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**PART-II**  
**COURSE CURRICULA**

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# 1 Agricultural Chemicals

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## TRIMESTER WISE DISTRIBUTION OF COURSES

### I TRIMESTER

		L	P
AC 501	INTRODUCTION TO AGROCHEMICALS	3	0
AC 502	GENERAL CHEMISTRY	3	1
AC 503	LABORATORY TECHNIQUES	1	2
AC 506	AGROCHEMICALS FOR INSECT AND MITE MANAGEMENT	3	1
AC 603	ADVANCED ORGANIC CHEMISTRY	3	1
AC 511	AGROCHEMICAL DECONTAMINATION AND DISPOSAL	2	1
AC 691	SEMINAR	1	0

### II TRIMESTER

AC 504	AGROCHEMICAL FORMULATIONS	2	1
AC 505	AGROCHEMICAL REGULATION, QUALITY CONTROL AND MANAGEMENT	3	0
AC 507	AGROCHEMICALS FOR DISEASE AND NEMATODE MANAGEMENT	3	1
AC 508	AGROCHEMICALS FOR WEED MANAGEMENT	3	1
AC 509	SPECTROSCOPIC AND CHROMATOGRAPHIC TECHNIQUES	3	1
AC 512/ ENT 512/ PL. PATH 521/ NEMA 513/ MB 512	NANOTECHNOLOGY IN CROP PROTECTION	2	1
AC 691	SEMINAR	1	0

### III TRIMESTER

AC 602	CHEMISTRY OF BIOPESTICIDES	3	1
AC 601	AGROCHEMICAL FORMULATION TECHNOLOGY	2	1
AC 510	PESTICIDE RESIDUE CHEMISTRY	3	2
AC 604	AGROCHEMICAL DYNAMICS AND ENVIRONMENTAL IMPLICATIONS	3	1
AC 605	ADVANCES IN AGROCHEMICALS	3	0
AC 691	SEMINAR	1	0

# AGRICULTURAL CHEMICALS

**Major Field** : Agricultural Chemicals

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

## DESCRIPTION OF COURSES

### AC 501 INTRODUCTION TO AGROCHEMICALS

(3L+0P) I

#### Objective

To give an overview of pesticides with reference to their classification, structure, mode of action, synthesis and formulations and pesticide residue analysis.

#### Theory

##### UNIT I

Chronological development, classification, structures, toxicity, general properties and uses.

##### UNIT II

Synthetic and natural agrochemicals.

##### UNIT III

Plant production chemicals, nitrification inhibitors, chemical hybridizing agents and hydrogels

##### UNIT IV

Seed coats and soil conditioners

##### UNIT V

Formulation analysis, quality control, safety aspects, pesticide poisoning and antidotes. Production, consumption and trade statistics of pesticides

##### UNIT VI

Implications in the environment and general aspects of pest and pesticide management.

#### Suggested Readings

Baker, D.R., Fenyes, J.G. and Steffens, J.J. (Eds.). 1992. *Synthesis and Chemistry of Agrochemicals*. Vols. I-III. ACS Symposium Series 504, ACS Washington D.C.

Buchel, K.H. (Ed.). 1992. *Chemistry of Pesticides*. John Wiley & Sons.

Handa, S.K. 2004. *Principles of Pesticide Chemistry*. Agrobios.

Hassal, K. 1982. *The Chemistry of Pesticides*. The Macmillan Press.

Marrs, T.C. and Bryan, B.T. (Eds.). 2004. *Pesticide Toxicology and International Regulation*. John Wiley & Sons.

Murayama, T. 1987. *Japan Pesticide Information*. Japan Plant Protection Association, Tokyo.

Parmar, B.S. and Tomar, S.S. 2004. *Pesticide Formulation: Theory & Practice*. CBS Publ.

Roberts, H.A. (Ed.). 1982. *Weed Control Handbook: Principles*. Blackwell Scientific Publ.

Rangasamy, Seeni and Dureja, Prem. *Hand Book of Pesticides*, SPS India.

Tomar, S.S. and Parmar, B.S. 1992. *Dictionary of Agricultural Chemicals*. Academic India Publ.

**Objective**

To acquaint the students with atomic structure, stereochemistry, nomenclature of organic compounds, their chemistry and properties.

**Theory**

## UNIT I

Organic compounds: nomenclature, isomerism - constitutional, configurational and conformational, chirality.

## UNIT II

Chemistry of terpenoids, alkaloids, flavonoids and heterocyclic compounds, carbohydrates, amino acids, proteins, nucleic acids.

## UNIT III

Chemical kinetics

## UNIT IV

Solutions and colligative properties

## UNIT V

Surface chemistry

**Practicals**

General aspects and Introduction, Detection of elements in organic compounds, Detection of functional groups and preparation of their derivatives, Separation and identification of organic compounds in binary mixtures.

**Suggested Readings**

Clarke, H.T. and Hayes, W.C. 1964. *Handbook of Organic Analysis*. Edward Arnold.

Clyde, R.M. 1988. *Schaum's Outline of Physical Chemistry*. 2nd Ed. McGraw-Hill.

Ernest, L.E. and Samuel, H.W. 1994. *Stereochemistry of Organic Compounds*. Wiley-Interscience.

Finar, I.L. 1989. *Organic Chemistry*. Vols. I, II. Longmans.

James, B.H., Donald, J.C. and George, S.H. 1970. *Organic Chemistry*. McGraw-Hill.

Negi, A.S. and Anand, S.C. 2003. *A Text Book of Physical Chemistry*. Wiley Eastern.

Robert, A.A. and Robert, J.S. 1996. *Physical Chemistry*. 2nd Ed. John Wiley & Sons.

Robert, T.M. and Robert, N.B. 1992. *Organic Chemistry*. 6th Ed. Prentice Hall.

Samuel, G. and David, L. 1946. *Advanced Physical Chemistry*. Macmillan Education.

Vogel, A.I., Tatchell, A.R., Furnis, B.S. and Hannaford, A.J. 1996. *Vogel Textbook of Practical Organic Chemistry*. Forestmillbooks, UK.

Walter, J.M. 1987. *Basic Physical Chemistry*. Prentice Hall of India.

## AC 503 LABORATORY TECHNIQUES

(1L +2P) I

### Objective

To acquaint students with laboratory hygiene, upkeep and maintenance of laboratory, glassware and handling of chemicals, purification and drying of solvents, distillation and chromatographic techniques.

### Theory

#### UNIT I

Acquaintance with laboratory glassware and apparatus and laboratory safety procedures

#### UNIT II

Solvent purification, drying and standard solutions

#### UNIT III

Extraction techniques, distillation, crystallization, sublimation, separation methods

#### UNIT IV

Functions of common equipments – water and oil pumps, heating and cooling baths, stirrers, rotary evaporators

#### UNIT V

Principles of chromatography: thin layer, paper and column chromatography.

#### UNIT VI

pH (Hydrogen ion concentration), electrical conductivity, electrophoresis, uv-vis spectrophotometry

### Practicals

Introduction to Laboratory equipment and cleaning of glassware, Assembling of simple apparatus and finding density, Purification of solvents, Crystallization, identification and sublimation, Extraction, Chromatography: Paper, Column, TLC, Preparative TLC Column, Use of pH meters, electrical conductometer, electrophoresis, UV-Vis spectrophotometer, Steam Distillation, use of stirrer and vacuum pumps.

### Suggested Readings

Joan, S.F., Ralph, J.F. and Patty, F. 2001. *Organic Laboratory Techniques*. 3rd Ed. Brooks/Cole.

Patty, F. 2002. *Handbook for Organic Chemistry Lab*. 6th Ed. Brooks/Cole.

Shriver, D.F. and Drezdson, M.A. 1986. *The Manipulation of Air-Sensitive Compounds*. 2nd Ed. John Wiley & Sons.

Vogel, A.I. 1996. *Vogel's Textbook of Practical Organic Chemistry*. 5th Ed. Prentice Hall.

## AC. 504 AGROCHEMICAL FORMULATIONS

(2L+1P) II

### Objectives

To acquaint students with general aspects /types of formulation, pesticide mixtures and application technology.

## **Theory**

### UNIT I

General aspects: definition, objective, process, product spectrum, classification, formulation codes etc.

### UNIT II

Solid and liquid formulations: properties, specifications and uses.

### UNIT III

Pesticide mixtures: formulations, properties and uses.

### UNIT IV

Application: devices and quality of deposits.

## **Practicals**

Release of active ingredient from controlled release formulations, determination of wettability and suspensibility of wettable powder, Determination of flash point and specific gravity, viscosity, stability of emulsion concentrate and application technology.

## **Suggested Readings**

Parmar, B.S. and Tomar, S.S. 2004. *Pesticide Formulation -Theory and Practice*. CBS Publication.

Wade, Van Valkenburg, Sugavanam, B. and Khetan, S.K.1998. *Pesticide Formulation*. New Age International.

## **AC 505 AGROCHEMICAL REGULATION, QUALITY CONTROL AND MANAGEMENT**

**(3L+0P) II**

## **Objective**

To acquaint students about the insecticide laws, national and international guidelines, fertilizer control order, quality and quality control.

## **Theory**

### UNIT I

Laws, acts and rules governing registration and regulations of agrochemical production and use.

### UNIT II

EPA, WHO, FAO, JMPR, Codex committee guidelines.

### UNIT III

National / international guidelines on pesticide safety.

### UNIT IV

Provisions of Insecticide Act and Rules

### UNIT V

Quality: Establishment of quality control laboratories. Concepts of accreditation of quality control laboratories

### UNIT VI

Management and pesticide management

## Suggested Readings

- Fred, L. 2000. *Organizational Behavior*. McGraw-Hill.
- George, W. and David, W. 2004. *The Pesticide Book*. Meister Publ.
- Gnther, V., Gerardo, R. and Gü Nther, V. 2003. *Chemistry of Crop Protection: Progress and Prospects in Science and Regulation*. Wiley-vch Verlag Gmbh.
- Philip, K. 1988. *Marketing Management – Analysis Planning and Control*. Prentice Hall of India, New Delhi.
- Prasad, D. (Ed.). 2005. *Crop Protection: Management Strategies*. Daya Publishers, New Delhi.
- Prasad, L.M. 1990. *Principles and Practice of Management*. S. Chand & Sons. New Delhi.
- Zahir, M.A. 2003. *Facets of Business Management*. Medallion Press.

## AC 506 AGROCHEMICALS FOR INSECT AND MITE MANAGEMENT

(3L+1P) I

### Objective

A course to deal with the chemistry, mode of action and synthesis of different classes of pesticides like organochlorines, organophosphorus, neonicotinoids, acaricides and pyrethroids.

### Theory

#### UNIT I

Preparation, properties, uses, structure-activity relationship (QSAR) and acaricides (organochlorines, organophosphorus pesticides, carbamates, pyrethroids and neonicotinoids).

#### UNIT II

Insecticide synergists

#### UNIT III

Mode of action of different groups of insecticides

#### UNIT IV

Synthetic IGRs

#### UNIT V

Fumigants and other chemicals for post-harvest storage of agricultural commodities

### Practicals

Preparation and characterization of DDT, DDE, and Methoxychlor, Preparation of organophosphorus insecticide-Part A –phosphorodichloridite, and Part B -phosphonate, Preparation and characterization of oxime ether, Preparation of DDVP.

### Suggested Readings

- Brooks, G.T. 1976. *Chlorinated Insecticides*. Vols. I, II. CRC Press.
- Buchel, K.H. (Ed.). 1992. *Chemistry of Pesticides*. John Wiley & Sons.
- Cremlyn, R.J. 1990. *Pesticides: Preparation and Mode of Action*.
- Wiley Eto, M. 1979. *Organophosphorus Pesticides: Organic and Biological Chemistry*. CRC Press.
- Kuhr, R.J. and Dorough, H.W. 1979. *Carbamate Insecticide Chemistry and Biochemistry*. CRC Press.

Leahey, J.P. 1985. *The Pyrethroid Insecticides*. Taylor & Francis.

Metlosky, G., Nadasy, M. and Andriska, V. 1988. *Pesticide Chemistry*. Elsevier. U.K

Perry, A.S., Yamamoto, I., Ishaaya, I. and Perry, R. 1998. *Insecticides in Agriculture and Environment. Retrospects and Prospects*. Narosa.

## **AC 507 AGROCHEMICALS FOR DISEASE AND NEMATODE MANAGEMENT (3L+1P) II**

### **Objective**

To teach students about the plant diseases causing fungi and nematodes and synthetic fungicides and nematicides.

### **Theory**

#### UNIT I

Preparation, properties, uses, structure-activity relationships and mode of action of major groups of fungicides.

#### UNIT II

Inorganics: copper, mercury and sulphur compounds. Organometallics: compounds of tin arsenic, mercury etc.

#### UNIT III

Organophosphorus compounds and dithiocarbamates

#### UNIT IV

Polyhalogenalkanes, sulfenyl compounds, phenols, quinones, carboxamides, carboximides

#### UNIT V

Azoles and other heterocyclics compounds

#### UNIT VI

Nematicides: halocarbons, organophosphorus compounds, carbamates etc.

### **Practicals**

Preparation of Zineb (Z), Preparation, purification and characterization of dichlorophen (D), Salicylanilide (S), an organophosphorus/heterocyclic fungicide (OP), Glyodin (G) and DBCP, a nematicide (DB) and fungicide bioassay (FB).

### **Suggested Readings**

Bell, C.V. and Alford, D.V. 2000. *Pest and Disease Management Handbook*. British Crop Protection Council. Wiley-Blackwell.

Buchel, K.H. (Ed.). 1992. *Chemistry of Pesticides*. John Wiley & Sons.

Copping, L.G., Hewitt, H.G. and Leonard, G.C. 1998. *Chemistry and Mode of Action of Crop Protection Agents*. Royal Society of Chemistry.

Cremlyn, R.J. 1990. *Pesticides: Preparation and Mode of Action*. John Wiley & Sons, U.K.

Metlosky, G., Nadasy, M. and Andriska, V. 1988. *Pesticide Chemistry*. Elsevier.

Nene, Y.L. and Thapliyal, P.N. 1989. *Fungicides in Plant Disease Control*. India Book House.

Roy, N.K. 2002. *Chemistry of Pesticides*. CBS Publishers, New Delhi.

Vyas, S.C. 1984. *Hand book of Systemic Fungicides*. Tata Mc Graw Hill.

## AC 508 AGROCHEMICALS FOR WEED MANAGEMENT

(3L+1P) II

### Objective

To teach classification, chemistry, synthesis and mode of action of different classes of herbicides, plant growth regulators.

### Theory

#### UNIT I

Preparation, properties, uses, structure-activity relationship and mode of action of phenoxy alkanolic acids, carbamates and substituted phenylureas.

#### UNIT II

Preparation, properties, uses, structure-activity relationship and mode of action of triazines, pyridinium compounds and dinitroanilines.

#### UNIT III

Preparation, properties, uses, structure-activity relationship and mode of action of sulfonylureas, imidazolinones and phenoxy-phenoxy propionic acid (fop) herbicides.

#### UNIT IV

Herbicide safeners

#### UNIT V

Synthetic plant growth regulators

### Practicals

Synthesis of 2,4-D. Its m.p, TLC, NMR, Preparation of nitrosomethyl urea, preparation of diazomethane and derivatization of 2,4-D, GC of methyl derivative, Introduction to Weeds: Field visit, synthesis of propionyl chloride and its distillation, TLC, NMR, synthesis of propanil, m.p, TLC, NMR, synthesis of maleic hydrazide, m.p, TLC, NMR, Educational Tour to some agrochemical factory/ laboratory.

### Suggested Readings

Audus, L.J. 1964. *The Physiology and Biochemistry of Herbicides*. Academic Press.

Buchel, K.H. (Ed.). 1992. *Chemistry of Pesticides*. John Wiley & Sons.

Cremlyn, R.J. 1990. *Pesticides: Preparation and Mode of Action*. John Wiley & Sons .

Kearnay, P.C. and Kaufman, D.D. 1975. *Herbicides: Chemistry, Degradation and Mode of Action*. Vols. I, II. Marcel Dekker.

Kramer, W.K. and Ulrich, S. 2007. *Modern Crop Protection Compounds*. Wiley-vch Verlag GmbH.

Metlosky, G., Nadasy, M. and Andriska, V. 1988. *Pesticide Chemistry*. Elsevier.

Unger, T.A. 1996. *Pesticide Synthesis Hand Book*. William Andrew.

## AC 509 SPECTROSCOPIC AND CHROMATOGRAPHIC TECHNIQUES

(3L+1P) II

### Objective

To acquaint students with the techniques used in separation, estimation and structure elucidation of agrochemicals.

## Theory

### UNIT I

Principles of chromatographic techniques like high performance thin layer chromatography, high performance liquid, gas liquid chromatography

### UNIT II

Principles of instrumentation and application of spectrophotometric techniques ; UV and IR

### UNIT III

Principles of instrumentation and application of spectroscopic techniques of <sup>13</sup>C and PMR

### UNIT IV

Principles of instrumentation and application Mass spectrometry

### UNIT V

Principles of instrumentation and application of ion-exchange chromatography, gel chromatography, flash chromatography and supercritical fluid chromatography

### UNIT VI

Tandem techniques like GC-MS, LC-MS, GC-MS-IR, MS-MS, etc.

## Practicals

Spectroscopy: UV-VIS Spectroscopy, IR Spectroscopy, Mass Spectrometry, NMR Spectrometry, Conventional Chromatography. Advances in Chromatography. Structure elucidation using tandem techniques.

## Suggested Readings

Dyer, J.R. 1994. *Application of Absorption Spectroscopy of Organic Compounds*. Prentice Hall of India.

Friebolin, H. and Becconsall, J.K. 1993. *Basic One- and Two-Dimensional NMR spectroscopy*. John Wiley & Sons.

Jack, D. 1993. *Gray Beal Molecular Spectroscopy*. McGraw-Hill.

McLafferty, F.W. and Venkataraghavan, R. 1982. *Mass Spectral Correlations*. Oxford University Press.

Scott, R.P.W. *Chrom-Ed Series* <http://www.chromatography-online.org/>

Sharma, J.M. and Follweiler, J. 1984. *CRC Handbook of Chromatography: Pesticides and Related Organic Chemicals*. CRC Press.

Silverstein, R.M., Bassler, G.C. and Morrill, T.C. 1983. *Spectrometric Identification of Organic Compounds*. 4<sup>th</sup> Ed. John Wiley & Sons.

## AC 510 PESTICIDE RESIDUE CHEMISTRY

(3L+2P) III

### Objective

To teach students the concept of pesticide residue, planning, layout and design of experiments, instruments and techniques involved data analysis and legal issues of pesticide residue analysis.

### Theory

#### UNIT I

Pesticide residues-concepts and toxicological significance

## UNIT II

Experimental design and sampling

## UNIT III

Principles of extraction and clean up from different substrates

## UNIT IV

Application of spectrophotometric and chromatographic techniques estimation /detection of micro level pesticides residue, ELISA and radiotracer techniques

## UNIT V

Confirmatory techniques, bound and conjugated residues, multi residue methods

## UNIT VI

Method validation: linearity, accuracy, precision, LOD and LOQ. Interpretation of data and statistical analysis and measurement of uncertainty.

### Practicals

Identification of Organochlorine insecticides in water by TLC, identification of carbamate insecticides in water by TLC, estimation of carbamate insecticide residues in vegetables by visible spectroscopic method, estimation of organophosphorus insecticide residues in soil by visible spectroscopic method. Standardization of protocol for the detection of organochlorine / organophosphorus / carbamates pesticides by thin layer chromatography. Detection of organochlorine / organophosphorus / carbamates pesticides in water by thin layer chromatography and use of suitable visualizing reagents. Standardization of protocol for the detection of organophosphorus / carbamates by visible spectrophotometry- development of colored products. Extraction and clean up techniques for pesticides in different substrates,like water,milk, soil, vegetables and cereals. Use of UV, IR, GLC, HPLC and GC MS techniques for estimation and confirmation of pesticide residues.

### Suggested Readings

Gupta, A. 2006. *Pesticide Residue in Food Commodities*. Agrobios (India).

Handa, S.K., Agnihotri NP & Kulshrestha G. 2000. *Pesticide Residue Analysis, Significance, Management and Analysis*. Vedams eBooks.

Moye, H.A. 1981. *Analysis of Pesticide Residues*. John Wiley & Sons.

## AC 511 AGROCHEMICAL DECONTAMINATION AND DISPOSAL

(2L+1P) I

### Objective

To teach students the concept of agrochemical / pesticide residue management, disposal and decontamination techniques.

### Theory

#### UNIT I

General aspects of disposal and decontamination of agrochemicals.

#### UNIT II

Decontamination: techniques (physical, chemical and biological), soil, water, plant and agricultural produces.

### UNIT III

Guidelines for pesticide disposal in the environment and effluent treatment plants.

### UNIT IV

Disposal: methods of disposal of containers, obsolete /out dated pesticides, industrial effluents and other xeno-biotics.

### UNIT V

Sensors for monitoring contaminations

## Practicals

Chemical detoxification of potential toxic xenobiotics, oxidative degradation and decontamination methods, decontamination of pesticides from water using different adsorbents, culinary methods for pesticide decontamination from fruits and vegetables, microwave induced decontamination of pesticides, photochemical decontamination of pesticides.

## Suggested Reading

Peter, C.Z. (Editor). 2007. *New Biocides Development: The Combined Approach of Chemistry and Microbiology*

Jay, J.G., Peter, C.Z., Steven, D.A. and Ann, T.L. (Eds) 2003. *Pesticide Decontamination and Detoxification* Vols. 863. American Chemical Society, USA

## AC 512 NANOTECHNOLOGY IN CROP PROTECTION

(2 L+1P)

(Multi-disciplinary: Agric. Chemicals, Plant pathology, Entomology, Nematology, Microbiology)

## Objective

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

## Theory

### UNIT I

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

### UNIT II

Effect of bioactive nano-materials on insect pests and beneficial insects. (2 Lectures, Entomology)

### UNIT III

Different types of nano-compounds and their use in the management of plant disease incited by pathogenic fungi, bacteria and viruses with special reference to copper, sulfur etc, Interaction of bioactive nano-materials on plant pathogens including fungi, bacteria, virus etc (3 lectures, Plant Pathology).

### UNIT IV

Nematodes: Plant pathogenic and entomopathogenic nematodes, life cycle, Efficacy of nano chemicals against nematodes, Biotoxins from *Xenorhabdus* and *Photorhabdus*. Identification and quantification of biotoxins effective in nano-doses. (3 lectures, Nematology).

#### UNIT V

Microbes: Microbes of agricultural importance. Life cycle: genesis, growth, reproduction, identification and quantification. Nanotechnological application in microbiology (3 lectures, Microbiology).

#### UNIT VI

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

#### Practicals

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

#### Suggested Reading

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

### AC 601 AGROCHEMICAL FORMULATION TECHNOLOGY

(2L+1P) III

#### Objective

To teach general aspects along with latest developments of formulations, chemistry, classification and properties of formulants, machinery and equipment involved in preparation, packaging and labeling and bioefficacy of formulations.

#### Theory

##### UNIT I

Formulation ingredients: active ingredients and carriers/ diluents, surfactants, synergists, safeners, encapsulants, binders, anti-oxidants, stabilizers.

##### UNIT II

Formulant-toxicant interactions.

##### UNIT III

Preparation, properties, specifications and uses of solid and liquid formulations.

##### UNIT IV

Control release formulations: preparation, properties, specifications and uses.

##### UNIT V

Hydrogels: preparation, properties, specifications and uses.

##### UNIT VI

Equipments and machineries: formulation research. Basic considerations, absorption, penetration, translocation and activity for improvement of bioefficacy, industrial equipments and plants

#### Practicals

Laboratory mills/ equipments used in formulation research, Preparation of standard hard water, Determination of acidity of a pesticide, Determination of alkalinity of a pesticide, Preparation of

controlled release formulation, Release of active ingredient from CR formulation in soil and water, Preparation of toxicant based creams, Study of solid carriers: Determination of I. Surface acidity by volumetric method, II. Surface area, Study of solid carriers: III. Sorptivity and IV. Particle size, Preparation of dust, wettable powder and granules, Determination of wettability and suspensibility of wettable powder, Study of liquid carriers I: Flash point and specific gravity, Study of liquid carriers II: Determination of viscosity, Study of surfactants: Micelle formation, Preparation of liquid formulations, Determination of emulsion stability of an emulsifiable concentrate, Application technology : Sprayers.

### Suggested Readings

Parmar, B.S. and Tomar, S.S. 2004. *Pesticide Formulation -Theory and Practice*. CBS Publ.

Wade, V.V., Sugavanam, B. and Khetan, S.K.1998. *Pesticide Formulation*. New Age International.

## AC 602 CHEMISTRY OF BIOPESTICIDES

(3L+1P) III

### Objective

To teach chemistry of conventional biopesticides, semiochemicals and allelochemicals, phytoalexins, pesticides of microbial origin and application of biotechnology in pest management.

### Theory

#### UNIT I

Sources of biopesticides and extraction (ASE, SFE /solvent extraction

#### UNIT II

Isolation, characterization, properties and mode of action of important groups of naturally occurring insecticides (pyrethroids, nicotinoids, rotenoids, limonoids, microbial macrolides).

#### UNIT III

*Bacillus thuringiensis* and nuclear polyhedrosis virus based insecticides and other biopesticides.

#### UNIT IV

Semiochemicals, insect hormones, insect growth regulators, feeding deterrents and repellents etc

#### UNIT V

Natural nematicides, fungicides, molluscicides and rodenticides

#### UNIT VI

Allelochemicals. Anti JH / JH mimics and moulting agonists.

### Practicals

Extraction by hydrodistillation, isolation of pure compounds, their characterization, Extraction of tobacco leaves, isolation of nicotine and its identification, Extraction of neem seed kernels, enrichment of azadirachtin, analysis of azadirachtin and its analysis.

### Suggested Readings

Alexander, M. 1999. *Biodegradation and Bioremediation*. 2nd Ed. Academic Press.

Copping, L.G. 1996. *Crop Protection Agents from Nature: Natural Products and Analogues*. Royal Soc. Chem., London.

- Dev, S. and Koul, O. 1997. *Insecticides of Natural Origin*. Harwood Acad. Publishers.
- Godfrey, C.R.A. 1995. *Agrochemicals from Natural Products*. Marcel Dekker.
- Hall, J.C., Hoagland, R.E. and Zablotowicz, R.M. 2001. *Pesticide Biotransformation in Plants and Microorganisms: Similarities and Divergences*. ACS Symposium Series 777. Washington, DC.
- Hassal, K.A. 1990. *The Biochemistry*. Plenum Press. .
- Jacobson, M. 1965. *Insect Sex Attractants*. John Wiley & Sons .
- Jacobson, M. 1970. *Naturally Occurring Insecticides*. John Wiley & Sons
- Khan, S.U. 1980. *Pesticides in the Soil Environment*. Elsevier.
- Leahey, J.P. 1985. *The Pyrethroid Insecticides*. Taylor & Francis.
- Matsumura, F. 1975. *Toxicology of Insecticides*. Plenum Press.
- Menzie, C.M. 1980. *Metabolism of Pesticides*. Update III US Fish and Wildlife Service Special Scientific Report.
- Parmar, B.S. and Devakumar, C. 1990. In: *Botanical and Biopesticides*. Westvill Publ. House.
- Racke, K.D., Skidmore, M.W., Hamilton, D.J., Unsworth, J.B., Miyamoto, J. and Cohen, S.Z. 1997. *Pesticide Fate in Tropical Soils*. Pure and Appl. Chem. 69 (6): 1349-1371.

## AC 603 ADVANCED ORGANIC CHEMISTRY

(3L+1P) I

### Objective

To teach stereochemistry, mechanisms of stereospecific and streoselective reactions, reagents in organic synthesis, elucidation of structure of organic compounds.

### Theory

#### UNIT I

Stereochemistry, Cohn-Ingold-Prelog rules. Inductive, inductomeric, mesomeric and electromeric effects, Walden inversion, asymmetric synthesis, optical resolution, racemic modification.

#### UNIT II

Reaction mechanisms – substitution, elimination, addition and condensation reactions.

#### UNIT III

Important name reactions and rearrangements.

#### UNIT IV

Synthetic reagents and their applications.

#### UNIT V

Protective groups in organic synthesis.

#### UNIT VI

Photochemistry, pericyclic reactions and sigma tropic rearrangement.

### Practicals

Friedal craft reaction (Alkylation/Acylation), Aldol/Claisen Schmidt reaction, Pechmann condensation/Perkin reaction, Methylation, acetylation, elimination, Oxidation, reduction, hydrolysis, Acid chlorides, amides, esters, Characterisation of Organic compounds (NMR and IR spectroscopy)

## Suggested Readings

- Ahluwalia, V.K. and Aggarwal, R. *Comprehensive Practical Organic Chemistry - Preparation and Quantitative Analysis*. Universities Press.
- Corey, F.A. and Sundberg, R.J. 1983. *Advanced Organic Chemistry*. Subseries: Part A. *Structure & Mechanism*. Part B. *Reaction and Synthesis*. 2<sup>nd</sup> Ed. Plenum.
- Eliel, E.L. and Wilen, S.H. 1994. *Stereochemistry of Organic Compounds*. John Wiley & Sons.
- Finar, I.L. 1959. *Text book of Organic Chemistry*. Vols. I, II. 25th Ed. Pearson Edu.
- Hendrickson, J.B., Cram, D.J. and Hammond, G.S. 1970. *Organic Chemistry*. 3rd Ed. McGraw Hill.
- Jeny, M. 1992. *Advanced Organic Chemistry. Reactions, Mechanisms and Structure*. 4th Ed. John Wiley & Sons.
- Kalsi, P.S. 1996. *Stereochemistry and Mechanism through Solved Problems*. 2nd Ed. New Age International Publ.
- Morrison, R.T. and Boyd, R.N. 1992. *Organic Chemistry*. 6th Ed. Prentice Hall. Peter Sykes. 1996 *Organic Chemistry. Guidebook to Mechanism in Organic Chemistry*. 6th Ed. Prentice Hall.
- Vogel, A.I. 1996. *Vogel's Textbook of Practical Organic Chemistry*. 5th Ed. Printice Hall.

## AC 604 AGROCHEMICAL DYNAMICS AND ENVIRONMENTAL IMPLICATIONS (3L+1P) III

### Objective

To acquaint students with fate of pesticides in environment-their movement in plants and food chain, persistence, transformation and other metabolic fates.

### Theory

#### UNIT I

Biotic and abiotic transformations of agrochemicals in the environment.

#### UNIT II

Soil: sources of contamination, microbial transformation, adsorption-desorption, leaching/mobility, volatilization.

#### UNIT III

Aquatic bodies: sources of contamination, transformation processes, bioaccumulation etc.

#### UNIT IV

Air: sources of contamination, transformation and transport processes.

#### UNIT V

Soil –plant –animal system: uptake, translocation, metabolism, degradation.

#### UNIT VI

Adverse effects of pesticides on micro-flora, fauna and on other non-target organisms.

### Practicals

Preparation of metabolites, photodegradation of pesticides, leaching and volatilization of pesticides, biological degradation in soil.

## Suggested Readings

- Alexander, M. 1999. *Biodegradation and Bioremediation*. 2nd Ed. Academic Press.
- Hall, J.C., Hoagland, R.E. and Zablutowicz, R.M. 2001. *Pesticide Biotransformation in Plants and Microorganisms: Similarities and Divergences*. ACS Symposium Series 777. Washington, DC.
- Hassal, K.A. 1990. *The Biochemistry*. Plenum.
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- Khan, S.U. 1980. *Pesticides in the Soil Environment*. Elsevier.
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- Matsumura, F. 1975. *Toxicology of Insecticides*. Plenum Press.
- Menzie, C.M. 1980. *Metabolism of Pesticides*. Update III US Fish and Wildlife Service Special Scientific Report.
- Racke, K.D., Skidmore, M.W., Hamilton, D.J., Unsworth, J.B., Miyamoto, J. and Cohen, S.Z. 1997. *Pesticide Fate in Tropical Soils*. Pure and Appl. Chem. 69 (6): 1349-1371.

## AC 605 ADVANCES IN AGROCHEMICALS

(3L+0P) III

### Objective

To develop proficiency of the student in his/her area of specialization.

### Theory

#### UNIT I

Recent advances in pesticide development, formulation, and analysis and safety evaluation.

#### UNIT II

Combinatorial chemistry, modeling etc for development of new molecules, mode of action and metabolism.

#### UNIT III

Innovations in pesticide formulation and delivery systems

#### UNIT IV

Application of biotechnology in developing herbicide tolerant and insect resistant transgenic plants.

#### UNIT V

Recent developments in botanicals and bio-pesticides

#### UNIT VI

Sanitary / phyto-sanitary issues, accreditations of testing laboratories

## Suggested Readings

Selected topics from review books and journals.