik | 15 | 8 | 5 | - | - |
| 4 | Dr. V. S. Desai | 26 | 25 | 42 | 6 | 2 |

Contact information

Dr Anand lalba Narangalkar
Head,
Department of Agril. Entomology,
Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth,
Dapoli 415712 District Ratnagiri Maharashtra state
Phone 02358- 282415 Extn. 223
Cell – 9405360519, 9422431681
Email – nanand47@rediffmail.com