Faculty of Agriculture Science & Technology

Department of Agriculture Science

Study and Evaluation Scheme

Of

M.Sc (Ag) Horticulture
(Fruit Science)

(Applicable w.e.f Academic Session 2014-16 till revised)

AKS UNIVERSITY, SATNA

Study and Evaluation Scheme

** The University Authorities reserve all the rights to make any additions/ deletions or changes/ modifications to this syllabus as deemed necessary
M. Sc. (Ag)  
(Two Year Master Degree Programme)  
Requirement of credit hours for award of the degree

<table>
<thead>
<tr>
<th>S.No</th>
<th>Nature of courses</th>
<th>Credit hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Major courses</td>
<td>23</td>
</tr>
<tr>
<td>2</td>
<td>Minor courses</td>
<td>06</td>
</tr>
<tr>
<td>3</td>
<td>Supporting courses</td>
<td>06</td>
</tr>
<tr>
<td>4</td>
<td>Master Seminar</td>
<td>01</td>
</tr>
<tr>
<td>5</td>
<td>Master Research</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Total credits</td>
<td>56</td>
</tr>
</tbody>
</table>

Major Subject: The subject (Department/Discipline) in which a student takes admission.
Minor Subject: The subject closely related to a student’s major subject.

Supporting subject: The subject not related to the major subject. It could be any subject considered relevant for student’s research work or necessary for building his overall competence.

Non-Credit compulsory Courses: Six courses (PGS 1 – PGS 6) are of general nature and are compulsory.
# M.Sc (Ag) Horticulture (Fruit Science)

## Semester wise distribution of courses

### First Semester:

#### A. Major Courses *

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Course code</th>
<th>Title of Course</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FSC 501*</td>
<td>Tropical and Dry land fruit Production</td>
<td>2+1=3</td>
</tr>
<tr>
<td>2</td>
<td>FSC 504*</td>
<td>Canopy Management of Fruit Crop</td>
<td>1+1=2</td>
</tr>
<tr>
<td>3</td>
<td>FSC 505*</td>
<td>Propagation &amp; Nursery Management for Fruit Crops</td>
<td>2+1=3</td>
</tr>
<tr>
<td>4</td>
<td>FSC 603*</td>
<td>Advances in Growth Regulators of Fruit Crops</td>
<td>2+1=3</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Total</strong></td>
<td><strong>11(7+4)</strong></td>
</tr>
</tbody>
</table>

#### B. Minor Courses **

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Course code</th>
<th>Title of Course</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FSC 506</td>
<td>Breeding of Fruit Crops</td>
<td>2+1=3</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Total</strong></td>
<td><strong>3(2+1)</strong></td>
</tr>
</tbody>
</table>

#### C. Supporting Courses

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Course code</th>
<th>Title of Course</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>STAT 511</td>
<td>Statistical Methods in applied science</td>
<td>2+1=3</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Total</strong></td>
<td><strong>3(2+1)</strong></td>
</tr>
</tbody>
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#### D. Non Credit Courses

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Course code</th>
<th>Title of Course</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PGS 502</td>
<td>Technical Writing &amp; Communication Skill</td>
<td>N.C.</td>
</tr>
<tr>
<td>2</td>
<td>PGS 503</td>
<td>Intellectual Property &amp; its management in Agriculture</td>
<td>N.C.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Total</strong></td>
<td><strong>17</strong></td>
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### Second Semester:

#### A. Major Courses *

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Course code</th>
<th>Title of Course</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FSC 502*</td>
<td>Sub Tropical and temperate fruit production</td>
<td>2+1=3</td>
</tr>
<tr>
<td>2</td>
<td>FSC 507*</td>
<td>Post harvest technology for fruit crops</td>
<td>2+1=3</td>
</tr>
<tr>
<td>3</td>
<td>FSC 508*</td>
<td>Growth and Development of Horticultural Crop</td>
<td>2+1=3</td>
</tr>
<tr>
<td>4</td>
<td>FSC 511*</td>
<td>Protected Cultivation</td>
<td>2+1=3</td>
</tr>
<tr>
<td></td>
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<td><strong>Total</strong></td>
<td><strong>12(8+4)</strong></td>
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#### B. Minor Courses **

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Course code</th>
<th>Title of Course</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FSC 509</td>
<td>Biotechnology of Horticultural Crop</td>
<td>2+1=3</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Total</strong></td>
<td><strong>3(2+1)</strong></td>
</tr>
</tbody>
</table>

#### C. Supporting Courses

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Course code</th>
<th>Title of Course</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>STAT 512</td>
<td>Experimental Design</td>
<td>2+1=3</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Total</strong></td>
<td><strong>18</strong></td>
</tr>
</tbody>
</table>

#### D. Non Credit Courses

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Course code</th>
<th>Title of Course</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PGS 504</td>
<td>Library &amp; Information Services</td>
<td>N.C.</td>
</tr>
<tr>
<td>2</td>
<td>PGS 501</td>
<td>Basic Concepts in Laboratory Techniques</td>
<td>N.C.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Total</strong></td>
<td><strong>18</strong></td>
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</table>
### Third Semester

#### A. Major courses*

<table>
<thead>
<tr>
<th>S.No</th>
<th>Courses Code</th>
<th>Title of Course</th>
<th>Credit hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FSC 591</td>
<td>Master Seminar</td>
<td>1(0+1)</td>
</tr>
<tr>
<td>2</td>
<td>FSC 599</td>
<td>Master’s Research</td>
<td>10(0+10)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>11 (1+10)</td>
</tr>
</tbody>
</table>

#### B. Non Credit Course**

<table>
<thead>
<tr>
<th>S.No</th>
<th>Courses Code</th>
<th>Title of Course</th>
<th>Credit hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PGS 506</td>
<td>Disaster Management</td>
<td>N.C.</td>
</tr>
<tr>
<td>2</td>
<td>PGS 505</td>
<td>Agricultural Research, Research Ethics and Rural Development Programmes</td>
<td>N.C.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grand Total</td>
<td></td>
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</table>

### Fourth Semester

#### A. Major courses*

<table>
<thead>
<tr>
<th>S.No</th>
<th>Courses Code</th>
<th>Title of Course</th>
<th>Credit hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FSC 599</td>
<td>Master’s Research Seminar</td>
<td>10(0+10)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>10(0+10)</td>
</tr>
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</table>
M.Sc (Ag) Horticulture (Fruit Science)
1st Semester

Major Courses
FSC 501    TROPICAL AND DRY LAND FRUIT PRODUCTION    2+1

Objective
To impart basic knowledge about the importance and management of Tropical and dry land fruits grown in India.

Theory
Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, role of bioregulators, abiotic factors limiting fruit production, physiology of flowering, pollination, fruit set and development, honeybees in cross-pollination, physiological disorders- causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; industrial and export potential, Agri. Export Zones (AEZ) and industrial supports. Crops

UNIT I: Mango and Banana
UNIT II: Citrus and Papaya
UNIT III: Guava, Sapota and Jackfruit
UNIT IV: Pineapple, Annonas and Avocado
UNIT V: Aonla, Pomegranate, Phalsa and Ber, minor fruits of tropics

Practical
1. Identification of important cultivars of tropical & dry land fruit crop
4. Analyses of quality attributes of tropical & dry land fruit crop.
5. Project preparation for establishing commercial orchards.

Book & Reference:
Nakasone HY & Paul RE. 1998. Tropical Fruits. CABI.
M.Sc (Ag) Horticulture (Fruit Science)
1st Semester

FSC 504 CANOPY MANAGEMENT IN FRUIT CROPS 1+1

Objective
To impart knowledge about the principles and practices in canopy management of fruit crops.

Theory

UNIT I
Canopy management - importance and advantages; factors affecting canopy development.

UNIT II
Canopy types and structures with special emphasis on geometry of planting, canopy manipulation for optimum utilization of light. Light interception and distribution in different types of tree canopies.

UNIT III
Spacing and utilization of land area - Canopy classification; Canopy management through rootstock and scion.

UNIT IV
Canopy management through plant growth inhibitors, training and pruning and management practices.

UNIT V
Canopy development and management in relation to growth, flowering, fruiting and fruit quality in temperate fruits, grapes, passion fruits, mango, sapota, guava, citrus and ber.

Practical
1. Study of different types of canopies.
2. Training of plants for different canopy types.
3. Canopy development through pruning.
4. Use of plant growth inhibitors in fruit crops.
5. Geometry of planting.
6. Study on effect of different canopy types on production and quality of fruits.

Book & Reference:
M.Sc (Ag) Horticulture (Fruit Science)  
1st Semester

FSC 505     PROPAGATION AND NURSERY MANAGEMENT FOR FRUIT CROPS         2+1

Objective
Familiarization with principles and practices of propagation and nursery management for fruit crops.

Theory
UNIT I

UNIT II

UNIT III

UNIT IV

UNIT V
Nursery – types, structures, components, planning and layout. Nursery management practices for healthy propagule production.

Practical
1. Anatomical studies in rooting of cutting and graft union.
2. Construction of propagation structures.
3. Study of media and PGR.
5. Visit to TC labs and nurseries.

Book & Reference:
M.Sc (Ag) Horticulture (Fruit Science)
1st Semester

FSC 603 ADVANCES IN GROWTH REGULATION OF FRUIT CROPS 2+1

Objective
Appraisal on the advances in growth regulation of fruit crops.

Theory
UNIT I
Ecophysiological influences on growth and development of fruit crops—flowering, fruit set—Crop load and assimilate partitioning and distribution.

UNIT II
Root and canopy regulation, study of plant growth regulators in fruit culture—structure, biosynthesis, metabolic and morphogenetic effects of different plant growth promoters and growth retardants.

UNIT III
Absorption, translocation and degradation of phytohormones—internal and external factors influencing hormonal synthesis, biochemical action, growth promotion and inhibition, canopy management for fertigated orchards.

UNIT IV
Growth regulation aspects of propagation, embryogenesis, seed and bud dormancy, fruit bud initiation, regulation of flowering, off season production.

UNIT V
Flower drop and thinning, fruitset and development, fruit drop, parthenocarpy, fruit maturity and ripening and storage, molecular approaches in crop growth regulation—current topics.

Practical
1. Root-shoot studies.
2. Quantifying the physiological and biochemical effects of physical and chemical growth regulation.
3. Bioassay and isolation through chromatographic analysis for auxins, gibberellins, experiments on growth regulation during propagation.
4. Dormancy, flowering, fruitset and fruit development stages.

Suggested Readings
M.Sc (Ag) Horticulture (Fruit Science)
1st Semester

Minor Courses
FSC 506 BREEDING OF FRUIT CROPS 2+1

Objective
To impart comprehensive knowledge about the principles and practices of breeding of fruit crops.

Theory
Origin and distribution, taxonomical status - species and cultivars, cytogenetics, genetic resources, blossom biology, breeding systems, breeding objectives, ideotypes, approaches for crop improvement - introduction, selection, hybridization, mutation breeding, polyploidy breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, biotechnological interventions, achievements and future thrust in the following selected fruit crops.

Crops
UNIT I: Mango, banana and pineapple
UNIT II: Citrus, grapes, guava and sapota
UNIT III: Jackfruit, papaya, custard apple, aonla, avocado and ber
UNIT IV: Litchi, jamun, phalsa, mulberry, raspberry, and nuts.
UNIT V: Apple, pear, plums, peach, apricot, cherries and strawberry

Practical
2. Study of anthesis, estimating fertility status.
3. Practices in hybridization, ploidy breeding, mutation breeding,
4. Evaluation of biometrical traits and quality traits.
5. Visit to research stations working on tropical, subtropical and temperate fruit improvement

Book & Reference:
Nijjar GS. 1977. (Eds.). Fruit Breeding in India. Oxford & IBH.
M.Sc (Ag) Horticulture (Fruit Science)  
1st Semester

Supporting Courses
STAT 511  STATISTICAL METHODS FOR APPLIED SCIENCES  3(2+1)

Objective
It would also help them in understanding the concepts involved in data presentation, analysis and interpretation. The students would get an exposure to presentation of data, probability distributions, parameter estimation, and tests of significance, regression and multivariate analytical techniques.

Theory
UNIT I
Classification, tabulation and graphical, representation of data. Box-plot, Descriptive statistics.
UNIT II
Exploratory data analysis;
UNIT III
Measures of central tendency- Mean, Median, Mode, Geometric mean, Harmonic mean.
UNIT IV
Measures of Dispersion- Range, Quartile deviation, Mean deviation, Standard deviation.
UNIT V
Theory of probability. Random variable and mathematical expectation. Discrete and continuous probability distributions. Correlation and regression

UNIT V
Binomial, Poisson, Negative Binomial, Normal distribution, Beta and Gamma distributions and their applications. Concept of sampling distribution: chi-square, t and F distributions. Tests of significance based on Normal, chi-square, t and F distributions.

Practical
1. Exploratory data analysis, Box-Cox plots; fitting of distributions.
2. Binomial, Poisson, Negative Binomial, Normal; Large
3. Sample tests, testing of hypothesis based on exact sampling distributions-chi square, t and F;
5. Correlation and regression analysis, fitting of orthogonal polynomial regression;
6. Applications of dimensionality reduction and discriminant function analysis.
7. Nonparametric tests.

Book & Reference:

M.Sc (Ag) Horticulture (Fruit Science)
1st Semester

Non Credit Courses

PGS 502: Technical Writing and Communications Skills (0+1)

Objective
To equip the students/scholars with skills to write dissertations, research papers, etc. To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical

Technical Writing Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

Communication Skills:
Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

Book & Reference:

- High School English Grammar and Composition. S. Chand & Co.
Non Credit Courses

PGS 503  Intellectual Property and Its management in Agriculture  1(1+0)

Objective
The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Theory
Unit I:
Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs;
Unit II:
Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers’ rights and biodiversity protection;
Unit III:
Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection.
Unit IV
National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture.
Unit V:
Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Book & Reference:
M.Sc (Ag) Horticulture (Fruit Science)
2nd Semester

Major Courses

FSC 502 SUBTROPICAL AND TEMPERATE FRUIT PRODUCTION 2+1

Objective
To impart basic knowledge about the importance and management of subtropical and temperate fruits grown in India.

Theory
Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, bioregulation, abiotic factors limiting fruit production, physiology of flowering, fruit set and development, abiotic factors limiting production, physiological disorders-causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, precooling, storage, transportation and ripening techniques; industrial and export potential, Agri Export Zones (AEZ) and industrial support.

Crops
UNIT I: Apple, pear, grapes.
UNIT II: Plums, peach, apricot, cherries, hazelnut.
UNIT III: Litchi, loquat, persimmon, kiwifruit, strawberry.
UNIT IV: Nuts- walnut, almond, pistachio, pecan.
UNIT V: Minor fruits- carambola, bael, wood apple, fig, jamun, rambutan, pomegranate

Practical
1. Identification of important cultivars SUBTROPICAL AND TEMPERATE FRUIT.
2. Observations on growth and development of Sub tropical and Temperate Fruit.
3. Analyses of quality attributes
4. Project preparation for establishing commercial orchards.

Book & Reference:
Nijjar GS. 1977. (Eds.). Fruit Breeding in India. Oxford & IBH.
FSC 507  POST HARVEST TECHNOLOGIES FOR FRUIT CROPS  2+1

Objective
To facilitate deeper understanding on principles and practices of post harvest management of fruit crops.

Theory

UNIT I
Maturity indices, harvesting practices for specific market requirements, influence of pre-harvest practices, enzymatic and textural changes, respiration, and transpiration.

UNIT II
Physiology and biochemistry of fruit ripening, ethylene evolution and ethylene management, factors leading to post-harvest loss, pre-cooling.

UNIT III
Treatments prior to shipment, viz., chlorination, waxing, chemicals, biocontrol agents and natural plant products. Methods of storage ventilated, refrigerated, MAS, CA storage, physical injuries and disorders.

UNIT IV
Packing methods and transport, principles and methods of preservation, food processing, canning, fruit juices, beverages, pickles, jam, jellies, Candies.

UNIT V
Dried and dehydrated products, nutritionally enriched products, fermented fruit beverages, packaging technology, processing waste management, food safety standards.

Practical
1. Analyzing maturity stages of commercially important horticultural crops.
2. Improved packing and storage of important horticultural commodities.
3. Physiological loss in weight of fruits and vegetables.
5. Estimation of quality characteristics in stored fruits.
6. Cold chain management - visit to cold storage and CA storage units,
7. Visit to fruit and vegetable processing units,

Book & Reference:
Mitra SK. 1997. Post Harvest Physiology and Storage of Tropical and Sub-tropical Fruits. CABI.
FSC 508     GROWTH AND DEVELOPMENT OF HORTICULTURAL CROPS     2+1

Objective
To develop understanding of growth and development of horticultural crops which have implications in their management.

Theory
UNIT I
Growth and development- definition, parameters of growth and development, growth dynamics, morphogenesis.

UNIT II
Annual, semi-perennial and perennial horticultural crops, environmental impact on growth and development, effect of light, photosynthesis and photoperiodism, vernalisation, effect of temperature, heat units, thermoperiodism.

UNIT III
Assimilate partitioning during growth and development, influence of water and mineral nutrition during growth and development, biosynthesis of auxins, gibberellins, cytokinins, abscissic acid, ethylene, brasssinosteroids, growth inhibitors, morphactins, role of plant growth promoters and inhibitors.

UNIT IV
Developmental physiology and biochemistry during dormancy, bud break, juvenility, vegetative to reproductive interphase, flowering, pollination, fertilization and fruit set, fruit drop, fruit growth, ripening and seed development.

UNIT V
Growth and developmental process during stress - manipulation of growth and development, impact of pruning and training, chemical manipulations in horticultural crops, molecular and genetic approaches in plant growth development.

Practical
1. Understanding dormancy mechanisms in seeds, tubers and bulbs and stratification of seeds, tubers and bulbs.
2. Visit to arid, subtropical and temperate horticultural zones to identify growth and development patterns, techniques of growth analysis.
3. Evaluation of photosynthetic efficiency under different environments, study of growth regulator functions, hormone assays.
4. Understanding ripening phenomenon in fruits and vegetables.
5. Study of impact of physical manipulations on growth and development.
6. Study of chemical manipulations on growth and development.
7. Understanding stress impact on growth and development.

Book & Reference:
M.Sc (Ag) Horticulture (Fruit Science)  
2nd Semester

FSC 511 PROTECTED FRUIT CULTURE 2+1

Objective
Understanding the principles, theoretical aspects and developing skills in protected cultivation of fruit crops.

Theory
UNIT I

UNIT II
Basics of greenhouse design, different types of structures – glasshouse, shade net, poly tunnels - Design and development of low cost greenhouse structures.

UNIT III
Interaction of light, temperature, humidity, CO₂, water on crop regulation - Greenhouse heating, cooling, ventilation and shading.

UNIT IV
Types of ventilation- Forced cooling techniques - Glazing materials - Micro irrigation and Fertigation.

UNIT V
Automated greenhouses, microcontrollers, waste water recycling, Management of pest and diseases – IPM.

Practical
1. Designs of greenhouse, nethouse- Regulation of light, temperature, humidity in greenhouses.
3. Media for greenhouse cooling systems, ventilation systems, fertigation systems.
4. Special management practices
5 Project preparation for greenhouses, visit to greenhouses.

Book & Reference:
Mears DR, Kim MK & Roberts WJ. 1971. *Structural Analysis at an Experimental Cable-supported Air Inflated Green Houses*. Trans.ASAE.
Minor Courses
FSC 509  BIOTECHNOLOGIES OF HORTICULTURAL CROPS  2+1

Objective
Understanding the principles, theoretical aspects and developing skills in biotechnology of horticultural crops.

Theory
UNIT I
Harnessing bio-technology in horticultural crops, influence of plant materials, physical, chemical factors and growth regulators on growth and development of plant cell, tissue and organ culture.

UNIT II
Callus culture – types, cell division, differentiation, morphogenesis, organogenesis, embryogenesis.

UNIT III
Use of bioreactors and *in vitro* methods for production of secondary metabolites, suspension culture, nutrition of tissues and cells, regeneration of tissues, ex vitro, establishment of tissue cultured plants.

UNIT IV
Physiology of hardening - hardening and field transfer, organ culture – meristem, embryo, anther, ovule culture, embryo rescue, somaclonal variation, protoplast culture and fusion.

UNIT V

Practical
1. An exposure to low cost, commercial and homestead tissue culture Laboratories.
2 Media preparation, inoculation of explants for clonal propagation, callus induction and culture.
3. Regeneration of plantlets from callus, sub-culturing.
4 techniques on anther, ovule, embryo culture.
6. Project development for establishment of commercial tissue culture laboratory.

Book & Reference:
Supporting Courses
STAT 512       EXPERIMENTAL DESIGNS        2+1

Objective
This course is meant for students of agricultural and animal sciences other than Statistics. Designing an experiment is an integrated component of research in almost all sciences. The students would be exposed to concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

Theory
UNIT I
Need for designing of experiments, characteristics of a good design. Basic principles of designs-randomization, replication and local control.
UNIT II
Uniformity trials, size and shape of plots and blocks; Analysis of variance; completely randomized design, randomized block design and Latin square design.
UNIT III
Factorial experiments, (symmetrical as well as asymmetrical). Orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.
UNIT IV
Split plot and strip plot designs; Analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, crossover designs, balanced incomplete block design, resolvable designs and their applications ~ Lattice design, alpha design-concepts, randomisation procedure, analysis and interpretation of results. Response surfaces. Experiments with mixtures.
UNIT V
Bioassays- direct and indirect, indirect assays based on quantal dose response, parallel line and slope ratio assays potency estimation.

Practical
1. Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law;
2. Analysis of data obtained from CRD, RBD, and LSD;
3. Analysis of factorial experiments without and with confounding;
4. Analysis with missing data; Split plot and strip plot designs; Transformation of data;
5. Analysis of resolvable designs; Fitting of response surfaces.

Book & Reference:
Non Credit Courses

PGS 504: Basic Concepts in Laboratory Techniques 1(0+1)

Objective:
To acquaint the students about the basics of commonly used techniques in laboratory.

Practical:
Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vacuups; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agrochemical doses in field and pot applications; Preparation of solutions of acids; Neutralization of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sand bath, water bath, oil bath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy

Book & Reference:

Objective:
To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

Practical:
Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; ere sources access methods.

Book & Reference:
ICTBasedLibraryandInformationServices by Akhtar Hussain ESS ESS Publication
Foundations of Library and Information Science, Third Edition by Richard Rubin
Information Literacy Instruction: Theory and Practice, Second Edition (Information Literacy Sourcebooks) by Esther S. Grassian and Joan R. Kaplowitz (Jul 31, 2009)
Objective
To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

UNIT I
History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

UNIT II
Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT III
Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings
Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.