

**CURRICULUM**

**OF**

**PLANT PROTECTION**

**B.Sc (Hons)**

**M.Sc (Hons)**

**Ph.D.**

(Revised 2005)



**HIGHER EDUCATION COMMISSION**

**ISLAMABAD**

## **CURRICULUM DIVISION, HEC**

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Composed by Mr. Zulfiqar Ali, HEC Islamabad

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## PREFACE

Curriculum of a subject is said to be the throbbing pulse of a nation. By looking at the curriculum one can judge the state of intellectual development and the state of progress of the nation. The world has turned into a global village; new ideas and information are pouring in like a stream. It is, therefore, imperative to update our curricula regularly by introducing the recent developments in the relevant fields of knowledge.

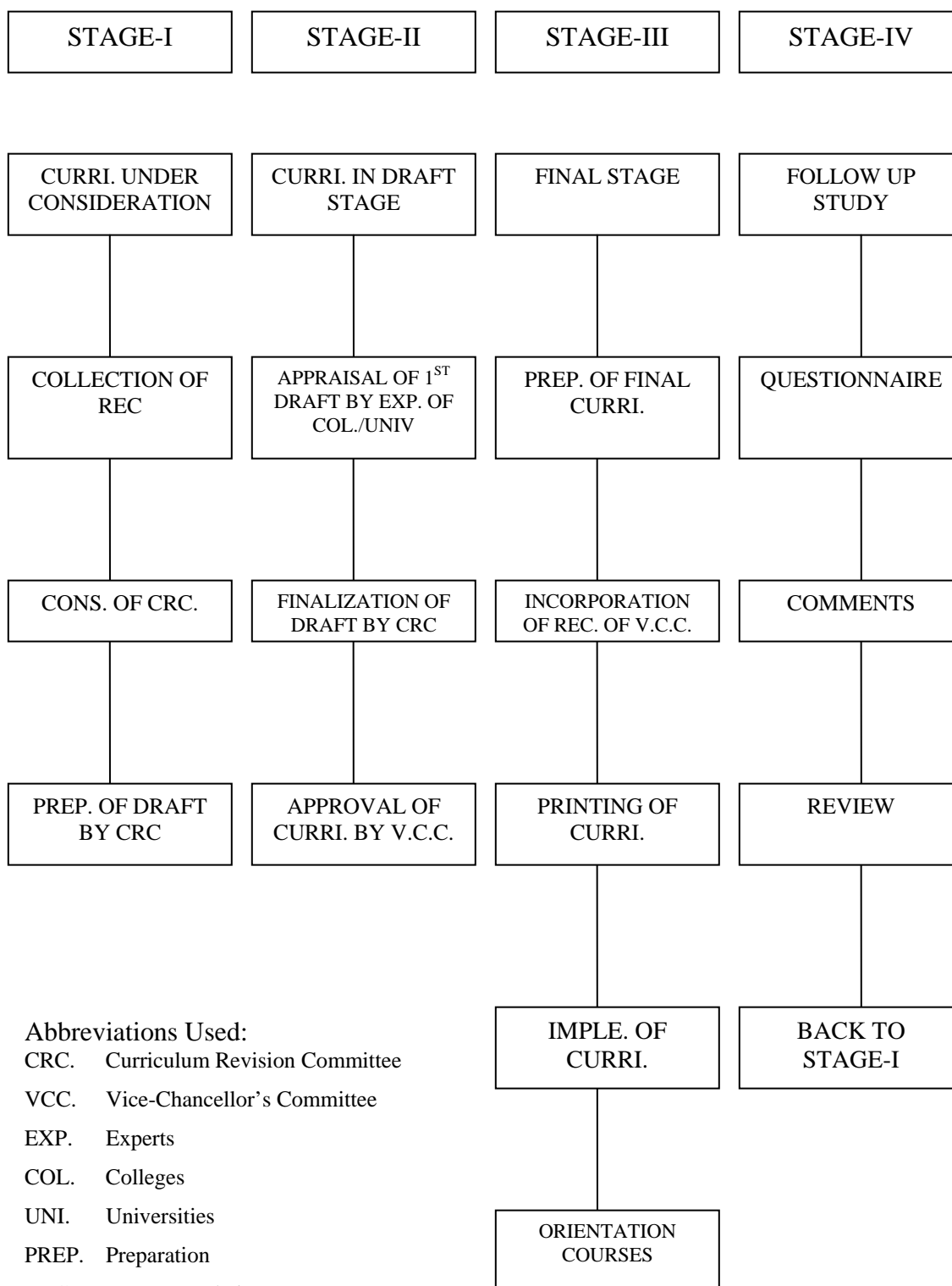
In exercise of the powers conferred by sub-section (1) of section 3 of the Federal Supervision of Curricula Textbooks and Maintenance of Standards of Education Act 1976, the Federal Government vide notification no. D773/76-JEA (Cur.), dated December 4, 1976, appointed University Grants Commission as the competent authority to look after the curriculum revision work beyond class XII at bachelor level and onwards to all degrees, certificates and diplomas awarded by degree colleges, universities and other institutions of higher education.

In pursuance of the above decisions and directives, the Higher Education Commission (HEC) is continually performing curriculum revision in collaboration with universities. According to the decision of the special meeting of Vice-Chancellors' Committee, curriculum of a subject must be reviewed after every 3 years. For the purpose, various committees are constituted at the national level comprising senior teachers nominated by universities. Teachers from local degree colleges and experts from user organizations, where required, are also included in these committees. The National Curriculum Revision Committee for Plant Protection in its meeting held in June 13 to 15, 2005 at the HEC Regional Centre, Peshawar revised the curriculum after due consideration of the comments and suggestions received from universities and colleges where the subject under consideration is taught. The final draft prepared by the National Curriculum Revision Committee duly approved by the Competent Authority is being circulated for implementation by architectural institutions.

**(PROF. DR. ALTAF ALI G. SHAIKH)**  
**Adviser (Acad/R&D)**

July 2005

# CURRICULUM DEVELOPMENT





## INTRODUCTION

The final meeting of the National Curriculum Revision Committee to review/revise the curriculum of B.Sc. (Hons.), M.Sc.(Hons.) and Ph. D. in Plant Protection was held from June 13-15, 2005 at HEC, Regional Centre, Peshawar. Following experts attended:

- |    |   |          |
|----|---|----------|
| 1. | Prof. Dr. Shafi Muhammad Nizamani,<br>Dean,<br>Faculty of Crop Protection,<br>Sindh Agriculture University,<br>Tandojam.  | Convener |
| 2. | Prof. Dr. Mushtaq Ahmad Saleem<br>Principal,<br>University College of Agriculture,<br>B.Z University, Multan.   | Member   |
| 3. | Dr. Nazir Javed,<br>Associate Professor,<br>Department of Plant Pathology,<br>University of Agriculture,<br>Faisalabad.   | Member   |
| 4. | Dr. Masood Khan Khattak,<br>Associate Professor,<br>Department of Entomology,<br>Faculty of Agriculture,<br>Gomal University, D. I. Khan.                       | Member   |
| 5. | Dr. Ghulam Shabir Shah,<br>Entomologist,<br>Agricultural Research Institute,<br>Tarnab, Peshawar.   | Member   |
| 6. | Dr. Muhammad Rahim Khan,<br>Associate Professor,<br>Department of Entomology,<br>University College of Agriculture,<br>Rawalakot, District Poonch Azad Kashmir. | Member   |
| 7. | Dr. Rashida Parveen,<br>Assistant Professor (Plant Pathology),<br>University College of Agriculture,<br>B. Z. University, Multan                                | Member   |

- |     |   |                   |
|-----|---|-------------------|
| 8.  | Dr. Abdul Rauf Bhutta,<br>Deputy Director,<br>Federal Seed Certification & Registration Department,<br>G-9/4, Islamabad                                 | Member            |
| 10. | Dr. Ahmad-Ur-Rahman Saljoqi,<br>Associate Professor,<br>Department of Plant Protection,<br>NWFP Agricultural University,<br>Peshawar                    | Member            |
| 11. | Dr. Muhammad Afzal Akhtar,<br>Principal Scientific Officer,<br>Crop Diseases Research Programme<br>National Agricultural Research Centre,<br>Islamabad. | Member            |
| 12. | Dr Salik Nawaz Khan,<br>Assistant Professor,<br>Department of Mycology and Plant Pathology,<br>University of the Punjab,<br>Lahore                      | Member            |
| 13. | Dr. Inamullah Khan,<br>Professor<br>Department of Plant Protection,<br>NWFP, Agricultural University,<br>Peshawar.                                      | Member            |
| 14. | Dr. Manzoor H. Soomro<br>Chief Scientific Officer<br>Pakistan Science Foundation,<br>Islamabad.   | Member            |
| 16. | Dr. Farman Ullah<br>Professor & Chairman Plant Protection Department<br>NWFP Agricultural University<br>Peshawar.                                       | Member/ Secretary |

Meeting started with recitation from the Holy Quran by Dr. A.R Saljoqi. . Prof. Dr. Altaf Ali G. Shaikh, Advisor (Acad, R & D), HEC welcomed the participants and briefed about the obligations of the Commission for review/revision of curriculum. He briefed the participants about on-going activities of HEC for uplift of Higher Education in the Country.

The committee considered the existing curriculum and expatriate Pakistani expert's comments.

The committee agreed to recommend B.Sc.(Hons)Plant Protection courses comprising core and supporting courses as compulsory for all students majoring in Plant Protection and relevant elective courses for their proper training in the subject . More emphasis has been given to the major courses in Plant Protection and Research at post graduate level. Sufficient flexibility has also been incorporated in the curriculum for giving more emphasis to the courses to cater the needs of the area where university/college is located. The Committee agreed to recommend the Plant Protection courses for B.Sc.(Hons) and M.Sc. (Hons.)

## Scheme of Study for 4-Year B.Sc (Hons) Agriculture

Mathematics / Biology	6 Credits
Statistics 1 & 2	6
Computers / IT	3
Pak Studies	2
Islamiat	2
Communications Skills	3
English	3
Basic Agriculture	3
<b>Sub-Total</b>	<b>28</b>

One subject from each of the following disciplines

Agronomy	3
Plant Breeding & Genetics	3
Entomology	3
Plant Pathology	3
Food Technology	3
Horticulture	3
Soil Sciences	3
Agriculture Economics	3
<b>Sub-Total</b>	<b>24</b>

Additional Courses from disciplines mentioned below and above

Agriculture Extension	
Forestry & Range Management	
Animal Science	
Marketing & Agri Business	
Rural Development	
Human Nutrition	
Agriculture Chemistry	
Agriculture Engineering	
Water Management	
<b>Sub-Total</b>	<b>21-25</b>

**Sub-Total during the first four semesters**      **73 – 77**

**Semester 5, 6, 7** 19 Credit Hours each      **57**  
**Final Semester**      **15**

**Grand Total**      **145 – 149**

**PART-I**  
**UNDERGRADUATE COURSE**  
**A- BASIC COURSE**

**INTRODUCTORY PLANT PROTECTION**

**CH 4(3+1)**

**Theory:**

Introduction, importance and scope. The concepts of pest, predator, parasitoid and pathogen. Introduction to plant pests: insects, vertebrates, diseases, weeds, parasitic plants, mites and nematodes. Losses and damages caused by pests. Pesticides and their use. Plant protection equipments. Introduction to integrated crop and integrated pest management (ICM and IPM). Application of bio-technology in plant protection.

**Practical:**

Field demonstration of damages and losses caused by pests. Collection, preservation and identification of major pests of crops, fruits, vegetables and their natural enemies. Use of Plant protection equipments

**Books Recommended:**

1. Agrios, G. N. 2005. Plant Pathology, 5<sup>th</sup> ed. Elsevier Academic Press Inc., New York.
2. Shah, H. A. and Saleem, M. A. 2005. Applied Entomology. 3<sup>rd</sup> ed. B. Z. University Press, Multan.
3. Ahmad, I. and Bhutta, A. R. 2004. Text book of Introductory Plant Pathology. Pub. National Book Foundation, Islamabad, Pakistan.
4. Khuhro, I. 2003. Fundamentals of Plant Protection. Faizan Printers, Saddar, Hyderabad.
5. Fenemore, P.G. 1984. Plant Pests and their Control. Butterworths and Co. London.
6. Robert, D.A. 1978. Fundamentals of Plant Pest Control. Freeman and Co. USA.

## **B. SPECIALIZATION IN PLANT PROTECTION**

The Committee has proposed the following “TITLES” with credit hours for specialization in Plant Protection during III year (5<sup>th</sup> and 6<sup>th</sup> semesters) and 4<sup>th</sup> year (7<sup>th</sup> and 8<sup>th</sup> semesters). These are the “CORE” courses, comprising 65 credit hours including internship, writing and presentation. To fulfill minimum requirements for the completion of the degree, each university may incorporate more courses according to their needs into their schemes of studies (Curricula).

<b>III Year</b>	<b>5<sup>th</sup> Semester</b>	<b>Credit Hours</b>
	Fundamentals of Weed Science	4(3-1)
	Introductory Ecology	4(3-1)
	Pesticides & their Application Techniques	4(3-1)
	Acarology	4(3-1)
	Elective	4(3-1)
	<b>6<sup>th</sup> Semester</b>	
	Plant Nematology	4(3-1)
	Pests of Field Crops	4(3-1)
	Principles of Plant Disease Management	4(3-1)
	Insect Classification	4(3-1)
	Elective	4(3-1)
<b>IV Year</b>	<b>7<sup>th</sup> Semester</b>	
	Principles of Plant Protection	4(3-1)
	Pests of Fruits, Vegetables & Ornamentals	4(3-1)
	Vertebrate Pest Management	4(3-1)
	Post-harvest Pest Management	4(3-1)
	Elective	4(3-1)
<b>IV (Final) Year</b>	<b>8<sup>th</sup> Semester</b>	
	Internship including report Writing & presentation	10(0-10)

**III YEAR****5th SEMESTER****FUNDAMENTALS OF WEED SCIENCE****CH 4(3+1)****Theory:**

Introduction; origin of weeds, economic importance. Weed sampling, identification, classification, biology, ecology and dissemination. Weed-crop competition and damage. Weed-insect and pathogen interactions. Principles and methods of weed management. Classification of herbicides. Selectivity and safe use of herbicides. Weed management in major field crops.

**Practical:**

Collection, preservation and identification of weeds. Sampling techniques, methods and determination of population density of weeds. Herbicide application equipment and calibrations.

**Books Recommended:**

- 1 Monaco, T J.; Weller, S.C. and Ashton, F.M. . 2002. Weed Science - Principles and Practices, 4th Edition. John Wiley & Sons.
2. Gressel, J.B. . 2002. Molecular Biology of Weed Control. CRC Press.
3. Liebman, M., Mohler, C.L. and Staver, C.P.. 2001. Ecological Management of Agricultural Weeds. Cambridge University Press.
- 4 Rao, V.S., 2000. Principles of Weed Science. 5<sup>th</sup> ed. Oxford & IBH Publ. Co. Ltd., New Delhi.
- 5 Zimdahl, R.L. 1999. Fundamentals of Weed Science, Second Edition. Academic Press, San Diego, CA.
- 6 Aldrich R.J. and R.J. Kremer. 1997. Principles in Weed Management, Second Edition. Iowa State University Press, Ames, IA.
- 7 Anderson, W.P. 1996. Weed Science: Principles and Applications, Third Edition. West Publishing Company, St. Paul MN.
- 8 Methews, G.A. 1992. Pesticide Application Methods. 2<sup>nd</sup> ed. John Wiley & Sons Inc. New York.
- 9 Raeenthal, S.S., D.M. Meddex and K. Brunetti. 1986. Biological Methods of Weed Control. Thomsan Pub. Francisco, California. USA.
- 10 Ross, H.A. and C.A. Lembi, 1985. Applied Weed Science. Burgees Publ. Co., U.S.A
10. Klingman, G.C., F.M. Aston and L.J. Noordhoff. 1975. Weed Science. Principles and practices. John Wiley and Sons, New York.

**INTRODUCTORY ECOLOGY****CH 4(3+1)****Theory:**

Introduction. Divisions of ecology. Biotic & Abiotic factors and their measurement. Habitat and niche. Inter and intraspecific interactions. Natural and agro-ecosystems. Flow of energy. Trophic relations: Food chain, food web and food mesh concepts. Ecological succession. Population, its characteristics and estimation. Introduction to Life-table. Concepts of environmental impact assessment (EIA's).

**Practical:**

Maintenance and measurement of temperature, humidity and light with different instruments. Population estimation and construction of Life-tables. Calculation of day degree and the prediction of generation turn over rates and pest out breaks.

**Books Recommended:**

1. Baret, G. 2004. Fundamentals of Ecology. Thomsons Learning.
2. Saleem, M. A and Ashfaq, M. 2004. Environmental Pollution and Agriculture. B. Z. University Press, Multan.
3. Henderson, P. 2003. Practical Methods in Ecology. Blackwell Pub., UK.
4. Smith, R. and Smith, T. 2002. Ecology and Field Biology: Hands-On Field package (With CD and Additional Printer Guide) – 6<sup>th</sup> Edition. Pearson Education.
5. Smith, R. and Smith, T. 2002. Elements of Ecology, 5<sup>th</sup> ed. Pearson Education.
6. Newman, E. I. 2001, Applied Ecology. Blackwell Science, UK.
7. Schowalter, Y.D.. 2000. Insect Ecology - An Ecosystem Approach. Academic Press
8. Southwood, T.R.E. and Henderson, P.A. 2000. Ecological Methods, Third Edition, Blackwell publishing.
9. Ricklefs, R.R.E. and Miller, G.L. 1999. Ecology. W. H. Freeman & Co.
10. Chapman, J.L. and M. J. Reiss, M.J.. 1998. Ecology - Principles and Applications - 2nd Edition. Cambridge University Press
11. Price, P.W., 1997. Insect Ecology. 3<sup>rd</sup> Edition. John Willey and Sons, N.Y.
12. Yazdani, S.S. and Agonod, M.I. 1997. Elements of Insect Ecology. Navosa Pub. House New Delhi.
13. Huffaker, C.B. and Rabb, R.L., 1984. Ecological Entomology. Willey Intersciences, U.S.A.

**Theory:**

Introduction, history, classification and formulation of pesticides. Pesticide regulation, registration and distribution in Pakistan. FAO code of conduct for pesticides use and handling (Codex Alimentarius) Pesticide hazards, safety, storage, indoor and out door application, soil application and fogging. Pesticide compatibility, selectivity. Pre-harvest safety intervals.. Pesticide application equipment, different methods of pesticide application and their safe use. Calibration methods and measurement of droplet size.

**Practical:**

Demonstration of different pesticide formulations and preparation of field solutions. Types of sprayers and nozzles and their uses. Pesticide application equipments and their calibration. Measurement of droplet size. Visit to formulation plant/ quality lab.

**Books Recommended:**

1. Pretty, J. (Edit). 2005. The Pesticide Detox: Towards A More Sustainable Agriculture. Earthscan. London, UK.
2. Jorgen, S. 2004. Chemical pesticides: Mode of action and toxicology. CRC Press, London.
3. Saleem, M. A. 2002. Principles of Insect Toxicology, Volume 1, Izhar sons Printers, 9 Rattangan Road, Lahore.
4. FAO 2001. Policy and strategy for rational use of Pesticides in Pakistan. FAO-UN, Pakistan
5. Mathews, G. A. 1999. Application of Pesticides to Crops. World Science. Publishing Co.
6. Mathews, G.A. 1992. Pesticides Application Methods. 4<sup>th</sup> ed. Longman Inc., New York.
7. Metcalf, R. A., 1992. Destructive and Useful Insects. 5<sup>th</sup> ed. McGraw Hill Book Co., New York.
8. Agricultural Pesticides Ordinance 1971 and Rules 1973 and subsequent amendments /SROs, MINFAL, Government of Pakistan

**INTRODUCTORY ACAROLOGY****CH 4(3+1)****Theory:**

Introduction; methods of collection, rearing and preservation; morphology; Classification of mites, mites as pests of important crops, vegetables, fruit trees, stored grains, stored products and their control; parasitic and predatory mites; losses caused by and control of mite pests; ecology and dispersal. Methods of estimation of mite population and losses. Mites and plant diseases.

**Practical:**

Collection, preservation, sampling and rearing techniques of phytophagous, predatory, parasitic and stored grain mites; preparation of permanent slides of mites; identification of phytophagous, predatory, parasitic and stored grain mites; estimation of mite population and losses in crop plants and stored grains.

**Books Recommended:**

1. Khuhro, R.D. 1998. Introduction to Acarology. Kashif Publishers, Hyderabad (Sindh), Pakistan.
2. Evans, G.O. 1992. Principles of Acarology, C.A.B. International Cambridge University Press, Cambridge
3. Helle, W. and Sabelis, M.W. (edit.) 1985. Spider Mites, Their biology, Natural enemies and control, Vols IA. and IB. Elsevier Oxford, U.K.
4. Rodriguez, J. G. (Edit.) 1979. Recent Advances in Acarology, Vol. I & II. Academic Press Inc., New York.
5. Krantz, G.W., 1978. A Manual of Acarology, 2<sup>nd</sup> ed. Oregon State Univ. Book Store Inc., Corvallis, Oregon, USA.
6. Jeppson, L.R., H.M. Keifer and E.W. Baker, 1975. Mites Injurious to Economic Plants. Univ. Calif. Press.

**6TH SEMESTER****PLANT NEMATODOLOGY****CH4(3+1)****Theory:**

Introduction. History and importance of nematodes in agriculture. Types of plant parasitic nematodes (Parasitism). Symptoms caused by plant parasitic nematodes. Taxonomy, morphology and biology of nematodes of agricultural importance. Plant-nematode relationship. Nematodes as vectors and their interaction with other plant pathogens. Dispersal, survival and diseases of economically important crops caused by plant nematodes. Methods of nematode control. Nematicides and methods of their application through integrated nematode management.

**Practical:**

Sampling, extraction of nematodes from soil and plant materials. Staining and preparation for microscopic studies. Identification and culturing of nematodes. Preparation of temporary, semi permanent and permanent slides of different nematode. Cultural practices and use of nematicides for management of nematode diseases.

**Books Recommended:**

1. Ahmad, I. and Bhutta, A. R. 2005. Text book of Introductory Plant Pathology. Pub. National Book Foundation, Islamabad, Pakistan.
2. Luc, M., R.A. Sikora and J. Bridge. 2005. Plant Parasitic Nematodes in Sub-tropical and tropical Agriculture. 2<sup>nd</sup> Ed. C.A.B. Intl. Inst. of Parasitology, London.
3. Siddiqi, M. R. 2002. Tylenchida: Parasities of plant and insects
4. Sterr, J.L., R.Cook and J. Bidge. 2002. Plant Resistance to Parasitic Nematodes.
5. Maqbool, M.A. and F. Shahina. 2001. Systematic and distribution: Biodiversity of nematode Fauna in Pakistan
6. Alam M.M. and N. Sharma 2002. Nematode control in crops.
7. Shurtleff, M.C. and Averre III, C.W. 2000. Diagnosing Plant Diseases Caused by Nematodes. APS
8. Trivedi, P. C. 1998. Plant nematode management (A bio-control approach) CBS, Publisher & distributors, India.
9. Whitehead, A. G. 1998. Plant nematode control. Wallingford, UK: CAB International.
10. Dropkin, V.H. 1989. Introduction to Plant Nematology. John Wiley and sons, New York.
11. Maqbool, M.A. 1988. Advances in Plant Nematology. National Centre of Nematology, University of Karachi, Karachi, Pakistan.
12. Brown, R.H. and B.R. Kerry, 1987. Principles and Practice of Nematode Control in Crops. Academic Press, New York.

**INSECT PESTS OF FIELD CROPS****CH 4(3+1)****Theory:**

Introduction, identification, distribution of insect pests of economic importance and their symptoms. Nature of damage, life history and management of insect pests of major field crops; Sugarcane and sugar beet, Wheat, Maize, Rice, Sorghum, Cotton, Tobacco, Pulses, Oil Seed Crops and general pests (e.g. locust, armyworm, termites etc).

**Practical:**

Collection and identification of insect pests of various crops. Symptoms of damage and loss assessment.

**Books Recommended:**

1. Shah, H. A. and Saleem, M. A. 2005. Applied Entomology. 3<sup>rd</sup> ed. B. Z. University Press, Multan.
2. Upadhyay, R.K. 1999. IPM system in agriculture. 5 Vol. set. Aditya Bokk, Pvt. Ltd.
3. Hashmi, A.A. 1994. Insect Pest Management (Vol-I &III). PARC, Islamabad.
4. Hill, D.S. 1993. Agricultural Insect Pests of the Tropics and their Control. Cambridge University Press.
5. Atwal, A.S. 1991. Agricultural Pests of India and South East Asia. Kalyani Publishers India.

**PRINCIPLES OF PLANT DISEASE MANAGEMENT CH 4(3+1)****Theory:**

Introduction to integrated management of plant diseases. Symptoms and disease-index of important diseases of field crops, fruits and vegetables. Principles and methods of plant disease management. Role of environmental factors and nutrition in relation to plant disease development.. Host plant resistance in disease management. Epidemiological basis of disease management strategies, such as plant disease forecasting, regulatory procedures, pathogen exclusion and eradication.

**Practical:**

Collection, identification and diagnosis of different plant diseases. Sampling designs and assessment of disease index. Demonstration of different disease control methods. Acquaintance with equipment and machinery and their calibration. Safety measures for use of chemicals.

**Books Recommended:**

1. Agrios, G. N. 2005. Plant Pathology, 5<sup>th</sup> ed. Elsevier Academic Press Inc., New York.
2. Ahmad, I. and Bhutta, A. R. 2005. Text Book of Introductory Plant Pathology. Pub. National Book Foundation, Islamabad, Pakistan.
3. Strange, R. N. 2003. Introduction to Plant Pathology. New York, John Willey.

4. Mehrotra, R. S. 2003. Plant Pathology. TATA McGraw Hill. Pub. Company Ltd. New Dehli, India.
5. Trigiano, R.N., Windham, M.T. and A.S Windham . 2003. Plant Pathology: Concepts and Laboratory Exercises. CRC Press
6. Kranz, J. . 2002. Comparative Epidemiology of Plant Diseases. Springer
7. Samuel, S.G. 2002. Biological Control of Crop Diseases
8. Trivedi, P.C. 2002. Plant Diseases.
9. Maloy, O.C.. and Murray, T.D. . 2001. Encyclopedia of Plant Pathology in 2 Volumes. John Wiley & Sons
10. Narayanasamy, P. 2001. Plant Pathogen Detection and Disease Diagnosis (Second edition, revised and expanded). Marcel Dekker
11. Thind, T.S. 1998. Diseases of Field Crop and their Management.
12. Maloy O.C. 1993. Plant Diseases Control, Principle & Practices.
13. Lucas, J. A. Dickinson, C. H. 1998. Plant Pathology and Plant Pathogens 3<sup>rd</sup> ed.

## **INSECT CLASSIFICATION**

**CH 4(3+1)**

### **Theory:**

Introduction: Ontogeny and phylogeny, types of classification. Classification of insect orders up to family level with particular reference to insects of Pakistan.

### **Practical:**

Study of existing phylogenetic arrangement of insect orders. Collection and identification of insects up to family level with the help of taxonomic keys.

### **Books Recommended:**

1. Hashmi, A.A. 1994. Pest Management. (Vol. III). PARC, Islamabad.
2. Borror, D.J., DeLong, D.M and. Triplehorn, C.A. 1985. An Introduction to the Study of Insects, 6th ed. Holt, Rinehar and Winston, N.Y.
3. Richards, O.W. and Davies, R.G. 1984. IMM's General Text Book of Entomology. Vol. II, 10th ed. (Revised), Chapman and Co. Ltd., London.
4. Ross, H.H., Ross, C.A and. Ross, J.R.P. 1982, A Text **Book** of Entomology. 4th ed. John Wiley and Sons Inc., N.Y.

**PRINCIPLES OF PLANT PROTECTION****CH 4(3+1)****Theory:**

Introduction: Importance and scope. Methods of plant protection (Cultural, Mechanical, Physical, Biological, Chemical Ecology, Reproductive, Legislative & Chemical Control).

Pesticide equipments. Agro-ecosystem. Integrated pest management (IPM). Concept, principles and components of participatory IPM: Training of Facilitators (TOF) & Farmer Field Schools (FFS). Concept of field biodiversity conservation. Crop appraisal (Damage vs loss). Concept of community Agriculture (Conflict resolution, team building, and social aspects of community). Communication and facilitation skills.

**Practical:**

Study of nature and extent of major pest damage. Demonstration of various methods of pest control and use of equipment. Role play for conflict resolution. Demonstration of communication / facilitation skills. Visits to FFS & TOF.

**Books Recommended:**

1. Shah, H. A. and Saleem, M. A. 2005. Applied Entomology. 3<sup>rd</sup> ed. B. Z. University Press, Multan.
2. Upadhyay, R. K. 1999. Integrated Pest & Disease Management CAB Kew, UK.
3. Pedigo, L.P. 1996. Entomology & Pest Management (2<sup>nd</sup> ed.). Prentice Hall, International London.
4. Hashmi, A.A. 1994. Pest Management (Vol. I,II,III). PARC, Islamabad.
5. Atwal, A.S. 1993. Agricultural Pests of India and South East Asia. 3<sup>rd</sup> ed. Kalyani Publishers, New Delhi.
6. Chattopadhyay, S.B. 1989. Principles and Procedures of Plant Protection. 2<sup>nd</sup> Ed. Oxford & IBH Pub. Co. New Delhi.
7. Nyval, R.F. 1989. Field Crop Diseases Hand Book. AVI Pub. Co. New York.
8. Ross, M.A. and C.A. Lembi, 1985. Applied Weed Science. Burgees Publishing Co. Minneapolis, U.S.A.
9. Martin, H. and D. Woodcock. 1983. Scientific Principles of Crop Protection. Edward Arnolds & Co., London.
10. Pontius, J, Dilts R and Bartlett A. 2002. From farmer field School to comm.: Ten years of IPM training in Asia. FAO Community IPM Program-FAO Regional Office for Asia and the Pacific , Bangkok Thailand.
11. Community IPM. 2005. <http://www.comunityipm.org>

## **PESTS OF FRUITS, VEGETABLES AND ORNAMENTALS**

**4(3+1)**

### **Theory:**

Identification, distribution, host plants, economic importance, extent and nature of damage, life history and integrated management of pests of fruits and vegetables. Assessment of a wide range of pests management options including biological, phytosanitation, bio-pesticides and rational use of selective pesticides.

### **Practical:**

Field visit, collection, identification and nature of damage by pests of various fruits vegetables and ornamentals. Collection and identification of parasitoids and predators of fruits, vegetables and ornamental pests.

### **Books Recommended:**

1. John C. 2001. Handbook of Vegetable Pests. Academic Press.
2. Upadhyay, R.K. 1999. IPM system in agriculture. 5 Vol. set. Aditya Bokk, Pvt. Ltd.
3. Hashmi, A.A. 1994. Insect Pest Management. Pests of Fruits. (Vol-II). PARC, Islamabad.
4. Leslie, A.R. 1994. Handbook of Integrated Pest Management for Turf and Ornamental. CRC Press
5. Atwal, A.S. 1991. Agricultural Pests of India and South East Asia. Kalyani Publishers, India.
6. Compendium of fruits and ornamental plant diseases, Published by American Phytopathological Society, USA.

## **VERTEBRATE PEST MANAGEMENT**

**CH 4(3+1)**

### **Theory:**

Introduction to vertebrate pests and their impact on agricultural economy. Principles of vertebrate pest management. Important vertebrate pests, their biology, behaviour, ecology and distribution. Methods of population and damage assessment. Methods of vertebrate pests control. Causes and prevention of damage by vertebrate pest species to: food and fiber plants and structures. Rodenticides: classification, properties and biosafety. Bait formulations and application methods. Control of porcupine, Murree vole, desert hare, Afghan pika, wild-boar and bird pests.

**Practical:**

Identification of important vertebrate pests. Population and damage assessment methods. Formulations, application methods and field evaluation of baits in control programmes.

**Books Recommended:**

1. Brooks J. E. 1990. Training Manual. Vertebrate Pest Management. PAR/USAID/DWRC Publication.
2. Ahmad, E., J.E. Brook, S. Munir and I. Hussain, 1990. Vertebrate Pest Management in Grain Storage. GOP/USAID/DWRC/NARC Publication.
3. Prakash, I. 1988. Rodent Pest Management. CRC Press, Inc. Boca, Raton Florida.
4. Roberts, T.J. (ed.) 1981. Hand Book of Vertebrate Pest Control in Pakistan. FAO/PARC Publication.
5. Roberts, T.J. 1977. The Mammals of Pakistan. Ernest Benn, London.

**POST-HARVEST PEST MANAGEMENT****CH 4(3+1)****Theory:**

Economic importance of Post-harvest management of food grains. Types of post-harvest losses. Factors affecting post-harvest losses (physical, physiological, biochemical and pathological considerations). Compositional and physical changes occurring during maturation and senescence. Biology and Ecology of storage pests. Methods of loss assessment; sampling techniques and quality analysis procedures. Storage structure and methods of storage at farm and public levels. Inspection and suitability of building and commodity. Grain storage management and fumigation technology.

**Practical:**

Post-harvest loss assessment. Collection and identification of stored grain pests and their natural enemies, assessment of rodent infestation in godowns. Demonstration techniques of spray, fumigation, baits and traps.

**Books Recommended:**

1. Bhutta, A. R., Hussain, A and Rehman, M. R, 2004. Handbook on Seed Processing and Storage, Publ. by Federal Seed Certification & Registration Department, GOP, Islamabad.
2. David Rees. 2004. Insects of Stored Products. Manson Publishing

3. Chakraverty, A. Muyumdar, A. S. Raghavan, GSV and Ramaswamy, H. S. 2003. Handbook of Post Harvest Technology, Published by Marcel Dekhar Inc. New York, USA. P. 864
4. Dennis S. Hill. 2002. Pests of Stored Foodstuffs and their Control. Kluwer Academic Publishers
5. J A Bartz and J K Brecht . 2002. Postharvest Physiology and Pathology of Vegetables. Marcel Dekker
6. Bhutta, A. R. and Ahmad, I. 2000, Seed Pathological Techniques and their Application. Publ. National Book Foundation, Islamabad, Pakistan.
7. Ahmad, E., J.E. Brooks, S. Munir and I. Hussain, 1990. Vertebrate Pest Management in Grain Storage. GOP/USAID/DWRC/NARC Publication.
8. Monro, H.A.U., 1969. Manual of Fumigation for Insect Control. F.A.O. Publication.
9. Lawson, T.J. (Ed.) 1987. Stored Products Pests Control. British Crop Protection Council Monograph No.37, England.
10. Roberts, T.J., 1981. Hand Book of Vertebrate Pest Control in Pakistan. F.A.O. Publication.
11. Harris, H, and C.S. Lindblad., 1978. Post-harvest Loss Assessment Methods. F.A.O. Publication.

### **8<sup>TH</sup> SEMESTER**

**INTERNSHIP INCLUDING PROPOSAL DEVELOPMENT,  
REPORT WRITING AND PRESENTATION. CH 10(0-10)**  
(Format as per Thesis manual of the University concerned)

**Break up for Internship grading:**

<b>Particulars</b>	<b>Marks (300)</b>
<b>Assessment by the Host organization (public / private)</b>	<b>75</b>
• Attendance	20
• Behavior	15
• Performance / Achievement	20
• Oral presentation	20
<b>Assessment by the parent organization.</b>	<b>225</b>
• Oral presentation	75
• Written Exam.	75
• Report submission	75

## PART-II

### POSTGRADUATE COURSES PLANT PROTECTION

#### A- M.Sc.(Hons.)

Minimum requirement for the completion of M.Sc.(Hons.) in Plant Protection will be 35 credit hours course work. Out of which 6 credit hours shall be allocated to compulsory courses (3 credit hours for Biochemistry and 3 credit hrs for Statistics). Out of remaining 29 credit hours 2/3 shall be allocated to major courses, whereas 1/3 credit hours shall be from supporting courses. Thesis will bear 10 credit hours.

The committee drafted the following postgraduate courses for the scheme of studies of Plant Protection:

1.	Insect Pathology	4(3+1)
2.	Host Plant Resistance	4(3+1)
3.	Vectors of Plant Diseases	4(3+1)
4.	Advanced Integrated Pest Management	4(3+1)
5.	Biological Control	4(3+1)
6.	Pesticide Toxicology	4(3+1)
7.	Pesticide Residue Analysis	4(3+1)
8.	Research Methods in Plant Protection	4(2+2)
9.	Microbial Control	4(3+1)
10.	Environment and Plant Protection	3(3+0)
11.	Advanced Ecology	4(3+1)
12.	Pesticide Resistance Management	4(3+1)
13.	Urban Pest Management	4(3+1)
14.	Chemistry and Action of Herbicides	4(3+1)
15.	SPS Measure and Quarantine	4(3+1)

#### Core Courses

The following shall be the core courses in plant protection at M.Sc. (Hons) level.

i.	Research Methods in Plant Protection	3(2-1)
ii.	Community IPM	3(2-1)
iii.	Biological Control	3(2-1)
iv.	Host Plant Resistance	3(2-1)

**B- Ph.D.**

The Committee recommended that course work should be compulsory prerequisite for the Ph.D. degree. It was, further decided that for a Ph.D. degree, a student shall have to complete 25 credit hours, out of which 2/3 credit hours shall be from major courses and 1/3 from supporting courses and a comprehensive examination (written and oral) shall follow.

The following courses were recommended as “CORE COURSES” for Ph. D. degree in Plant Protection.

**CORE COURSES**

i	Advanced Integrated Pest Management	3(2+1)
ii	Microbial Control	3(2-1)
iii.	Environment and Plant Protection	3(2-1)

## INSECT PATHOLOGY

### CH 4(3-1)

#### Theory:

Introduction, history and scope.. Types of insect pathogens (bacteria, fungi, viruses, nematodes etc). Resistance and immunity in insects. Transmission of plant pathogens by insects and mites. host range, persistence and virulence of insect pathogens. Types of injuries and methods of infection by pathogens in insects. Pathogenic diseases and their diagnosis in insects, extra cellular and intracellular microbiota of healthy insects. Control of microbial diseases of useful insects. Role of pathogens in IPM.

#### Practical:

Isolation, purification, culture and identification of insect pathogens from the diseased insects. Diagnosis of different pathogenic diseases in insects. Control of microbial diseases of useful insects. Determination of extent of parasitism by pathogens in insects.

#### Books Recommended:

1. Gaugler, R. 2001. Entomopathogenic nematology
2. Navon, A. 2000. Bioassays of Entomopathogenic microbes and nematodes ISBN # 0851994229 (Pak Book corporation).
3. Boucias, D.G. 1998. Principles of Insect Pathology. Chapman Hall, London.
4. Van Dreische, R. G. 1996. Biological Control. An International Thomson Publishing Company.
5. Tanada, Y. and H. Kaya, 1992. Insect Pathology. Academic Press, New York.
6. Burge, H.D. 1981. Microbial Control of Pest and Plant Diseases. Academic Press, London.
7. Poinar, G.O. Jr. and G.M. Thomas, 1978. Diagnostic for the Identification of Insect Pathogens, Press, New York.
8. Burges, H.D. and N.W. Hussey, 1972. Microbial Control of Insect and Mites. Academic Press London.

## HOST PLANT RESISTANCE

### CH 4(3+1)

#### Theory:

Introduction, types and mechanisms of resistance against insects and pathogens. Ecological, physiological, asynchrony. Induced and genetic resistance, antixenosis, antibiosis, tolerance, disease escape & immunity. Factors of resistance. Genetic basis of resistance. Effect of environment on resistance. Biotypes and resistance. Measurement of resistance. Development of resistant varieties. Methods of screening crop germplasm for the sources of resistance. Comprehensive review of the concepts and achievements in resistance. Study of various infection types on host differentials.

**Practical:**

Testing and measurement of relative plant resistance to pests. Determination of factors and mechanisms of resistance. Preparation of mass inocula of various plant pathogens and methods of application to host plants. Screening of crop germplasm for the detection of sources of resistance.

**Books Recommended:**

1. Sadasivan, S. and Thayumanavan, B. 2003. Molecular Host Plant Resistance to Pests. Marcel Dekker.
2. Sterr, J.L, Cook, R., and Bridge J 2002. Plant Resistance to parasitic nematodes. (Pak Book corporation)
3. Mills, D., Kunoh, H. Keen, N. and S. Mayama. 1996. Molecular Aspects of pathogenicity and Resistance Requirements for Signal Transduction. American Phytopathology Society Press, St., Paul. Minnesota, USA.
4. Pedigo, L.P. 1996. Entomology & Pest Management. Prentis & Hall. Inc. London.
5. Smith, C., Z. Khan and M. Pathak, 1994. Techniques for Evaluating Insect Resistance in Crop Plants. CRC Press, U.S.A.
6. Fowden G. Maxwell and Peter R. Jennings ( Eds.) 1979. Plants resistant to Insects by. John Wiley and Sons New York.
7. Agrawal, A. A., Tuzun S. and Bent E. 1999. Induced Plant defence against pathogens and herbivores. APS
8. Bernays, E., 1989-93. Insect-Plant Interaction (Vol. I-V), CRC Press, U.S.A.
9. Smith, C.M., 1989. Plant Resistance to Insects. A Fundamental Approach. John Wiley & Sons., New York.
10. Russel, G.E. 1981. Plant Breeding for Pest & Disease Resistance Butter-Worthic Co. Ltd. London.
11. Panda, N., 1980. Principles of Host Plant Resistance to Insect Pests. Allanheld, U.S.A.
12. Painter, R.H. 1951. Insect Resistance in Crop Plants. McMillan Co., N.Y.

## VECTORS OF PLANT DISEASES

### CH 4(3-1)

#### Theory:

Introduction, identification & bionomics of different vectors. Inter-relationship of plants, and vectors. Mode and mechanism of transmission of plant pathogens by insects, nematodes and mites. Study of causal organisms, etiology, symptoms and control of important fungal, bacterial, viral and nematode diseases of crop plants transmitted by various vectors.

#### Practical:

Collection and identification of insect, mite and nematode vectors and pathogens. Rearing and handling of vectors for plant pathological studies. Bioassay and study of mode of transmission of the plant pathogens by different vectors.

#### Books Recommended:

1. Van Emden, H. F. and Service, M. 2004. Pest and Vector Control. Cambridge University Press, UK.
2. Taylor, C. E. and D. J. F. Brown. 1997. Nematode vectors of plant viruses. Wallingford,UK: CAB International.
3. Basu, A.N. and B.K. Gerry. 1993. The Essentials of Viruses. Vectors and Plant Diseases. Wiley, Estern Ltd. New Delhi, India.
4. Atkins, M.D. 1978. Insects in Perspective. McMillan Pub.Co. Inc. New York.
5. Jeppson, L.R., H.H. Keifer and E.W. Baker, 1975. Mites Injurious to Economic Plants. Univ.Calif. Press.
6. Carter, W., 1973. Insects in Relation to Plant Diseases. 2nd ed. Inter-science Publishers, N. Y., London.

## ADVANCED INTEGRATED PEST MANAGEMENT CH 4(3+1)

#### Theory:

Introduction, history and concepts of IPM. Agro-ecosystems. Quantitative basis of IPM and sampling methods. Analyses of key pests and their natural enemies. Economic levels in IPM. Principles of IPM technology transfer. Resurgences and outbreaks of pests. Role of parasites, parasitoids, predators, pathogens, pheromones, feeding deterrents and antimetabolites in IPM. Plant resistance in IPM. Role of genetic control and transgenic technology in IPM. Pesticides, bio-pesticides and IGR's in IPM. Remote sensing and current developments in suppressing pests. Comprehensive review of IPM in Pakistan.

**Practical:**

Methods of pest scouting, monitoring and forecasting. Estimation of different insect population, weeds and plant pathogens. Estimation of losses by different sampling techniques. Estimation of losses caused by insects, mites, pathogens, and weeds. Economic levels and their determination. Working knowledge of climatological procedures. Visit to Training of facilitators (TOF) and farmer field school (FFS).

**Books Recommended:**

1. Horowitz, A. Rami: Ishaaya, Isaac, 2004. Insect Pest Management – Field and Protected Crops. Springer.
2. Thacker, J. R. M. 2002. An Introduction to Arthropod Pest Control. Cambridge University Press
3. Norris, R., Caswell-Chen, E. and Kogan, M . 2002. Concepts in Integrated Pest Management. Pearson Education
4. Pimentel, D. 2002. Encyclopedia of Pest Management. Marcel Dekker
5. Mallis. A, Hedges, S.A. and Moreland, D. (eds.). 2004. The Mallis Handbook of Pest Control (9th Edition). Pest Control Technology (PCT)
8. George, G. K. and Turnia, S. B. 2000. Emerging Technologies for Integrated Pest Management, Concept Research and Implementation, UIC.
9. Upadhyay, R.K., K. G. Mukerji, B.P. Chawola and O.P. Dubey, 1998. Integrated Pest and Disease Management. APH Publishing Corp., New Delhi.
10. Dent, D. 1996. Integrated Peat Management. Chapman and Hall, London.
11. Pedigo, L. P. 1996. Entomology and Pest Management. Memillan Publ. Co. New York.
14. Metecalf, R.L. and W.H. Luckman, 1994. Introduction to Insect Pest Management. 3<sup>rd</sup>. John Willey and Sons, USA.
15. Pimental, D. 1991. Handbook of Pest Management in Agriculture, 3<sup>rd</sup> ed. CRC. Press Boca Ratoon, Florida, USA.
16. Flint, M.L and R.V. Bosch, 1981. Introduction to Integrated Pest Management. Plemum Press, New York.

**BIOLOGICAL CONTROL****CH 4(3-1)****Theory:**

Introduction, concept, history and scope. Ecological basis of biological control. Natural enemies: predators, parasites, parasitoids and pathogens. Characteristics of bio-control agents. Procedure of biological control: introduction and colonisation, conservation, , mass culture, augmentation, release and monitoring. Biological control of weeds. Rearing techniques of biological control agents. Role of biological control in IPM.

**Practical:**

Collection, preservation and identification of predators & parasitoids. Laboratory rearing and culturing of important natural enemies. Study of extent of parasitism/predation of different bio-control agents. Visit to public/ private bio-control labs.

**Books Recommended:**

1. Copping, L.G. 2004. The Manual of Biocontrol Agents. BCPC
2. Hajek, A. 2003. Natural Enemies - An Introduction to Biological Control. Cambridge University Press
3. Samuel S.G 2002 Biological control of crop diseases (Pak book Corporation)
4. Rechcigl, J. E. and Rechcigl, N. A., 1999. Biological and Biotechnological Control of Insect Pests. CRC Press September
5. Hawkins, B. A. and Cornell, H. V., 1999. Theoretical Approaches to Biological Control. Cambridge University Press
6. Bellows, T. S., Fisher, T. W., Caltagirone, L. E., Dahlsten, D. L., Huffaker, C. and Gardh G., 1999. Handbook of Biological Control - Principles and Applications of Biological Control. Academic Press, USA.
7. Barbosa, P. 1998. Conservation Biological Control. Academic Press
8. Van Driesche, R. G. and Bellows, T. S. 1996. Biological Control. An international publishing company, New York.
9. Heikki M.T., Hokkeanen, James M. Lynch. 1996. Biological Control – Benefits and Risks Cambridge University Press.
10. Backaye, N.E., Thompson, S. N. and Federici, B. A., 1993. Parasites and Pathogens of Insects. Academic Press, New York.
11. Stirling, G., 1991 Biological Control of Plant Parasitic Nematodes. Uni. Arizona Press, U.S.A.
12. Hoy, M.A. and Herzog, D.C., 1984. Biological Control in Agricultural IPM Systems. Academic Press Inc. New York.
13. De'Bach, P. 1976. Biological Control of Pests and Weeds. Chapman & Brotes, London.

**PESTICIDE TOXICOLOGY****CH 4(3+1)****Theory:**

Introduction, chemistry of pesticides, mode of action, anticholinesterases, acetylcholine receptor agents, axonic poisons, monoamine oxidase inhibitors, chitin synthesis inhibitors, inhibitors of mitochondrial electron transport, uncouplers of oxidative phosphorylation, inhibitors of cell division etc. Pesticide metabolism: Phase-I and Phase-II reactions. Toxicokinetics: pesticide absorption, distribution and excretion in insects and humans. Antidotes against pesticides poisoning.

**Practical:**

Instructions regarding laboratory equipment used in the toxicological experiments. Gross symptoms produced by representative pesticides in insects and rodents. Use of time mortality determination in comparing relative toxicity of fumigants. Bio-assay of pesticides and probit analysis.

**Books Recommended:**

1. Tomlin, C 2003. The Pesticide Manual. 13<sup>th</sup> edition BCPC.
2. Saleem, M. A. 2002. Insect Toxicology. Izhar sons printer, Lahore.
3. Roberts, T. 2000. Metabolism of Agrochemicals in Plants. John Wiley & Sons
4. Gupta, H.C.L. 1999. Insecticides. Toxicology and uses. Agrotech Publishing Academy, Udaipur.
5. Ishaaya, I and D. Degheele 1998. Insecticides with novel modes of action- Springer Verlag.
6. Ware, G.W., 1997. Pesticides-An auto-tutorial Approach. W.H. Freeman, USA.
7. Hodgson, R.R. and N. Motogama (Edits), 1991-todate. Reviews in Pesticide Toxicology, Vol. 1-todate. Toxicology Communications. Inc. USA.
8. Hassall, K.E., 1990. Chemistry of Pesticides, their Metabolism, Mode of Action and Uses in Crop Protection. English Language Book Soc. London.
9. Matsumura, F., 1985. Toxicology of Insecticides. 2<sup>nd</sup> ed. Plenum Publishing Corp. USA.
7. Coats, J. R. 1982. Insecticides; Mode of Action. Academic Press, New York.

**PESTICIDE RESIDUE ANALYSIS****CH 4(3+1)****Theory:**

Theoretical and practical aspects of modern analytical techniques used in the qualitative and quantitative analysis of pesticides and their residues. Separation and quantification techniques: gas chromatography, high speed liquid chromatography, affinity chromatography, electrophoresis, and immuno-chemistry. Identification of pesticides and their metabolites through mass spectrometry, infrared, nuclear magnetic resonance, and ultraviolet spectroscopy.

**Practical**

Laboratory sessions for practical experience in the use of above mentioned methods. Interpretation of spectra of pesticide chemicals based on the techniques discussed in theory. Use of TLC, GLC, HPLC and other chromatographic & spectrometric equipment in pesticides residue analysis. .

**Books Recommended**

1. Horwitz, W. 2004. Official Methods of Analysis of AOAC International. 18<sup>th</sup> Eds. AOAC International , USA.
2. Lee, P.W. 2004. Hand book of residue analytical methods for agrochemicals. 2 volume set. Wiley New York.
3. Tomlin, C 2003. The Pesticide Manual. 13<sup>th</sup> edition BCPC.
4. Ohannesian, L. and Streeter, A. J. 2001. Handbook of Pharmaceutical Analysis. Marcel Dekker
5. Zwiig, G. W. and Sherma, J. 1967-1005. Analytical Methods of Pesticides and Plant Growth Regulators. Vol. 1 and onwards. Academic Press.
6. U. S. Food and Drug Administration . 1999. Pesticide Analytical Manual Volume I (PAM). <http://www.cfsan.fda.gov/~download/pami-all.exe>

**RESEARCH METHODS IN PLANT PROTECTION CH 4(2-4)****Theory:**

Introduction, art of scientific investigation, identification of problems, aims and objectives of work plan. Scientific background of proposed plan (review), techniques and apparatus employed in plant protection research. Scientific photography and digital image processing. Online information collection, digital library search. Computer software in plant protection. Data collection, analysis, interpretation and presentation. Project planning, execution and report writing.

**Practical:**

Lab exercises based on the matter described above.

**Books Recommended:**

1. Hicks, C.R. and K.V.Turner. 1999. Fundamental Concepts in the Design & Analysis of experiments, 5th Edition, Oxford University Press.
2. Hicks, C.R. and K.V.Turner. 1999. Solutions Manual for Fundamental Concepts in the Design & Analysis of experiments, 5th Edition, Oxford University Press.
3. Zar, Jerrold H. 1999. Biostatistical Analysis. 4th Edition. Prentice-Hall, Inc., Upper Saddle River, NJ.
4. Sokal, R. R. and F. J. Rohlf. 1995. Biometry: the principles and practice of statistics in biological research. 3rd edition. W. H. Freeman and Co.: New York.
5. Tonapai, G.T. 1994. Experimental Entomology – An aid to Laboratory and Field Studies. CBS Publishers and Distributors, Delhi, India.
6. Erlich, H., 1992. PCR Technology. Principles and Applications for Amplification. W.H. Freeman and Company, New York.
7. Bancroft, J.D. and Stevens, A. 1990. Theory and Practice of Histological Techniques. Chaschill Livingstone, London.
8. Singh, P. and Moore, R.F., 1985. Handbook of Insect Rearing. Vol-I & II, Elsevier, USA.
9. Blaker, A.A. 1977. Handbook for Scientific Photography. W.H. Freeman and Co., San Francisco.
10. Youdeowei, 1977. Laboratory Manual of Entomology. Oxford University Press, London.
11. Peterson, A. 1976. Entomological Techniques. Edward Bros. Inc. Ann. Arbor, Michigan, USA.

**MICROBIAL CONTROL****CH 4(3-1)****Theory:**

Introduction, history & scope. Ecological basis of microbial control. Characteristics of pathogens of pest species. Control of insects, mites, weeds and plant pathogens by pathogenic bacteria, fungi, viruses, nematodes and protozoa. Mass production of pathogens. Mode of action, storage, infectivity, virulence and bioassay of plant pathogens. Microbial control in agricultural IPM system. Microbial pesticides: production, standardization, formulation and application. Compatibility of microbial-pesticides with biological control agents.

**Practical:**

Collection, preservation and identification of pathogenic fungi, bacteria, nematodes, protozoa and viruses. Diagnosis of insect diseases. Isolation, purification, culturing, formulation and application of pathogens. Awareness, safety and quality control of microbial pesticides. Mass production of pathogens. Compatibility of microbial-pesticides with biological control agents.

**Books Recommended.**

1. Koul, O. and Dhaliwal, G. S. 2001. Microbial Biopesticides. CRC Press.
2. Gaugler R. 2001. Entomopathogenic Nematology (Pak Book Corporation).
3. Khetan, S. K. 2000. Microbial Pest Control. Marcel Dekkar.
4. Trividei, P. C. 1998. Plant Nematode Management: A biocontrol Approach.
5. Van Driesche, R. G. and Bellows, T. S. 1996. Biological Control. An international publishing company, New York
6. Metcalf, R.L. and Luckmann, W.H. 1994. Introduction to Insect Pest Management. John Willey and Sons, New York.
7. Burges, H.D. 1981. Microbial Control of Pests and Plant Diseases. Academic Press, London and New York.
8. Burges, H. D. and Hussey, N. W. 1971. Microbial Control of Insects and Mites. Academic Press, London and New York
9. Steinhaus, E. A. 1963. Insect Pathology. (Vol.1 & 2) Academic Press, London and New York.
18. Stirling, G., 1991 Biological Control of Plant Parasitic Nematodes. Uni. Arizona Press, U.S.A.

**ENVIRONMENT AND PLANT PROTECTION****CH 3(3+0)****Theory:**

Introduction to concept of environmental impact assessment (EIA). Diversity of pests in different environments. Interactions of various groups of pests with biological, chemical and physical constituents of their environments. Impact of air, water, soil pollutants and agrochemicals on pests and non-target organisms. Biological responses to pollutants and biogeochemical cycles. Pesticide pollution. Insects as bio-indicators of environmental pollution.

**Books Recommended:**

1. Pretty, J. (Edit). 2005. The Pesticide Detox: Towards A More Sustainable Agriculture. Earthscan. London, UK.
2. Saleem, M. A. and Ashfaq, M. 2004. Environmental Pollution and Agriculture. B. Z. University Press, Multan.
3. Hill, M.K 2004. Understanding Environmental Pollution, A Primer, 2<sup>nd</sup> Edition. Cambridge University Press.
4. Timbrell, J. A. 2002. Introduction to Toxicology, 3<sup>rd</sup> ed. Taylor and Francis, Bristol, Pennsylvania, USA.
5. Terry, R. 2000. Metabolism of Agrochemicals in Plants. John Willey and Sons, USA.
6. Perry, A.S. 1998. Insecticides in Agriculture and Environment. Retrospects and Prospects.
7. Hodgson, E. and Levi, T. 1997. A Textbook of Modern Toxicology, 2<sup>nd</sup> ed. Mc Graw-Hill, Professional Publishing.
8. Anonymous, 1983. Agrochemical Fate in Food and Environment. Published by I.A.E.A., Vienna.
9. McEwen, F.L. and G.I. Stephenson, 1979. The Use and Significance of Pesticides in the Environment. John Wiley & Sons Inc., New York.
10. Annual Review of Entomology. 1965 to date. Palo Alto, California, Ann. Rev. Inc. USA.
11. FAO 2001. Policy and strategy for rational use of pesticides in Pakistan.FAO-UN, Pakistan
12. Hussain, T. 1999. Pesticide-use and its Impact on crop Ecologies: Issues and Options. Working paper series # 42. Sustainable development policy Institute, Islamabad

**ADVANCED ECOLOGY****CH 4(3-1)****Theory:**

Population growth theories, life-tables, key factor analysis, regression, co-existence, co-habitation, competition & mutual displacement, variation, speciation and diversity. A mathematical approach to the dynamics of single- and multi-species populations and communities with analytical and simulation model techniques: mathematical and statistical techniques applied to population systems and community ecologies; critical survey of models of population growth, niche matrices, competition, predation, ecological genetics, species diversity and distribution, and ecological succession.

**Practical:**

Use of computer simulations in population of agricultural pests: computer modeling used by ecologists to clarify and interpret large field data by clustering, transforming, matrices and multivariate analysis.

**Books Recommended**

1. Bernstein, R. 2003. Population Ecology: An Introduction to Computer Simulations . Willey, New York.
2. Linda, A. 2003. An Introduction to Stochastic Processes with Biology Applications. Pearson Education
3. Mario Giampietro . 2003. Multi-Scale Integrated Analysis of Agroecosystems. CRC Press
4. Williams, B. K., Nichols, J. D. and Conroy, M. J. (eds.). 2002. Analysis and Management of Animal Populations. Academic Press, USA.
5. McGlade, J. 1999. Advanced Ecological Theory. Blackwell Publishing
6. Gutierrez, A. P. 1996. Applied Population Ecology: A Supply-Demand Approach Willey, New York.

**PESTICIDE RESISTANCE MANAGEMENT****CH 2(1-1)****Theory:**

Introduction. Development and types of resistance. Mechanisms of resistance: biochemical, behavioural and genetical resistance. Comparative metabolism of pesticides: activation and detoxication mechanism in pests. Monitoring and management of resistance against various pests. Comprehensive review of resistance development in Agri pests of Pakistan.

**Practical:**

Collection of potentially resistant strains/biotypes of pests from the pesticide treated fields. Detection of levels of resistance in resistant strains. Biochemical basis of resistance. Demonstration of resistance breaking techniques.

**Books Recommended:**

1. Saleem, M. A. 2005. Insecticide Resistance and Management. B. Z. University Press, Multan, Pakistan.
2. FAO 2001. Policy and strategy for rational use of pesticides in Pakistan.FAO-UN, Pakistan
3. Gupta, H.C.L. 1999. Insecticides. Toxicology and Uses. Agrotech Publishing Academy, Udaipur.
4. Pedigo, L.P. 1996. Entomology and Pest Management. Macmillan Publishing Co.,New York, London.

5. Walia, S. and Parmar, B.S. 1995. Pesticide Crop Protection and Environment. Oxford & IBH Publishing Co. New Delhi, Calcutta.
6. Hassall, K.A. 1990. The Biochemistry and Uses of Pesticides. Structure, Metabolism, Mode of Action and Uses in Crop Protection, ECBS/Macmillan, USA.
7. Anonymous. 1984. Pesticide Resistance, Strategies and Tactics for Management. National Academic Press, Washington.
8. Georghio, G.P. and Saito, T. 1983. Pest Resistance to Pesticides. Plenum Publishing Corporation, New York.
9. Wilkinson, C.F. 1976. Insecticides Biochemistry and Physiology. Heyden, London, New York, Rheine.

## URBAN PEST MANAGEMENT

CH 4(3+1)

### Theory:

Recognition, life history, habits of insect pests attacking wood, fabrics etc. Recognition, life history and habits of house hold pests such as obnoxious insects, birds, rats, mice & other pests of human habitations. Principles of fumigation such as evaporation, diffusion & penetration of fumigants, fumigation dosimetry, fumigant toxicity to insects & acquired resistance. Fumigation of mills, ships barges, empty cargo spaces, bagged goods etc. Sealing the space for fumigation, fumigant application techniques for methyl bromide & aluminum phosphide. Physical control methods such as air tight storage, insect proof containers, irradiation, sound & percussion.

### Practical:

Survey, collection, identification and preservation of important pests. Demonstration of fumigation, dosimetry and control methodologies.

### Books Recommended:

1. Ogg, B., Ferraro, D. and C. Ogg. 2005. Cockroach manual. <http://pested.unl.edu.ckcom.htm>
2. Termite Handbook. 2005. <http://pested.unl.edu/termite>
3. Ebeling, W, 2002. Urban Entomology. [www.entomology.ucr.edu](http://www.entomology.ucr.edu)
4. Introduction to Integrated Pest Management (IPM) for "Urban" Landscapes. 1996. IPM Associates, Inc., U.S.A. <http://members.efn.org>
5. Bennett, G.W. and J.M. Owens. 1986. Advances in Urban Pest Management. Van Nostrand Reinhold, New York.
6. Monroe, H.A.U. 1969. Manual of fumigation for insect control, FAO Working Bulletin.

**CHEMISTRY AND ACTION OF HERBICIDES****4(3+1)****Theory:**

Classification of herbicides. Chemical and physical properties of herbicides. Mode of entry and action of herbicides in plants. Factors affecting uptake and translocation. Metabolism of herbicides. Morphological responses of plants to herbicides. Herbicide effects on physiological processes, cell division and elongation, germination and early growth, solute transport, cell membrane structure and function, water and CO<sub>2</sub> exchange, photosynthesis and respiration. Herbicides : selectivity, resistance and tolerance in plants.

**Practical:**

Calculations of herbicide doses. Use of sprayers and their nozzles. Preparation of mixtures/solutions of different concentrations. Demonstration of different methods of herbicide application. Demonstration of herbicide effects on weeds and crop plants.

**Books Recommended**

- 1 Monaco, T J.; Weller, S.C. and Ashton, F.M. . 2002. Weed Science - Principles and Practices, 4th Edition. John Wiley & Sons.
- 2 Rao, V.S., 2000. Principles of Weed Science. 5<sup>th</sup> ed. Oxford & IBH Publ. Co. Ltd., New Delhi.
- 3 Zimdahl, R.L. 1999. Fundamentals of Weed Science, Second Edition. Academic Press, San Diego, CA.
- 4 Aldrich R.J. and R.J. Kremer. 1997. Principles in Weed Management, Second Edition. Iowa State University Press, Ames, IA.
- 5 Anderson, W.P. 1996. Weed Science: Principles and Applications, Third Edition. West Publishing Company, St. Paul MN.
6. Ross, H.A. and C.A. Lembi, 1985. Applied Weed Science. Burgees Publ. Co., U.S.A
7. Ashton, F.M., and A.S. Crafts. 1981. Mode of Action of Herbicides. 2<sup>nd</sup> ed. John Wiley and Sons. New York.
8. Audus, L.J. 1976. Herbicides Physiology, Biochemistry and Ecology. 2<sup>nd</sup> Ed. Academic Press, New York. USA.

**SPS MEASURES AND QUARANTINE****CH 4(3-1)****Theory:**

Introduction to Sanitary and Phytosanitary (SPS) Measures under WTO regime. Plant and pest related issues. Quarantine definition concept and principles. Domestic and international quarantine. Quarantine Act, standards and rules in Pakistan. Quarantine object. Pests and threats. Outbreak of some important pests introduced in Pakistan and elsewhere through import of plant and planting materials (eg. Banana Bunchy top virus, Codling moth) . Impact of SPS and quarantine measures on economy of Pakistan. Identification of pests and inspection procedure of import/export consignment.

**Practical:**

Analysis of various plants and planting material from exportable & importable lots. Visit of port of entry and dry port. Demonstration of quarantine procedure and inspection. Sampling and testing procedure of Federal Seed Certification & Registration Department.

**Books Recommended:**

1. Bhutta, A.R. and Ahmad, I. 2000. Seed pathological techniques and their application. National Book Foundation, Islamabad
2. FAO 2000. Multi lateral Trade Negotiation on Agriculture. A Resource Manual-III-SPS & TBT Agreement. Publ. FAO-UN, Rome, Italy.
3. Plant Quarantine Act 1976, Govt. of Pakistan.
4. Seed Act 1976, Govt. of Pakistan.
5. WTO Publications.

**COMMUNITY INTEGRATED PEST MANAGEMENT****3(3:0)****Theory:**

Community IPM basics; Community IPM at farmers' fields, homes, schools, industrial work places, office buildings, parks and recreational areas, public property, etc. Field base diagnostics. Biodiversity conservation. Educational foundations of the Field School ; The IPM Farmer Field School; Ecological principles underlying the FFS. Farmer field experimentation / Research. Participatory Management and Evaluation and Community IPM; Operational principles; Role of women in community IPM; Community IPM in Pakistan; Community IPM in Asia; Community IPM in USA. Policies and their impacts on community.

## Books Recommended

1. Community IPM. 2005. <http://www.communityipm.org/doc>
2. IPM-Based Landscape Design. 2005. <http://www.efn.org/~ipmpa/D-Mhome.html>
3. Fundamentals of a Low Maintenance, Integrated Pest Management Approach to Landscape Design. 2005. <http://www.efn.org/~ipmpa/des-cnsd.html>
4. FAO 2004. Environmental education for poor farmers. FAO-EU IPM Program for cotton in Asia. FAO Regional office for Asia and the Pacific, Bangkok, Thailand.
5. Van den Berg et al 2004. Farmer Field Research: An analysis of experiences in Indonesia. FAO Regional office for Asia and the Pacific, Bangkok, Thailand.
6. Kazmi, M. R. and R. Zada 2003 . Facilitation Skills: A Resource Book. National IPM Program, NARC, Islamabad.
7. Reijntius, J. and Dilts, R. and Bartlett, A. (eds.), 2002. From Farmer field school to community IPM, Ten years of IPM training in Asia. Published by FAO community IPM Programmes, FAO-UN, Regional Office for Asia and the Pacific, Bangkok, Thailand.
8. CABI Bioscience. 2000 Learning to cut the chemicals in cotton. CABI-Bioscience & PAN UK.
9. E. Van de Fliert and J. Proost .1999. Women and IPM - Crop Protection Practices and Strategies. ITDG Publishing

## **RECOMMENDATIONS**

### **A. UNDERGRADUATE COURSES**

1. The Committee recommends a minimum requirement of 145-149 credit hours (~90 credit hours supporting courses + ~ 60 credit hours specialization courses including not less than 10 credit hours internship) for the completion of the degree. It was already decided in the Deans Committee meeting held on September 28, 2005. These recommendations will be applicable in all the Universities/Institutes.

### **B. POSTGRADUATION IN PLANT PROTECTION**

1. Minimum requirement for the completion of M.Sc.(Hons.) in Plant Protection will be 35 credit hours course work. Out of which 6 credit hours shall be allocated to compulsory courses (3 credit hours each for Biochemistry and Statistics course). Out of remaining 29 credit hrs, 2/3 shall be allocated to major courses, whereas 1/3 credit hours shall be from supporting courses. Thesis will bear 10 credit hours.
2. Minimum credit hours, where applicable, for Ph.D. Programme should be 25, out of which 2/3 will be allocated to Major courses and 1/3 for supporting courses. Completion of course work should be followed by a comprehensive examination (written and oral parts). Other standard rules of the concerned University should be followed as per requirement.

### **C. GENERAL RECOMMENDATIONS**

#### **The committee recommends:**

1. If applicable, this Curricula may be introduced in the institutions where not being offered.
2. Along with the ever increasing standard of education at global level, latest advanced courses may frequently be introduced and for this purpose "Curriculum Development Committee" meetings may be held after every 3 years.
3. The Higher Education Commission may encourage and facilitate the curriculum based teachers exchange program so that expertise in a field present in an organization/institute may be utilized by other organization/institute. This practice will also help to induce a better understanding and cooperation in the faculty members of different universities/institutes. A comprehensive list of expertise present in each institute may be prepared and circulated to all the institutes.

4. The refresher courses based on **specific theme** may be arranged in the Universities/Institutes where “Resource Persons” are available. These courses may be offered to the faculty of other institutes, financially supported by the HEC.
5. For the evaluation of M.Sc. (Hons) and Ph.D. theses, appointment of external examiners from Agri. Universities/Institutes of other provinces may be encouraged. It will improve the standard of research and also develop interaction between the faculties of different institutes.
6. Pre-service training in “Teaching Methods” for freshly inducted teachers may be strengthened by the Higher Education Commission.
7. Keeping in view the urgent needs of Institutions for effective teaching and Advanced Research in various aspects of Plant Protection at Postgraduate level in the Institutions, the facilities of latest Audio-Visual Aids, Research Equipment and Books may be provided.
8. Practical trainings for the faculty in latest equipment being employed in different aspects of crop protection research may be organized by the Higher Education Commission, preferably at those institutions where these equipments are available.
9. Study tours of students to various Institutes may be encouraged by the Universities/Institutes.
10. For effective teaching and research in Plant Protection, the HEC may extend the support to set-up a good Plant Protection Museum at each Agriculture University in order to facilitate the correct identification of insect pests, parasitoids, predators, weeds and pathogens.
11. The Higher Education Commission may facilitate short training/visits abroad for the university teachers in order to obtain latest knowledge in various disciplines.
12. The Higher Education Commission may increase the funds for the purchase of books/journals of the relevant fields.
13. An evaluation committee may be constituted within the respective department to evaluate the question papers according to the course contents.

14. To avoid plagiarism, a copy of title with abstract of M.Sc. (Hons.) and Ph.D. Thesis/dissertation may be placed in HEC Library
15. A National conference may be organized & sponsored by HEC to device road map for long term policies on Agriculture education, Research, development and structural reforms.
16. An Agriculture Council like other professional Councils such as Pakistan Engineering Council & PMDC etc may be established for harmonizing activities and devising tools for implantation of road map recommended by NCRC'S.