



**ANNAMALAI UNIVERSITY**  
(Accredited with 'A+' Grade by NAAC)



**FACULTY OF AGRICULTURE**  
(Accredited by ICAR)

**DEPARTMENT OF HORTICULTURE**

---

**Academic Syllabi**

---

**M.Sc. (Hort.) Plantation, Spices, Medicinal and  
Aromatic Crops**

**Under Choice based credit system (CBCS) with Outcome  
based Education**

**2022-2023 Onwards**

**M.Sc. (Hort.) Plantation, Spices, Medicinal and Aromatic Crops**  
**Courses with Credit Load**

<b>I) Course work</b>	
Major Courses	<b>20</b>
Minor Courses	<b>08</b>
Supporting Courses	<b>06</b>
Common Courses	<b>05</b>
Seminar	<b>01</b>
<b>II) Thesis Research / IDEA</b>	<b>30</b>
<b>Total credits</b>	<b>70</b>

**Distribution Pattern of Courses and Credit (For Research Program)**

Semester	Major Courses	Minor Courses	Supporting Courses	Common Courses	Seminar	Research	Credit Load
I	8	-	6	2	-	2	18
II	12	-	-	2	-	6	20
III	-	6	-	1	1	10	18
IV	-	2	-	-	-	12	14
Credit Load	<b>20</b>	<b>8</b>	<b>6</b>	<b>5</b>	<b>1</b>	<b>30</b>	<b>70</b>

**Distribution Pattern of Courses and Credit (For IDEA Program)**

Semester	Major Courses	Minor Courses	Supporting Courses	Common Courses	Seminar	IDEA	Credit Load
I	8	-	6	2	-	-	16
II	12	-	-	2	-	-	14
III	-	6	-	1	1	10	18
IV	-	2	-	-	-	10 +10	22
Credit Load	<b>20</b>	<b>8</b>	<b>6</b>	<b>5</b>	<b>1</b>	<b>30</b>	<b>70</b>

**Distribution Pattern of Courses and Credit**  
**M.Sc. (Hort.) Plantation, Spices, Medicinal and Aromatic Crops**

S.no.	Course Code	Course Title	Credit Hours
<b>Major Courses</b>			
1	PSM501*	Production of Plantation Crops	3(2+1)
2	PSM502*	Production of Spice Crops	3(2+1)
3	PSM503*	Production of Medicinal and Aromatic Crops	3(2+1)
4	PSM504*	Breeding of Plantation and Spice Crops	3(2+1)
5	PSM505*	Breeding of Medicinal and Aromatic Crops	2(1+1)
6	PSM506	Systematics of Plantation and Spice Crops	2(1+1)
7	PSM 507	Systematics of Medicinal and Aromatic Crops	2(1+1)
8	PSM 508	Underexploited Plantation, Spice, Medicinal and Aromatic Crops	2(2+0)
9	PSM 509	Growth and Development of Plantation, Spice, Medicinal and Aromatic crops	3(2+1)
<b>Minor Courses</b>			
10	PSM 510	Biochemistry of Plantation, Spices, Medicinal and Aromatic Crops	3(2+1)
11	PSM511	Biodiversity and Conservation of Plantation, Spice, Medicinal and Aromatic crops	3(2+1)
<b>Supporting Courses</b>			
12	STA 501	Statistical methods for Applied sciences	3(2+1)
13	COM 501	Information technology in agriculture	3(2+1)
<b>Common courses</b>			
14	PGS 501	Agricultural Research, Research Ethics and Rural Development Programmes	1(1+0)
15	PGS 502	Technical Writing and Communications Skills	1(1+0)
16	PGS 503	Basic Concepts in Laboratory Techniques	1(0+1)
17	PGS 504	Library and Information Services	1(1+0)
18	PGS 505	Intellectual Property and its Management in Agriculture	1(1+0)
<b>Non Gradual Courses</b>			
19	NGC 511	Disaster Management (Contact hour: 1)	-
20	NGC 512	Constitution of India (Contact hour: 1)	-
21	PSM 591	Master's Seminar	1(0+1)
22	PSM 599	Research	0+30

\*Compulsory courses

### **Programme Outcomes (POs)**

**PO 1.** Students will have core knowledge leading to awareness on advancements in the field of Plantation, Spices, Medicinal & Aromatic crops including crop production, soil fertility, crop protection, crop improvement. Biotechnology, post harvest technologies and economics of cultivation.

**PO2.** Students will have understanding and skill on experimental tools in biological sciences, analytical techniques for plant and soil samples, microbial technologies, biotechnological breeding methods, statistical tools & analysis, research data computation, etc., required for higher learning in Plantation, Spices, Medicinal & Aromatic.

**PO 3.** Students will be mastering the modern horticulture techniques of crop production, water, soil & nutrient management, plant protection, crop improvement and ecosystem restoration.

**PO 4.** Students will be able design and execute individual research project , write concise & persuasive research articles and communicate effectively with their scientific colleagues , farmers and the general public .

**PO 5.** Students become eligible to work in commercial horticultural units, research project, post-harvest industries and POS.be able to address complex problems taking into account related ethical, social, legal, economic, and environmental issues.

### **PO and CO Mapping Matrix**

#### **AFFINITY LEVELS**

1	<b>Low</b>
2	<b>Moderate/ Medium</b>
3	<b>Substantial /High</b>

### SEMESTER WISE DISTRIBUTION OF COURSES (RESEARCH)

Sl. No.	Course Title	Credit hours
<b>I Semester</b>		
1.	Major Courses	8
2.	Supporting Courses	
	STA 501 - Statistical Methods for Applied Sciences	3
	COM 501 - Information Technology in Agriculture	3
3.	Common Courses	
	PGS 501 - Agricultural research, research ethics and rural development programmes	1
	PGS 502 - Technical writing and communications skills	1
4.	<b>PSM 599 Research</b>	2
	<b>Total</b>	<b>18</b>
<b>II Semester</b>		
1.	Major Courses	12
2.	Common Courses	
	PGS 503 - Basic Concepts in Laboratory Techniques	1
	PGS 504 - Library and information services	1
3.	<b>PSM 599 Research</b>	6
	<b>Total</b>	<b>20</b>
<b>III Semester</b>		
1.	Minor courses	6
2.	Common course	
	PGS 505 - Intellectual property and its management in agriculture	1
3.	NGC 511 Disaster Management (1+ 0)	-
4.	NGC 512 Constitution of India (Contact hour 1+ 0)	-
5.	<b>PSM 591 Master's Seminar</b>	1
6.	<b>PSM 599 Research</b>	10
7.	Value Added Course (3+0) ( <a href="https://annamalaiuniversity.ac.in/studport/value_added_crs.php">https://annamalaiuniversity.ac.in/studport/value_added_crs.php</a> )	-
	<b>Total</b>	<b>18</b>
<b>IV Semester</b>		
1.	Minor course	2
2.	<b>PSM 599 Research</b>	12 (8+4)
	<b>Total</b>	<b>14</b>

### SEMESTER WISE DISTRIBUTION OF COURSES (IDEA)

Sl. No.	Course Title	Credit hours
<b>I Semester</b>		
4.	Major Courses	8
5.	Supporting Courses	
	STA 501 - Statistical Methods for Applied Sciences	3
	COM 501 - Information Technology in Agriculture	3
6.	Common Courses	
	PGS 501 - Agricultural research, research ethics and rural development programmes	1
	PGS 502 - Technical writing and communications skills	1
4.	PSM 599 IDEA	
	<b>Total</b>	<b>16</b>
<b>II Semester</b>		
4.	Major Courses	12
5.	Common Courses	
	PGS 503 - Basic Concepts in Laboratory Techniques	1
	PGS 504 - Library and information services	1
6.	PSM 599 IDEA	
	<b>Total</b>	<b>14</b>
<b>III Semester</b>		
1.	Minor courses	6
2.	Common course	
	PGS 505 - Intellectual property and its management in agriculture	1
3.	NGC 511 Disaster Management (1+ 0)	-
4.	NGC 512 Constitution of India (Contact hour 1+ 0)	-
5.	PSM 591 Master's Seminar	1
6.	PSM 599 IDEA	10
7.	Value Added Course (3+0) ( <a href="https://annamalaiuniversity.ac.in/studport/value_added_crs.php">https://annamalaiuniversity.ac.in/studport/value_added_crs.php</a> )	-
	<b>Total</b>	<b>18</b>
<b>IV Semester</b>		
1.	Minor course	2
2.	PSM 599 IDEA	20 (10+10)
	<b>Total</b>	<b>22</b>

## PSM-501 PRODUCTION OF PLANTATION CROPS (2+1)

### Learning objectives

- This course will impart theoretical as well as hands-on experience to the learner on scientific production technology of various plantation crops in Indian perspectives.
- Students will be able to learn about advances in production technologies of plantation crops
- Students will gain basic knowledge in production technologies of plantation crops

### Theory

Role of plantation crops in national economy- export potential- IPR issues- clean development mechanism- classification and varietal wealth- plant multiplication including in vitro multiplication- systems of cultivation- multitier cropping photosynthetic efficiencies of crops at different tiers- rainfall- humidity temperature- light and soil PH on crop growth and productivity- high density planting- nutritional requirements- physiological disorders- role of growth regulators and macro and micro nutrients- water requirements- fertigation moisture conservation- shade regulation- weed management- training and pruning- crop regulation- organic production technologies- maturity indices harvesting- post harvest practices- cost benefit analysis- organic farming management of drought- precision farming of the following crops.

### Unit - I: Production technology of plantation crops -I

Tea and coffee

### Unit - II: Production technology of plantation crops -II

Rubber and cashew

### Unit - III: Production technology of plantation crops -III

Coconut and Arecanut

### Unit - IV: Production technology of plantation crops -IV

Palmyrah, oil palm and cocoa

### Unit - V: Production technology of plantation crops -V

Wattle and betel vine

### Practicals

Description of botanical and varietal features of plantation crops- selection of mother palms and seedlings in coconut and Arecanut- processing and value addition of plantation crops- visit to plantation industries and commodity boards.

### Lesson plan

1. Role of plantation crops in national economy, export potential and imports, area and production-IPR issues in plantation crops.
2. Varietal status, eco physiological requirements, recent trends in plant multiplication, planting and high-density planting, cropping systems, irrigation and fertigation, role of major and minor nutrients, nutrient management, growth regulators and shade regulation training and pruning, weed management, soil and moisture conservation, major biotic stresses and their management, harvesting, curing, processing, grading, packing, storage and value addition of the following crops:

3-6. Tea

7-10. Coffee

11-13. Rubber

14-16. Cashew

17. Mid semester examination

- 18-21. Coconut
- 22-24. Arecanut
- 25-26. Palmyrah
- 27-28. Oil palm
- 29-30. Cocoa
- 31. Wattle
- 32. Betel vine
- 33. Organic farming in plantation crops.
- 34. Role of commodity boards and developmental institutions in plantation crops.

**Practical**

- 1. Description of botanical and varietal features of tea.
- 2. Description of botanical and varietal features of coffee.
- 3. Processing of tea and coffee.
- 4. Description of botanical and varietal features of rubber.
- 5. Description of botanical and varietal features of cashew.
- 6. Processing of rubber and cashew.
- 7. Description of botanical and varietal features of coconut.
- 8. Selection of mother palms and seed nuts, quality nursery production in coconut.
- 9. Description of botanical and varietal features of Arecanut.
- 10. Processing of Arecanut.
- 11. Description of botanical and varietal features of palmyrah.
- 12. Description of botanical and varietal features of cocoa.
- 13. Processing of cocoa.
- 14. Description of botanical and varietal features of betel vine.
- 15. Description of botanical and varietal features of oil palm and wattle.
- 16. Visit to Commodity Boards and plantation industries.
- 17. Visit to Commodity Boards and plantation industries.

**Course outcome**

**CO1:** Students will be able to appreciate the research advancements made in plantation crops.

**CO2:** They will be able to recommend suitable package of practices for enhanced production of plantation crops.

**CO3:** Students will be able to manage plantation estates.

**CO4:** Students will be able to get pattern rights in plantation crops.

**CO5:** Students will be able to manage the manufacturing industries of plantation crops.

**CO -PO Mapping matrix**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>
<b>CO1</b>	3	2	1	1	1
<b>CO2</b>	3	2	1	2	1
<b>CO3</b>	3	3	1	1	2
<b>CO4</b>	2	2	2	1	1
<b>CO5</b>	3	2	1	1	1

**References**

- 1. Anonymous, 1985. Rubber and its Cultivation. The Rubber Board of India.
- 2. Chopra, V.L. and K.V. Peter. 2005. Handbook of Industrial Crops. Haworth Food Products Press, New York.



3. Choudappa P, Anitha K, Rajesh MK and Ramesh SV. 2017. Biotechnology of Plantation Crops.
4. Harler CR. 1963. The Culture and Marketing of Tea. Oxford Univ. Press.
5. Kurian, A. and K.V. Peter. 2007. Commercial Crops Technology. New India Publ., New Delhi.
6. Nair, M.K., E.V.V. Bhaskara Rao, K.K.N. Nambiar and M.C. Nambiar. 1979. Cashew. CPCRI, Kasaragod.
7. Peter, K.V. 2002. Plantation Crops. National Book Trust.
8. Pradeep Kumar, T., B. Suma, Jyothibhaskar. and K. N. Satheesan. 2008. Management of Horticultural Crops. Part I, II. New India Publ. Agency.
9. Ranganathan, V. 1987. Hand Book of Tea Cultivation. UPASI, Tea Res. Stn. Cinchona.
10. Thampan, P. K. 1981. Hand Book of Coconut Palm. Oxford & IBH.

#### **Suggested journals**

1. SpiceIndia
2. Journal of spices and aromatic crops
3. Indian spice
4. Journal of Horticultural sciences
5. Indian Horticulture

#### **E-Resources**

1. <http://cpcri.nic.in/>
2. <http://rubberboard.org.in/>
3. <http://www.ap.nic.in/ncrop>
4. <http://kar.nic.in/cashew/>

### **PSM502 PRODUCTION OF SPICE CROPS (2+1)**

#### **Learning objectives**

- This course will impart theoretical as well as hands-on experience to the learner on scientific production technology of various spice crops in Indian perspectives.
- To gain comprehensive knowledge about diversification of spices, importance, export, employment potential and production technology of spices grown in India
- To gain knowledge in Good Agricultural practices in spice production.

#### **Theory**

Introduction- importance of spice crops-historical accent- present status - national and international- future prospects- botany and taxonomy- climatic and soil requirements-commercial varieties/hybrids- site selection- layout-sowing/planting time and methods- seed rate and seed treatment- nutritional and irrigation requirements- intercropping- mixed cropping- intercultural operations-weed control- mulching- physiological disorders- harvesting-post harvest management- plant protection measures and seed planting material and micropropagation- precision farming- organic resource management- organic certification-quality control- pharmaceutical significance and protected cultivation of:

#### **Unit - I: Production technology of major spices- I**

Black pepper, cardamom

#### **Unit - II: Production technology of major spices -II**

Turmeric, ginger and garlic

#### **Unit - III: Production technology of tree spices**

Clove, cinnamon, nutmeg and allspice

#### **Unit - IV: Production technology of seed spices**

Coriander, fenugreek, cumin, fennel, ajowan, dill and celery

### **Unit - V: Production technology of minor spice crops**

Tamarind, garcinia, vanilla and herbal spices

#### **Practicals**

Identification of seeds and plants- botanical description of plants preparation of herbarium- propagation- nursery raising- field layout and method of planting- cultural practices- harvesting- drying- storage- packaging and processing- value addition; short term experiments on spice crops

#### **Lesson plan**

1. History and classification of spices
2. Scope and importance, area, production, productivity, export potential of spices. Crop improvement, varieties, propagation and production technology of the following crops:
3. Black Pepper
4. Cardamom
5. Turmeric
6. Ginger
7. Garlic
8. Clove
9. Cinnamon
10. Nutmeg
11. All spice
12. Coriander
13. Fenugreek
14. Cumin
- 15-16. Fennel
17. **Mid Semester Examination**
18. Ajowan
19. Dill
- 20-22. Celery
- 23-25. Tamarind
26. Garcinia
27. Vanilla
28. Herbal spices
29. Organic spice production
30. Protected cultivation in spice crops
31. Precision farming practices in spice crops.
32. Organic resource management, organic certification, quality control, pharmaceutical significance
33. Role of commodity boards in spice development.
34. Good Agricultural Practices for spice production

#### **Practical**

1. Description of related species and varieties of black pepper and cardamom
2. Propagation and rapid multiplication in pepper and cardamom
3. Processing of pepper and cardamom
4. Description of related species and varieties of turmeric and ginger
5. Processing of turmeric and ginger
6. Description of related species and varieties of garlic

7. Description of related species and varieties of tree spices
8. Nursery techniques in tree spices
9. Description of related species and varieties of seed spices
10. Nursery techniques in seed spices
11. Description of related species and varieties of tamarind, garcinia and vanilla
12. Description of related species and varieties of herbal spices
13. Protected cultivation of spices
14. Value addition in spices
15. Project preparation
16. Visit to spice gardens
17. Visit to commodity boards

#### Course outcome

**CO1:** Students will be able to appreciate the research advancements made in spice crops.

**CO2:** They will be able to recommend suitable package of practices for enhanced spice production.

**CO3:** Students will be able to manage spices estates.

**CO4:** Students will be able to get pattern rights.

**CO5:** Students will be able to manage spices industry.

#### CO - PO Mapping matrix

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	2	1
CO2	3	2	1	2	1
CO3	3	2	2	2	1
CO4	2	3	1	1	2
CO5	3	2	1	2	1

#### References

1. Agarwal, S., E.V.D. Sastry. and R.K. Sharma. 2001. Seed Spices: Production, Quality, Export. Pointer Publ, Jaipur
2. Chadha, K. L. and P. Rethinam (Eds.). 1993. Advances in Horticulture. Vols. IX-X. Plantation Crops and Spices. Malhotra Publ. House, New Delhi
3. Gupta, S. (Ed.). Hand Book of Spices and Packaging with Formulae. Engineers India Research Institute, New Delhi.
4. Kumar, N., Abdul Khader, R. Rangaswami and I. Irulappan. 1997. Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants. Oxford and IBH. Publishing Co. Pvt Ltd., New Delhi
5. Nybe, E.V., N. Miniraj. and K.V. Peter. 2007. Spices. New India Publ. Agency, New Delhi.
6. Parthasarthy, V.A., V. Kandianna and V. Srinivasan. 2008. Organic Spices. New India Publ. Agency, New Delhi.
7. Peter, K.V. 2001. Hand Book of Herbs and Spices. Vols. I-III. Wood Head Publ. Co. UK and CRC USA.
8. Ramachandra et al. 2018. Breeding of Spices and Plantation crops. Narendra Publishing House, New Delhi.
9. Sharangi AB, Datta S and Deb P. 2018. Spices "Agrotechniques for quality produce". Apple Academic Press (Tylor and Francis Groups), New Jersey, USA.
10. Tiwari, R.S. and A. Agarwal. 2004. Production Technology of Spices. International Book Distr. Co, New Delhi.

#### Suggested journals

1. SpiceIndia
2. Journal of spices and aromatic crops
3. Indian spice
4. Journal of Horticultural sciences
5. Indian Horticulture
6. Acta Horticulture
7. IndianJournalofHorticulture
8. Journal of American society of Horticulture sciences
9. Scientia Horticulture

#### **E-Resources**

1. <http://www.iisr.org/>
2. <http://www.indianspices.com/>
3. <https://www.scribd.com/document/439136733/revised-breeding-of-spices>

### **PSM503 PRODUCTION OF MEDICINAL AND AROMATIC CROPS (2+1)**

#### **Learning objectives**

- This course will impart theoretical as well as hands on experience to the learner on scientific production technology of various medicinal and aromatic crops in Indian perspectives.
- To gain comprehensive knowledge about the breeding methodologies, concepts and principles of Production technology of medicinal and aromatic crops
- To gain knowledge in crop improvement of the plantation and spice crops

#### **Theory**

Herbal industry- WTO scenario- export and import status- Indian systems of medicine- indigenous traditional knowledge- IPR issues- classification of medicinal crops- systems of cultivation- organic production- role of institutions and NGO's in production- gap in medicinal crop production- production technology- organic practices- post harvest handling- drying- processing- grading- packing and storage processing and value addition GMP and quality standards in herbal products phytochemical extraction techniques- aromatic industry- WTO scenario- export and import status- Indian perfumery industry- production technology- post-harvest handling- distillation methods- advanced methods- solvent extraction process-quality analysis- value addition- institutional support and international promotion of essential oil and perfumery products

#### **Unit - I: Production technology of medicinal plants -I**

Senna, periwinkle, coleus, ashwagandha, glory lily, sarpagandha

#### **Unit - II: Production technology of medicinal plants -II**

*Dioscorea* sp, *Aloe vera*, *Phyllanthus*, kalmegh, medicinal solanum, gymnema, *Andrographis paniculata*

#### **Unit - III: Production technology of aromatic crops- I**

Isabgol, ipecac, poppy, safedmusli, stevia, *Mucuna pruriens*

#### **Unit - IV: Production technology of aromatic crops -II**

Palmarosa, lemon grass, citronella, vetiver, geranium, mentha, artemisia

#### **Unit - V: Production technology of aromatic crops -III**

Ocimum, eucalyptus, rosemary, thyme, patchouli, lavender, marjoram, origanum.

#### **Practicals**

Botanical description- propagation techniques- maturity standards- extraction of secondary metabolites- project preparation for commercially important medicinal crops- visit to

medicinal crop fields- visit to herbal extraction Units- extraction of essential oils- project preparation for commercially important aromatic crops- visit to distillation and value addition Units.

### **Lesson plan**

1. Herbal industry, WTO scenario, export and import status.
2. Indian system of medicine, indigenous traditional knowledge of medicinal plants.
3. Classification of medicinal plants and systems of cultivation. Climate and soil requirements, varieties-site selection, season and method of propagation, pre sowing treatment, irrigation and nutrient management, intercultural operations, plant protection measures, maturity indices harvesting and post-harvest management of the following crops:
4. Senna and Periwinkle
5. Coleus
6. Ashwagandha
7. Glory lily
8. Sarpagandha and *Andrographispaniculata*
9. Dioscorea and Aloe vera
10. Phyllanthus and kalmegh
11. Gymnema
12. Medicinal solanum and ipecac
13. Isabgol and safedmusli
14. Poppy
15. Stevia and *Mucuna pruriens*
16. Phytochemical extraction techniques
17. **Mid-semester examination**
18. Aromatic industry-WTO scenario- export and import status
19. Indian perfumery industry- history-advancements in perfume industry
20. Palmarosa and lemongrass
21. Citronella and vetiver
22. Geranium and artemisia
23. Mint
24. Ocimum
25. Patchouli
26. Rosemary and thyme
27. Origanum and marjoram
28. Lavender and eucalyptus
29. Organic production of medicinal and aromatic crops
30. IPR issues for medicinal and aromatic crops
31. Role of institutions and NGOs in production and regulations for herbal raw materials
32. Distillation methods, advanced methods-solvent extraction process, steam distillation
33. Perfumes from non-traditional plants.
34. Quality analysis, value addition, aroma chemicals, quality standards and regulation.

### **Practical**

Botanical description of species - improved cultivars - propagation techniques - maturity standards - harvest and post-harvest handling of the following crops:

1. Senna, Periwinkle and coleus
2. Aloe vera, Glory lily and ashwagandha
3. Gymnema, sarpagandha and poppy

4. Phyllanthus, kalmegh and ipecac
5. Medicinal solanum, safedmusli and dioscorea
6. Isabgol and stevia
7. Aromatic grasses
8. Geranium and mint
9. Ocimum and patchouli
10. Vettiver and eucalyptus
11. Rosemary, thyme, oreganum and marjoram
12. Extraction of secondary metabolites in medicinal crops
13. Extraction of essential oils from aromatic crops
14. Project preparation for commercially important medicinal and aromatic crops
15. Field visit to commercial medicinal plantations
16. Field visit to commercial aromatic plantations
17. Visit to herbal extraction Units, distillation and value addition Units

#### Course outcome

**CO1:** Students will be able to appreciate the research advancements made in medicinal crops.

**CO2:** Students will be able to appreciate the research advancements made in aromatic crops.

**CO3:** They will be able to recommend suitable package of practices for enhanced production of medicinal and aromatic crops.

**CO4:** They will be able to recommend suitable package of practices for enhanced production of aromatic crops.

**CO5:** Students will be able to work in essential oil extraction Units of aromatic crops.

#### CO - PO Mapping matrix

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	1	1
CO2	3	2	1	1	-
CO3	3	2	1	1	1
CO4	2	2	1	2	1
CO5	3	1	2	1	2

#### References

1. AtalCK&KapurBM.1982. CultivationandUtilizationofAromaticPlants. RRL, CSIR, Jammu.
2. Atal, C.K. and B.M. Kapur. 1982. Cultivation and Utilization of Medicinal Plants. RRL, CSIR, Jammu.
3. Farooqi, A. A. and B.S.Sriramu. 2001. Cultivation Practices for Medicinal and Aromatic Crops. University Press, Hyderabad.
4. Farooqi, A. A., M.M. Khan. and M. Vasundhara. 2001. Production Technology of Medicinal and Aromatic Crops. Natural Remedies Pvt. Ltd.
5. Hota, D. 2007. Bio Active Medicinal Plants. Gene Tech Books.
6. Khan, I.A. and A. Khanum. 1998. Role of Bio Technology in Medicinal and Aromatic Plants. Vol. 3. Ukaaz Publ.
7. Kurian, A. and M. Asha Sankar. 2007. Medicinal Plants. Horticulture Science Series, New India Publ. Agency.
8. Prajapati, S. S., H. Paero, A.K. Sharma. and T. Kumar. 2006. A Hand book of Medicinal Plants. Agro Bios.
9. Shankar SJ. 2018. Comprehensive post-harvest technology of flowers, medicinal and aromatic plants. Narendra Publishing House, New Delhi.

10. Skaria, P., Baby, Samuel Mathew, Gracy Mathew, Ancy Joseph. and Ragina Joseph. 2007. Aromatic Plants. New India Publ. Agency.

#### **Suggested journals**

1. SpiceIndia
2. Journal of spices and aromatic crops
3. Indian spice
4. Journal of Horticultural sciences
5. Indian Horticulture

#### **E-Resources**

1. <http://www.cimap.org/>
2. <http://dbtindia.nic.in>
3. <http://www.fintrac.com/gain/>

### **PSM504 BREEDING OF PLANTATION AND SPICE CROPS (2+1)**

#### **Learning objectives**

- This course will impart theoretical as well as hands-on experience to the learner on reproductive biology, breeding methods and breeding achievements in various plantation and spice crops.
- To gain comprehensive knowledge about the breeding methodologies, concepts and principles of breeding of plantation and spice crops
- To gain knowledge in crop improvement of the plantation and spice crops

#### **Theory**

Species and cultivars- cytogenetics- survey- collection- conservation and evaluation- blossom biology- breeding objectives- approaches for crop improvement- introduction- selection- hybridization- mutation breeding- polyploid breeding- improvement of quality traits- resistance breeding for biotic and abiotic stresses- molecular aided breeding and biotechnological approaches- marker assisted selection- bioinformatics- IPR issues- achievements and future thrusts.

#### **Unit - I: Breeding of plantation crops -I**

Coffee, Tea, Rubber, Cashew and Cocoa

#### **Unit - II: Breeding of plantation crops -II**

Coconut, Areca nut, Oil palm and Palmyrah

#### **Unit - III: Breeding of spices crops -I**

Black pepper, Cardamom, Ginger, Turmeric

#### **Unit - IV: Breeding of spice crops - II**

Fenugreek, Coriander, Fennel, Celery and Ajowain

#### **Unit - V: Breeding of spice crops - III**

Nutmeg, Cinnamon, Clove and Allspice

#### **Practicals**

Characterization and evaluation of germplasm accessions- blossom biology studies on pollen behavior- practices in hybridization- ploidy breeding- mutation breeding- evaluation of biometrical traits and quality traits- screening for biotic and abiotic stresses- haploid culture- protoplast culture and fusion- induction of soma clonal variation and screening the variants. Identification and familiarization of spices; floral biology anthesis; fruit set; selfing and crossing techniques; description of varieties. Salient features of improved varieties and cultivars from public and private sector- bioinformatics- visit to radiotracer laboratory- national institutes for plantation crops and plant genetic resource centers- genetic transformation in plantation crops

for resistance to biotic stress/quality improvement etc.

### **Lesson plan**

1. Species and cultivars- cytogenetics- survey- collection- conservation and evaluation- blossom biology- breeding objectives- approaches for crop improvement- introduction- selection- hybridization - mutation breeding polyploidy breeding- improvement of quality traits- resistance breeding for biotic and abiotic stresses- molecular aided breeding and biotechnological approaches marker assisted selection- bio informatics- IPR issues. Achievements and future thrusts of following crops.
2. Methods of breeding in perennial spices
3. Methods of breeding in seed spices
4. Methods of breeding in plantation crops
5. Biotechnological approaches in breeding of spice crops
6. IPR issues, protection of plant varieties and farmers rights act.
7. Breeding methods in Coffee
8. Tea
9. Rubber
10. Cashew
11. Cocoa
- 12-13. Coconuts
14. Arecanut
15. Oil palm
16. Palmyrah
17. **Mid- semester examination**
18. Black pepper
19. Cardamom
20. Ginger
- 21-22. Turmeric
23. Fenugreek
24. Coriander
25. Fennel
26. Celery
27. Ajowan
28. Cinnamon
29. Clove
- 30-31. Nutmeg
32. Cinnamon
33. Clove
34. All spice

### **Practical**

1. Scoring techniques for genomic status in coffee and tea.
2. Study of blossom biology in Coffee and tea.
3. Study of blossom biology in Cashew, Cocoa and Rubber
4. Study of blossom biology in Coconut and Arecanut
5. Study of blossom biology in palmyrah and oil palm.
6. Study of floral biology, anthesis in Black pepper, cardamom, ginger and turmeric.
7. Study of floral biology, anthesis in fenugreek, coriander, fennel, celery and Ajowan
8. Study of floral biology, anthesis in cinnamon, clove, All spice and nutmeg



9. Practices in in-vitro approaches in improvement of plantation crops
10. Practices in in-vitro approaches in improvement of spice crops.
11. Estimation of pollen output, viability and germinability in plantation crops.
12. Estimation of pollen output, viability and germinability in spice crops
13. Practices in hybridization of fenugreek, coriander.
14. Screening techniques for resistance against abiotic stress -salt and drought tolerance in possible plantation crops.
15. Screening techniques for resistance against abiotic stress -salt and drought tolerance in possible spice crops.
16. Visit to research institutes working on important plantation crops and studying breeding programmes.
17. Visit to research institutes working on important spice crops and studying breeding programmes.

#### Course outcome

**CO1-** The students must be able to demonstrate different breeding techniques in plantation and spice crops.

**CO2-** The students must be able to demonstrate different breeding techniques in spice crops

**CO3-** The student will develop the capacity to become a breeder in plantation and spice crops.

**CO4-** The student will develop the capacity to become a breeder in spice crops.

**CO5-** The student will develop the capacity in hybrid seed production of seed spices.

#### CO - PO Mapping matrix

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	1	1
CO2	3	3	2	-2	1
CO3	3	2	1	2	3
CO4	2	3	3	1	2
CO5	2	3	2	1	1

#### References

1. Arya, P.S. 2003. Spice crops of India. Kalyani Publishers, New Delhi.
2. Chadha KL. 1998. Advances in Horticulture. Vol. IX. Plantation and Spices Crops. Malhotra Publishing House, New Delhi
3. Chadha, K.L., P.N. Ravindran. and L. Sahijram. 2000. Biotechnology in Horticulture and Plantation Crops. Malhotra Publ., India.
4. Choudappa P, Anitha K, Rajesh MK and Ramesh SV. 2017. Biotechnology of Plantation Crops. Daya Publishing House, New Delhi.
5. Devi AR, Sharangi AB, Acharya SK and Mishra GC. 2017. Coriander in Eastern India: The landraces and genetic diversity. KrishiSanskriti Publications. New Delhi. ISBN: 978-93-85822-48-3.
6. Kumar, N. 2017. Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants. CBS Publishers.
7. Peter, K.V. (Ed). 2010. Biodiversity in Horticultural crops. Vol.3 Daya publishers, New Delhi.
8. Peter, K.V. 2001. Hand book of herbs and spices Vol I-II Wood Head Publishers Co, USA
9. Peter, K.V. and Z. Abraham (Eds). 2007. Biodiversity in horticultural crops. Vol.1 Daya publishers, New Delhi.
10. Ramawat, K.G. and J.M. Merillon. 2003. Biotechnology secondary metabolites. Oxford and

IBH, New Delhi.

### **E-Resources**

1. <https://agrimoon.com/wp-content/uploads/Breeding-of-Fruit-and-Plantation-Crops.pdf>
2. [https://www.researchgate.net/publication/330279627\\_Modern\\_concepts\\_in\\_breeding\\_of\\_spices](https://www.researchgate.net/publication/330279627_Modern_concepts_in_breeding_of_spices)
3. <https://ijcrt.org/papers/IJCRT1704281.pdf>
4. <https://www.scribd.com/document/439136733/revised-breeding-of-spices>
5. <https://www.iaritoppers.com/2019/06/Breeding-of-Vegetable-Tuber-and-spice-cropsICAR-Ecourse-Free-PDF-Book-Download-e-krisshi-shiksha.html>
6. <https://agrimoon.com/wp-content/uploads/Breeding-of-Fruit-and-Plantation-Crops.pdf>

## **PSM505 BREEDING OF MEDICINAL AND AROMATIC CROPS (1+1)**

### **Learning objectives**

- This course will impart theoretical as well as hands-on experience to the learner on reproductive biology, breeding methods and breeding achievements in various medicinal and aromatic crops.  
To impart comprehensive knowledge about different methods of breeding techniques employed, achievement so far made and problems encountered during breeding of the principles and practices of breeding of medicinal and aromatic crops.
- To impart comprehensive knowledge on the principles and practices in the breeding of important medicinal and aromatic crops

### **Theory**

Species and cultivars- Cytogenetics- Survey, collection, conservation and evaluation- Blossom biology- Breeding objectives, approaches for crop improvement - Introduction, selection, hybridization, mutation breeding, polyploid breeding, improvement of quality traits - Resistance breeding for biotic and abiotic stresses- Molecular aided breeding and biotechnological approaches, marker assisted selection- Bioinformatics- IPR issues- Regulatory affairs in cultivar release - Achievements and future thrusts.

#### **Unit - I: Breeding of medicinal crops -I**

Glory lily, medicinal coleus, aswagandha

#### **Unit - II: Breeding of medicinal crops -II**

Isabgol, medicinal yam, poppy

#### **Unit - III: Breeding of medicinal crops -III**

Aloe, periwinkle, senna and medicinal solanum.

#### **Unit - IV: Breeding of aromatic crops -I**

Citronella, lemongrass, palmarosa, vetiver, Ocimum

#### **Unit - V: Breeding of aromatic crops -II**

Artemisia, Mentha species, rosemary, patchouli, geranium

### **Practicals**

Characterization and evaluation of germplasm accessions- floral biology, anthesis, fruit set, selfing and crossing techniques - Practices in hybridization, ploidy breeding, mutation breeding, evaluation of biometrical traits and quality traits screening for biotic and abiotic stresses - description of varieties- Salient features of improved varieties and cultivars from public and private sector- Visit to radiotracer laboratory, National Institutes, Plant Genetic Resource centers.

### **Lesson plan**

1-2. Species and cultivars, conservation of germplasm, cytogenetics, breeding objectives- yield, secondary metabolites, resistance breeding for biotic and abiotic stresses, scope for introduction, selection, intra and interspecific hybridization, induced autotetraploidy  
Mutation breeding, biotechnological approaches, breeding problems in glory lily

3-4. Medicinal Coleus

5- 6. Ashwagandha

7-8. Isabgol

9-10. Medicinal yam

11-12. Poppy

13. Aloe

14-15. Periwinkle

16. Senna

17. **Mid Semester Examination**

18. Medicinal Solanum

19. Citronella

20. Lemon grass

21-22. Palmarosa

23-24. Vetiver

25-26. Ocimum species

27. Artemisia

28-29. Mentha species

30-31. Patchouli

32. Geranium

33. Role of bioinformatics in medicinal and aromatic crops breeding

34. IPR issues related to medicinal and aromatic plants

### **Practical**

1. Characterization, evaluation and screening of germplasm accessions in Glory lily

2. Characterization, evaluation and screening of germplasm accessions in Ashwagandha

Study of floral biology, anthesis and pollination mechanism in

3. Glory lily

4. Periwinkle

5. Senna

6. Ashawagandha

7. Medicinal aromatic crops

8. Induction of mutation in Glory lily and periwinkle

9. Induction of mutation in senna and isabgol

10. Practicing hybridization in ashwagandha

11. Characterization, evaluation and screening of germplasm accessions in vetiver

12. Description of varieties in vetiver

13. Practices in in vitro approaches in improvement of medicinal & aromatic plants

14. Visit to Plant Genetic Resource center- medicinal crops

15. Visit to Plant Genetic Resource center- aromatic crops

16. Visit to national institutes

17. Visit to radiotracer laboratory

### **Course outcome**

**CO1-** The students must be able to demonstrate different breeding techniques in medicinal crops

CO2- The students must be able to demonstrate different breeding techniques in aromatic crops

CO3- The student will develop the capacity to become a breeder in medicinal crops.

CO4- The student will develop the capacity to become a breeder in aromatic crops.

CO5- The student will develop skill on production of hybrid seeds in medicinal crops.

#### CO - PO Mapping matrix

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	1	1
CO2	3	3	2	-	1
CO3	2	3	1	2	2
CO4	3	2	2	1	1
CO5	2	2	1	1	2

#### References

1. Farooqi, A.A., M.M. Khan and M. Vasundhara.2001. Production technology of medicinal and Aromatic Crops, Natural Remedies Pvt. Ltd
2. Jain, S.K. 2000.Medicinal plants. National Book Trust
3. Jitendra Singh, 2001. Medicinal and Aromatic Crops. Eastern Book Consortium. New Delhi
4. Julia, F. and Mortun, C. Charters. 1997. Major medicinal plants-Botany, cultures and uses. Thomas Publishers, Illinois, USA.
5. Khan I.A and A. Khanum. 2001. Role of biotechnology in medicinal and aromatic crops. Orient Longman Publication
6. Ponnuswami et al. 2018. Blossom biology of Horticultural crops. Narendra Publishing House, New Delhi
7. Ponnuswami et al. 2018. Medicinal Herbs and Herbal Cure. Narendra Publishing House, New Delhi
8. Ramawat, K.G and J.M. Merillon. 2003.Biotechnology-secondary metabolites. Oxford and IBH.
9. Thakur, R.S., H.S.Pauri and Akthar Hussain.1989.Major medicinal plants of India. CSIR Publication, Lucknow.
10. Van Harten, A.M. 1998. Mutation breeding: Theory and practical applications. Cambridge University Press.

#### E-Resources

1. <http://www.cimap.org/>
2. <http://dbtindia.nic.in>
3. <http://www.fintrac.com/gain/>

#### PSM506SYSTEMATICS OF PLANTATION AND SPICE CROPS (1+1)

#### Learning objectives

- This course will impart theoretical knowledge to the learner on the origin and distribution, evolutionary process, taxonomy and cytogenetics of various plantation and spice crops.
- To impart comprehensive knowledge about the origin and development, evolutionary process, taxonomy, botany, cytogenetics and genetic resources of plantation.
- To impart comprehensive knowledge about the origin and development, evolutionary process, taxonomy, botany, cytogenetics and genetic resources of spice crops.

## **Theory**

Centre of origin, history, evolution, distribution, taxonomical status, phylogeny - botany, genetics, cytology, ploidy status, sex forms, flowering, floral biology, pollination biology, cytogenetics – significance of systematics, botanical description, genus, wild and related species and families, cultivar diversity - Indigenous and exotic germplasm collection and conservation - Biodiversity/NBPGR descriptors and their salient features - DUS guidelines and molecular aspects of systematics of plantation and spice crops.

### **Unit - I: Systematics of plantation crops I**

Coconut, Arecanut, Oil palm and Palmyrah

### **Unit - II: Systematics of plantation crops II**

Tea, Coffee, Cocoa, Cashew, Rubber and Betel vine

### **Unit - III: Systematics of major spices**

Black pepper, Cardamom, Ginger and Turmeric

### **Unit - IV: Systematics of major and seed spices crops**

Coriander, Fenugreek, Cumin, Fennel, Curry leaf, Paprika, Saffron and Garlic

### **Unit - V: Systematics of tree and minor spice crops**

Clove, Nutmeg, Cinnamon, All spice, Tamarind, Garcinia and Vanilla

## **Practicals**

Description and cataloguing of germplasm, genus, species and cultivar features of various plantation and spice crops, characterization of various plantation and spice crops based on descriptors, characterization of various plantation and spice crops based on DUS guidelines, study of sex forms and floral biology, pollination mechanisms and pollen viability tests of plantation and spice crops, study of molecular markers and exposure visits.

## **Lesson plan**

Origin and evolution, taxonomy, systematics and genetics, botany, cytology, floral biology, pollination biology and cytogenetics, significance of systematics, botanical description, genus, species and cultivar diversity, germplasm collection and conservation, descriptors, DUS guidelines and molecular approaches

1. Coconut
2. Palmyrah and Oil palm
3. Arecanut and Betel vine
4. Cocoa
5. Cashew
6. Rubber
7. Coffee
8. Black pepper and Cardamom
9. **Mid semester examination**
10. Ginger and Turmeric
11. Coriander, Fenugreek, Fennel and Cumin
12. Clove, Nutmeg, Cinnamon and All spice
13. Curry leaf, Tamarind and Garcinia
14. Vanilla, Paprika, Saffron and Garlic
15. Role and importance of NBPGR and national institutes in collection and conservation of germplasm and maintenance of crop diversity
16. Approaches and methods of conservation of germplasm, species and cultivars

## **Practical**

1. Description and cataloguing of germplasm - characterization based on descriptors and DUS guidelines for Coconut and Arecanut
2. Study of sex forms and floral biology in Palmyrah
3. Pollination and pollen viability tests in Coconut, Arecanut and Cocoa
4. Description and cataloguing of germplasm - characterization based on descriptors and DUS guidelines for Cocoa and Cashew
5. Description of genus, species and cultivar features of Coconut, Arecanut, Cocoa and Cashew
6. Exposure visit to UPASI, Conoor and Coffee Board, Yercaud
7. Molecular characterization of species, genotypes and cultivars (Coconut, Arecanut and Cocoa)
8. Description of genus, species and cultivar features of Black pepper and Cardamom
9. Description and cataloguing of germplasm - characterization based on descriptors and DUS guidelines in Turmeric
10. Description of genus, species and cultivar features of Ginger and Turmeric
11. Sex forms and Pollination mechanism in Spice crops (Black pepper, Nutmeg, Coriander, Fenugreek and Vanilla)
12. Description and cataloguing of germplasm in Coriander and Fenugreek
13. Study of floral biology and pollen viability tests in Coriander, Fenugreek and Fennel
14. Molecular characterization of turmeric and coriander genotypes using different markers
15. Exposure visit to Coconut Research Station - Description and cataloguing of cultivar features - characterization of different varieties/ cultivars based on DUS guidelines
16. Exposure visit to Regional Research Station - Description and cataloguing of cultivar features - characterization of different varieties/ cultivars based on DUS guidelines
17. Characterization of genotypes based on descriptors and DUS guidelines in garlic

**Course outcome**

**CO 1:** Students are expected to gain thorough knowledge and understanding of the systematics of plantation crops.

**CO 2:** Students are expected to gain thorough knowledge and understanding of the systematics of spice crops.

**CO 3:** Students are able to carry out genetic engineering work involving wild species in hybridization of new crop varieties in plantation crops.

**CO 4:** Students are able to carry out genetic engineering work involving wild species in hybridization of new crop varieties in spice crops.

**CO 5:** Students are able to do molecular characterization for evolving new varieties in plantation and spice crops.

**CO - PO Mapping**

	PO1	PO2	PO3	PO4	PO5
<b>CO 1</b>	3	2	2	1	1
<b>CO 2</b>	3	2	1	1	-
<b>CO 3</b>	2	2	2	2	2
<b>CO 4</b>	3	1	1	1	-
<b>CO 5</b>	3	2	1	1	1

**References**

1. Chadha KL & Rethinam P. (Eds.).1993. Advances in Horticulture. Vol. IX. Plantation Crops and Spices. Part-I. Malhotra Publ. House.

2. Chopra VL & Peter KV. Handbook of Industrial Crops. Haworth Press. Panama International Publishers, New Delhi (Indian Ed.).
3. Thampan PK 1981. Hand Book of Coconut Palm. Oxford & IBH
4. Panda, H. 2013. The Complete Book on Cashew. Asia Pacific Business Press Inc.
5. Ponnuswami et al. 2018. Blossom biology of Horticultural crops. Narendra Publishing House, New Delhi
6. Ponnuswami et al. 2018. Botany of Horticultural crops. Narendra Publishing House, New Delhi

#### **E-Resources**

1. <http://www.indianspices.com/>
2. <http://indiacoffee.org/>
3. <http://cpcrri.nic.in/>
4. <http://tea.nic.in/>
5. <http://rubberboard.org.in/>
6. <http://nbpgr.delhi.nic.in/>
7. <http://cdb.gov.in>
8. <http://dccd.gov.in>
9. <http://spices.res.in/>

### **PSM507SYSTEMATICS OF MEDICINAL AND AROMATIC CROPS (1+1)**

#### **Learning objectives**

- This course will impart theoretical knowledge to the learner on the origin and distribution, evolutionary process, taxonomy and cytogenetics of various medicinal and aromatic crops.
- To impart basic knowledge on the origin and development, evolutionary process, taxonomy, cytogenetics and genetic resources of medicinal crops.
- To impart basic knowledge on the origin and development, evolutionary process, taxonomy, cytogenetics and genetic resources of aromatic crops.

#### **Theory**

Centre of origin, distribution, taxonomical status, phylogeny, chemotaxonomy, botany, cytology, ploidy status, sex forms, flowering and pollination biology, cytogenetics, Wild and related species, cultivars, Indigenous and exotic germplasm, biodiversity/NBPGR descriptor, DUS guidelines and molecular aspects of systematic. Medicinal crops: Opium poppy, Isabgol, Aswagandha, Senna, Medicinal coleus, Glory Lily, Periwinkle, Sarpagandha, Long Pepper, Stevia, Safedmusli, *Plumbagozeylanica*. Aromatic crops: Lemongrass, Citronella, Palmarosa, Vetiver, Mint, Patcholi, Geranium, Ocimum, Rosemary, Lavender, *Kaempferia galanga*, Eucalyptus

#### **Unit - I: Origin of medicinal and aromatic crops**

Centre of origin, distribution, taxonomical status, phylogeny, chemotaxonomy of medicinal and aromatic crops

#### **Unit - II: Botany of medicinal and aromatic crops**

Botany, cytology, ploidy status, sex forms of medicinal and aromatic crops

#### **Unit- III: Floral biology of medicinal and aromatic crops**

Flowering and pollination biology, cytogenetics of medicinal and aromatic crops

#### **Unit - IV: Wild and related species of medicinal and aromatic crops**

Wild and related species, cultivars, Indigenous and exotic germplasm of medicinal and aromatic crops

## **Unit- V: Biodiversity and DUS guidelines of medicinal and aromatic crops**

Biodiversity/NBPGR descriptor, DUS guidelines of medicinal and aromatic crops.  
Molecular aspects of systematic of medicinal and aromatic crops

### **Practicals**

Genus, species and cultivar features of various medicinal and aromatic crops, Characterization based on descriptors, characterization based on DUS guidelines, Study of sex forms and floral biology, Study of molecular marker, Exposure visits to national institutes including NBPGR.

### **Lesson plan**

Centre of origin, distribution, taxonomical status, phylogeny, chemotaxonomy of

1. Opium poppy, Isabgol, Aswagandha,
2. Senna, Medicinal coleus, Glory Lily
3. Periwinkle, Sarpagandha, Long Pepper
4. Stevia, Safedmusli, *Plumbagozeylanica*
5. Lemongrass, Citronella, Palmarosa
6. Vetiver, Mint, Patcholi
7. Geranium, Ocimum, Rosemary
8. Lavender, *Kaempferia galanga*, Eucalyptus

### **9. Mid semester Examination**

10. Wild and related species, cultivars, Indigenous and exotic germplasm of medicinal crops
11. Wild and related species, cultivars, Indigenous and exotic germplasm of aromatic crops
12. Germplasm wealth of medicinal crops
13. Germplasm wealth of aromatic crops  
Biovarsity/NBPGR descriptor, DUS guidelines and molecular aspects of systematic in
14. Opium poppy, Isabgol, Aswagandha
15. Senna, Medicinal coleus, Glory Lily
16. Periwinkle, Sarpagandha, Long Pepper
17. Stevia, Safedmusli, *Plumbagozeylanica*

### **Practical**

1. Genus and species features of various medicinal crops
2. Genus and species features of various aromatic crops
3. Cultivar features of various medicinal and aromatic crops
4. Cytological studies in glory lily and ashwagandha
5. Cytological studies in tulsi and palmarosa
6. Characterization based on descriptors for medicinal crops-glory lily, medicinal coleus
7. Characterization based on descriptors for medicinal crops-Aloe, ashwagandha and kalmegh
8. Characterization based on descriptors for aromatic crops-geranium, patchouli, Mentha
9. Characterization based on descriptors for aromatic crops-basil, palmarosa
10. Characterization based on DUS guidelines for medicinal crops- kalmegh
11. Characterization based on DUS guidelines for aromatic crops-Mentha
12. Study of sex forms and floral biology for medicinal crops- glory lily, ashwagandha, medicinal solanum
13. Study of sex forms and floral biology for aromatic crops -bail, palmarosa
14. Study of floral biology for aromatic crops -bail, palmarosa
15. Study of molecular markers for medicinal crops
16. Study of molecular markers for aromatic crops



17. Exposure visits to national institutes including NBPGR.

#### Course outcome

**CO1:** Students are expected to have thorough understanding on the systematics of medicinal crops.

**CO2:** Students are expected to have thorough understanding on the systematics of aromatic crops.

**CO3:** Students are able to carry out genetic engineering work involving wild species in hybridization of new crop varieties in medicinal crops.

**CO4:** Students are able to carry out genetic engineering work involving wild species in hybridization of new crop varieties in aromatic crops.

**CO5:** Students are able to do molecular characterization for evolving new varieties in medicinal and aromatic crops.

#### CO - PO Mapping matrix

	PO1	PO2	PO3	PO4	PO5
CO 1	3	2	2	1	1
CO 2	3	2	1	1	-
CO 3	2	2	2	1	1
CO 4	3	1	1	2	-
CO 5	3	1	1	1	1

#### References

1. Birel Shah and Seth, A.K. 2005. Text book of Pharmacognosy and Phytochemistry. Cbs Publishers and distributors, New Delhi.
2. Charles Burnham. 1993. Discussions in Cytogenetics. Prentice Hall Publications
3. Diwan, A.P and Dhakad., N.K. 1996. Genetics and Development. Anmol Publications Private Limited, New Delhi.
4. Farooqi, A. A., Khan, M. M., and Vasundhara, M. 2001. Production Technology of Medicinal and Aromatic Crops. Natural Remedies Pvt. Ltd.
5. Gupta, R.K. 2010. Medicinal and Aromatic plants. CBS publications
6. Prajapati, N.D., Purohit, S. S., Sharma, A. K, Kumar, T. 2006. A Hand book of Medicinal Plants. Agro Bios (India).
7. Ponnuswamiet al. 2018 *Botany of Horticultural crops*. Narendra Publishing House, New Delhi
8. Sharma G. 2009. *Systematics of fruit Crops*. New India Publishing House, India.
9. Skaria P Baby et al. 2007. *Aromatic Plants*. New India Publ. Agency.

#### E-Resources

1. <https://bioone.org/journals/systematic-botany>
2. <https://guides.library.yale.edu/c.php?g=296241&p=1974147>
3. <https://www.jstor.org/journal/systbotamono>

### PSM508 UNDEREXPLOITED PLANTATION, SPICE, MEDICINAL AND AROMATIC CROPS (2+0)

#### Learning objectives

- To facilitate understanding on the importance and conservation of medicinal and aromatic crops.
- To gain knowledge in utilization and value addition in underutilized medicinal and aromatic crops.

- To facilitate understanding on cultivation of underutilized and lesser-known plantation, spice, medicinal and aromatic plants.

## **Theory**

### **Unit - I: Importance and Status**

Importance and Uses: Introduction, importance, economic parts used, traditional uses.  
Status and future prospects: Present status, origin, distribution and future prospects of under exploited PSMs

### **Unit - II: Production Technology of Under-Utilized Plantation and Spice Crops**

Propagation and varieties: Propagation and nursery techniques, species varieties Agro techniques: Climatic and soil requirements, planting and after care, weed and water management, manuring and plant protection

### **Unit - III: Production Technology of Medicinal and Aromatic Plants**

Propagation and varieties: Propagation and nursery techniques, species varieties Agro techniques: Climatic and soil requirements, planting and after care, weed and water management, manuring and plant protection

### **Unit- IV:Harvest and Post-Harvest Management of Under-Utilized Plantation and Spice Crops**

Harvest indices: Maturity indices, harvesting time, techniques, crop duration Post harvest management: Primary processing, extraction and value addition, storage, active ingredients

### **Unit - V:Harvest and Post-Harvest Management of Medicinal and Aromatic Plants**

Harvest indices: Maturity indices, harvesting time, techniques, crop duration Post harvest management: Primary processing, extraction and value addition, storage, active ingredients

## **Lesson plan**

1. Introduction, importance, economic parts used, traditional uses
  2. Present status, origin, distribution and future prospects of under-exploited PSMs
  3. Propagation and nursery techniques for under-exploited PSMs
  4. Species of underutilized plantation and spice crops
  5. Production technology and post-harvest management of Wattle
  6. Production technology and post-harvest management of minor species of Areca
  7. Production technology of Coffea
  8. Production technology of Hevea
  9. Production technology and post-harvest management for *Illicium verum*
  10. Production technology and post-harvest management for *Myristicamalabarica* and *M. beddomei*
  11. Production technology and post-harvest management for *Cinnamomumtamala* and *C. malabattrum*
  12. Production technology and post-harvest management for *Xanthoxylum*sp.
  13. Production technology and post-harvest management for *Curcuma caesia*, *C. aromatica*
  14. Production technology and post-harvest management for *C. zedoaria*, *C. amada*
  15. Production technology and post-harvest management for *Anethumgraveolense*, *Hyssopusofficinalis*
  16. Production technology and post-harvest management for *Eringiumfoetidum*, *Pimpinellaanisum* and *Artocarpuslacucha*
- 17. Mid semester examination**
18. Introduction and importance of underutilized medicinal and aromatic crops

19. Present status and future prospects of underutilized medicinal and aromatic crops
20. Economic parts used and traditional uses of underutilized medicinal and aromatic crops.
21. Origin, distribution, propagation and nursery techniques, species and varieties of underutilized medicinal and aromatic crops.
22. Origin, distribution, propagation and nursery techniques, species and varieties of underutilized and aromatic crops Production technology and post-harvest management for
23. *Flacourtiamontana*, *Plectranthusaromaticus*, *Adhatoda* sp.
24. *Hemidesmusindicus*, *Tinosporacordifolia*, *Gymnemasylvestre*
25. *Psoraleacorylifolia*, *Eclipta alba*, *Aristalochiaindica*, *Morindacitrifolia*
26. *Caesalpiniasappan*, *Terminaliachebula*, *T. bellerica*, *Phyllanthusamarus*
27. *Strychnosnuxvomica*, *S. indicum*, *S. xanthocarpum*, *Aeglemarmelos*
28. *Alpinia* sp., *Hibiscus subdariffa*, *Anthocephaluskadamba*, *Costus* sp.
29. *Kaempferia rotunda*, *K. parviflora*, *Picrorrhizakurroa*, *Nardostachisjatamansi* 1705
30. *Valerianaofficinalis*, *Swertiachiraita*, *Aconitum* sp., *Salvia officinalis*
31. *Centellaasiatica*, *Bixaorellana*, *Bacopamonnierei*
32. *Bursera* sp., *Commiphorawightii*, *Ocimumkilimandjaricum*
33. *Melaleuca*, *Michaeliachampaka*, *Rosa damascena*
34. *Cananga odorata*, *Marjoram*, *Chamomile*

#### Course outcome

**CO 1:** Students are expected to be thorough with the importance and commercial production technology of underutilized and lesser-known plantation plants and be able to start underutilized and lesser-known plantation plants-based enterprises.

**CO 2:** Students are expected to be thorough with the importance and commercial production technology of underutilized and lesser-known spice plants and be able to start underutilized and lesser-known spice plants-based enterprises.

**CO 3:** Students are expected to be thorough with the importance and commercial production technology of underutilized and lesser-known medicinal plants and be able to start underutilized and lesser-known medicinal plants-based enterprises.

**CO 4:** Students are expected to be thorough with the importance and commercial production technology of underutilized and lesser-known aromatic plants and be able to start underutilized and lesser-known aromatic plants-based enterprises.

**CO 5:** Students will be able to recommend package of practices for underutilized and lesser-known Plantation, Spice, Medicinal and Aromatic Plants.

#### CO - PO Mapping matrix

	PO1	PO2	PO3	PO4	PO5
<b>CO 1</b>	3	2	2	1	1
<b>CO 2</b>	3	2	1	1	-
<b>CO 3</b>	2	2	2	2	2
<b>CO 4</b>	2	1	1	1	-
<b>CO 5</b>	3	1	1	2	1

#### References

1. Atal, C. K. and Kapur, B. M. Cultivation and Utilization of Aromatic plants. R.R.L. Jammu
2. Barche, Swati. (2016). Production technology of spices, aromatic, medicinal and plantation crops. New India Publishing Agency, New Delhi
3. Chadha, K. L. and Gupta, R. 1995. Advance in Horticulture. Vol. XI. Medicinal and Aromatic Plants. Malhotra Publ. House.

4. Farooqui, A. A., Khan, M. M. and Sreeramu, B. S. 1997. Cultivation of Medicinal and Aromatic Crops in India. Naya Prokash.
5. Kurian, A. and Asha Sankar M. 2007. Medicinal Plants. Horticulture Science Series, New India Publ. Agency.
6. Nybe, E.V., Mini Raj, N and Peter, K.V. 2007. Spices. Horticulture Science Series, New India Publ. Agency.
7. Peter, K.V. Under exploited and underutilized Horticulture crops. Volume I-IV. New India Publication Agency.

#### **E-Resources**

1. [www.agritech.tnau.ac.in](http://www.agritech.tnau.ac.in)
2. [www.nmpb.nic.in](http://www.nmpb.nic.in)
3. [www.sciencedirect.com](http://www.sciencedirect.com)
4. <https://link.springer.com>

## **PSM509 GROWTH AND DEVELOPMENT OF PLANTATION, SPICE, MEDICINAL AND AROMATIC CROPS (2+1)**

### **Learning objectives**

- This course will impart theoretical as well as hands-on experience to the learner on these aspects of PSM crops for improving their productivity.
- To develop understanding of growth and development of horticultural crops which have implications in their management.
- To impart comprehensive knowledge on the growth, developmental stages and crop regulation to increase the productivity in PSMs

### **Theory**

#### **Unit - I: Growth and development**

Definition, parameters of growth and development, growth dynamics, morphogenesis in PSMs.

#### **Unit - II: Environmental impact on growth and development**

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**

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

#### **Unit - IV: Developmental physiology and biochemistry**

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 in PSMs.

#### **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.

### **Practicals**

Understanding dormancy mechanisms in seeds, tubers and bulbs and stratification of seeds, tubers and bulbs, visit to arid, subtropical and temperate horticultural zones to identify growth and development patterns, techniques of growth analysis, evaluation of photosynthetic efficiency under different environments, study of growth regulator functions, hormone assays, understanding ripening phenomenon in fruits and vegetables, study of impact of physical manipulations on growth and development, study of chemical manipulations on growth and development, understanding stress impact on growth and development.

### **Lesson plan**

1. Growth and development - definition and parameters of growth and development
2. Study of principles involved in growth dynamics
3. Morphogenesis of horticultural crops
4. Growth and development of annual horticultural crops
5. Growth and development of perennial and semi - perennial horticultural crops
6. Effect of light, photosynthesis, photoperiodism and vernalization on horticultural crops
7. Effect of temperature, heat Units and thermoperiodism on annual horticultural crops
8. Effect of temperature, heat Units and thermoperiodism on perennial horticultural crops
9. Assimilate partitioning during growth and development
10. Role of water and mineral nutrition on growth and development of horticultural crops
11. Biosynthesis of auxins and their role
12. Gibberellins - synthesis and their role
13. Cytokinins - synthesis and their role
14. Abscissic acid - synthesis and their role
15. Ethylene - synthesis and their role
16. Brassinosteroids - synthesis and their role
17. **Mid Semester Examination**
18. Role of growth inhibitors in horticultural crops
19. Various types and basis of dormancy and methods of breaking dormancy
20. Physiological and biochemical process of bud breaking
21. Physiological and biochemical changes which occurs in the inter phase of vegetative to reproductive stages
22. Physiological and biochemical basis of flowering, pollination and fertilization
23. Physiological changes occurring during fruit set
24. Causes and remedies of fruit drop
25. Various stages of fruit growth and physiological and bio chemical basis of ripening
26. Basis of seed development
27. Causes and various types of stress
28. Effect of stress on growth and development process
29. Manipulation of growth and development
30. Role of canopy management and its importance in horticultural crops
31. Types of training and its impact on perennial horticultural crops
32. Principles, causes, types and importance of pruning
33. Types of chemical manipulation in horticultural crops
34. Molecular and genetic approaches in plant growth and development

### **Practical**

1. Study of different types of dormancy and methods of breaking dormancy in seeds
2. Vernalisation and stratification of seeds
3. Dormancy and methods to overcome the dormancy in tubers and bulbs

4. Study of growth and development pattern of arid horticultural crops
5. Estimation of leaf area index
6. Visit to sub - tropical and temperate zone to study the growth and development pattern of Plantation, Spice, Medicinal and Aromatic Crops.
7. Various techniques to measure and analysis the growth
8. Estimation of number of pruning in tea for maximum production
9. Evaluation of photosynthetic efficiency under different environmental condition
10. Study of functions of growth regulators
11. Estimation of hormonal assay on annual and perennial horticultural crops
12. Measurement of physiological and biochemical processes which occur during ripening of fruits of tree spices.
13. Measurement of physiological and biochemical processes which occur during senescence of medicinal and aromatic crops.
14. Study of chemical manipulation on growth and development of Plantation, Spice, Medicinal and Aromatic Crops.
15. Study of factors involving stress
16. Standardization of ethylene with effect to ripening of tree spices.
17. Standardization of ethylene with effect to senescence of tree spices.

**Course outcome**

**CO 1:** Students will be able to appreciate the research advancements made in growth and development of Plantation Crops.

**CO 2:** Students will be able to appreciate the research advancements made in growth and development of Spice Crops.

**CO 3:** Students will be able to appreciate the research advancements made in growth and development of Medicinal Crops.

**CO 4:** Students will be able to appreciate the research advancements made in growth and development of Aromatic Crops.

**CO 5:** They will be able to recommend suitable package of practices for enhanced growth and development of Plantation, Spice, Medicinal and Aromatic Crops.

**CO - PO Mapping matrix**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>
<b>CO 1</b>	3	2	1	2	1
<b>CO 2</b>	3	2	1	2	1
<b>CO 3</b>	3	3	2	2	1
<b>CO 4</b>	2	2	1	1	2
<b>CO 5</b>	3	2	1	1	1

**References**

1. Afoakwa EO. 2016. Cocoa Production and Processing Technology. CRC Press
2. Buchanan.B. W. Gruissem and R. Jones. 2002. Biochemistry & Molecular Biology of Plants. John Wiley & Sons
3. Leopold, A.C. and P.E. Kriedermann. 1985. Plant growth and development. 3rd Ed. MC. Graw - Hill, New York.
4. Epstein, E. 1972. Mineral Nutrition of Plants: Principles and Perspectives. Wiley. New York.
5. Fosket, Donald E. 1994. Plant Growth and Development: a Molecular Approach, Academic Press, San Diego, CA.
6. Panda H. 2016. The Complete Book on Cultivation and Manufacture of Tea (2nd Revised Edition). Asia Pacific Business Press Inc.

7. Roberts, J., S. Downs and P. Parker. 2002. Plant growth development. In. plants (Edited by I. Ridge) pp221-274. Oxford University Press, UK.
8. Ravindran PN. 2017. The Encyclopedia of Herbs and Spices. CABI
9. Salisbury, Frank B. and Ross. Cleon W. 1992. Plant Physiology, 4th ed. Wadsworth Publishing Co., Belmont, CA.

#### **E-Resources**

1. <http://www.plantphysiol.org>
2. <http://www.plantphys.net>
3. <http://www.plantstress.com>
4. <http://www.ipni.net>
5. <http://www.edis.ifas.ufl.edu>
6. <http://www.greenair.com/plantlnk.html>
7. <http://www.tvdsb.on.ca>
8. [www.genfys.slu.se/](http://www.genfys.slu.se/)
9. [www.mpcer.nau.edu/ug/forest.html](http://www.mpcer.nau.edu/ug/forest.html)

### **PSM 510BIOCHEMISTRY OF PLANTATION, SPICES, MEDICINAL AND AROMATIC CROPS(2+1)**

#### **Learning objectives**

- This course will impart theoretical as well as hands-on experience to the learner on the biochemistry of PSM crops.
- To impart comprehensive knowledge on the biochemistry, production of primary and secondary metabolites from PSMs.
- To impart comprehensive knowledge on the extraction of bioactive principles from PSMs.

#### **Theory**

##### **Unit - I:Physiological and biochemical changes**

Maturity indices, changes during ripening, processing, factors affecting quality. Secondary metabolites and their biosynthetic pathways, factors affecting production of secondary metabolites in plantation and spice crops

##### **Unit - II:Contaminants**

Adulterants, and substitutes, sources of contamination- microbial, heavy metal, pesticide residues in Plantation and Spice Crops.

##### **Unit - III:Value added products**

Essential oils, oleoresins, aroma chemicals and other value-added products, their content, storage, medicinal and pharmacological properties, use in the food, flavour perfumery and pharmaceutical industries in spice crops.

##### **Unit - IV:Physiological and biochemical changes**

Maturity indices, changes during ripening, processing, factors affecting quality. Secondary metabolites and their biosynthetic pathways, factors affecting production of secondary metabolites. Contaminants: Adulterants, and substitutes, sources of contamination- microbial, heavy metal, pesticide residues in PSMs. Value added products: Fixed oils, essential oils, dyes, oleoresins, aroma chemicals and other value-added products, their content, storage, medicinal and pharmacological properties, use in the food, flavor perfumery and pharmaceutical industries. Quality standards: Quality standards of raw materials and finished products.

##### **Unit - V:Extraction methods**

Basic and advanced extraction techniques in PSMs Soxhlet, SCFE, Membrane extraction. Chemical characterization HPTLC, GCMS, LCMS, NMR. Plant tissue culture: Plant tissue cultures in the industrial production of bioactive plant metabolites. Cell suspension culture systems for large scale culturing of plant cells and production of secondary metabolites. Advantages of cell culture over conventional extraction techniques.

### **Practicals**

Biochemical characterization, Detection of adulterants and substitutes, Extraction and quantification of secondary metabolites, Chromatographic separation of the products Quality assurance, Testing the product, Exposure visit to leading industries, Assessment of antimicrobial properties, In vitro production of secondary metabolites.

### **Lesson plan**

1. Maturity indices, physiological and biochemical changes occur during maturity and harvest of plantation crops
2. Maturity indices, physiological and biochemical changes occur during maturity and harvest of spice crops
3. Factors affecting the quality of plantation and spice crops
4. Major secondary metabolites and their biosynthetic pathways
5. Factors influencing the production of plantation and spice crops
6. Adulterants and substitutes, sources of contamination - microbial and pesticide residues in plantation crops
7. Adulterants and substitutes, sources of contamination - heavy metal, microbial and pesticide residues in spice crops
8. Value added products - essential oils, bioactive compounds, aroma chemicals and other products in plantation and spice crops
9. Drying, storage methods and packing of value-added products in plantation and spice crops
10. Medicinal and pharmacological properties of spice crops, their use in the food, flavor and pharma industries
11. Quality standards of raw materials and finished products of plantation and spice crops
12. Isolation and extraction methods in spice crops
13. Chemical characterization of secondary metabolites in spice crops
14. Commercial exploitation of chemical constituents of essential oils from spice crops
15. Industrial production of bioactive plant metabolites in spice crops
16. Cell culture *vs* conventional extraction techniques in spice crops

### **17. Mid semester examination**

18. Maturity indices, physiological and biochemical changes occur during maturity and harvest of medicinal plants.
19. Maturity indices, physiological and biochemical changes occur during maturity and harvest of aromatic crops.
20. Factors affecting the quality of medicinal and aromatic plants.
21. Major secondary metabolites and outline study of: Alkaloids, phenolics, terpenes - nature, classification, distribution, biosynthesis and functions.
22. Major secondary metabolites and outline study of: Alkaloids, phenolics, terpenes - nature, classification, distribution, biosynthesis and functions.
23. Adulterants and substitutes, sources of contamination - microbial, heavy metal and pesticide residues in medicinal plants.
24. Adulterants and substitutes, sources of contamination - microbial, heavy metal and pesticide residues in aromatic crops.



25. Value addition and value-added products: fixed oils, essential oils, bioactive compounds, aroma chemicals and other value-added products and their content in medicinal and aromatic plants.
26. Value addition and value-added products: fixed oils, essential oils, bioactive compounds, aroma chemicals and other value-added products and their content in medicinal and aromatic plants.
27. Medicinal and pharmacological properties of medicinal and aromatic plants, their use in the food, flavor, perfumery and pharma industries
28. Quality standards of raw materials and finished products of medicinal and aromatic plants.
29. Isolation and extraction methods: TLC, HPTLC, Column chromatography, HPLC, GC, ASE used in medicinal and aromatic plants.
30. Methods of chemical characterization: spectroscopic, UV, visible, IR, NMR, mass spectrometry, atomic absorption, GCMS, LCMS used in medicinal and aromatic plants.
31. Essential oils: Distillation techniques and extraction with different solvents in aromatic plants; different models and its specific advantages.
32. Different essential oils and their chemical constituents along with commercial uses - citronella oil, geranium oil, lemon grass oil, davana oil, mentha oil, eucalyptus oil, vetiver oil and others.
33. Plant tissue cultures in the industrial production of bioactive plant metabolites cell suspension culture systems for large scale culturing of plant cells and production of secondary metabolites.
34. Advantage of cell culture over conventional extraction techniques in medicinal and aromatic plants.

### **Practical**

1. Biochemical characterization of bioactive molecules using modern methods from spice crops
2. Extraction of compounds from important spice crops using Soxhlet apparatus
3. Extraction of compounds using advanced equipments like ASE, MAE in spice crops
4. Distillation of essential oils through conventional methods from spice crops plants
5. Distillation of essential oils from spice crops through advanced techniques
6. In vitro production of secondary metabolites from spice crops
7. Detection of adulterants and substitutes and assessment of antimicrobial properties for quality assurance
8. Exposure visit to leading spices / plantation industries
9. Biochemical characterization of bioactive molecules using modern methods from medicinal plants
10. Extraction of compounds from important medicinal plants using soxhlet apparatus
11. Extraction of compounds using advanced equipments like ASE, MAE in medicinal plants
12. Distillation of essential oils through conventional methods from aromatic plants
13. Distillation of essential oils from aromatic plants through advanced techniques
14. In vitro production of secondary metabolites from medicinal plants
15. Detection of adulterants and substitutes and assessment of antimicrobial properties for quality assurance
16. Exposure visit to leading herbal industries
17. Exposure visit to leading aroma industries

### **Course outcome**

**CO 1:** Students are expected to develop the technical know-how on postharvest biochemistry of plantation crops.

**CO 2:** Students are expected to develop the technical know-how on postharvest biochemistry of spice crops.

**CO 3:** Students are expected to develop the technical know-how on postharvest biochemistry of medicinal crops.

**CO 4:** Students are expected to develop the technical know-how on postharvest biochemistry of aromatic crops.

**CO 5:** Students are able to identify adulterants through biochemical analysis in plantation and spice crops.

#### CO - PO Mapping matrix

	PO1	PO2	PO3	PO4	PO5
CO 1	-	1	2	1	-
CO 2	-	1	3	1	-
CO 3	-	1	2	1	-
CO 4	1	2	3	1	1
CO 5	1	1	2	2	2

#### References

1. Daniel, M. and Mammen, D. 2016. Analytical methods for medicinal plants and economic botany Scientific publishers
2. Das, K. 2013. Essential oils and their applications. New India Publishing Agency, New Delhi
3. E-manualon. Advances in Cashew Production Technology. ICAR-Directorate of Cashew Research, Puttur-574 202, DK, Karnataka
4. Orhan, I. 2012. Biotechnological Production of Plant Secondary Metabolites. Bentham Science Publishers
5. Parimelzhagan, T. 2013. Turning plants in to medicines: Novel approaches. New India Publishing Agency, New Delhi
6. Ponnuswami et al. 2018 Medicinal Herbs and herbal cure. Narendra Publishing House, New Delhi
7. Raaman, N. 2006. Phytochemical techniques. New India Publishing
8. RanjalKandall. Bioactive compounds and genomic study of medicinal plants. LAMBERT Academic Publishing
9. Tiwari/Chandra. 2018. Antimicrobial properties of Medicinal plants. Narendra Publishing House, New Delhi
10. Waghulkar, V. M. 2012. Quality assurance techniques in pharmaceuticals. New India Publishing Agency, New Delhi

#### E-Resources

1. [www.nmpb.nic.in](http://www.nmpb.nic.in)
2. <https://www.cimap.res.in/english/index.php>
3. <https://dmapr.icar.gov.in/>
4. <https://www.ayush.gov.in>

## PSM511BIODIVERSITY AND CONSERVATION OF PLANTATION, SPICE, MEDICINAL AND AROMATIC CROPS (2+1)

### Learning objectives

- This course will impart theoretical as well as hands on experience to the learner on centres of diversity, germplasm evaluation, documentation, data base management and cataloguing
- Understanding the principles of biodiversity, strategies in conservation and utilization of medicinal and aromatic plants
- To provide knowledge in learning about under exploited medicinal and aromatic plants in India.

### Theory

#### Unit - I: Importance of biodiversity and methods of conservation and Role of National institutes in conservation of plant quarantine

Biodiversity & conservation- issues and goals- centres of origin of cultivated medicinal and aromatic plants- primary and secondary centres of genetic diversity- present status of gene centers- exploration and collection of germplasm- conservation of genetic resources in-situ & ex-situ germplasm conservation problem of recalcitrant seeds cold storage of scions- tissue culture cryopreservation- pollen and seed storage inventory of germplasm. Introduction of germplasm-plant quarantine- role of knowledge, role of national institutes is conservation- TBGRI- NBPGR. Intellectual property rights- regulatory horticulture- plant variety protection authority- maintenance of core group using rational knowledge for plant conservation.

#### Unit - II: Plantation crops

Tea- coffee- cashew - rubber- cocoa - palmyrah - oil palm - coconut - Arecanut

#### Unit - III: Spice crops

Black pepper- cardamom- ginger- turmeric- coriander- fennel- nutmeg- cinnamon- clove

#### Unit- IV: Medicinal Plants

Senna- Coleus- Ashwagandha- Glory lily- Sarpagandha- *Dioscorea* sp- *Aloe vera*- Phyllanthus- kalmegh- medicinal solanum- gymnema-Isabgol- ipecac-periwinkle-poppy- safedmusli- stevia

#### Unit- V: Aromatic plants

Palmarosa- lemon grass- citronella- vetiver- geranium- menthe- Artemisia- Ocimum- eucalyptus- rosemary- thyme- patchouli- lavender- marjoram- origanum.

### Practicals

Documentation of germplasm maintenance of passport data and other records of accessions; field exploration trips- exercise on *ex situ* conservation; cold storage-pollen/seed storage-cryopreservation- visit to National Gene Bank and other centers of PGR activities.

### Lesson plan

1. Biodiversity- introduction- principles, goals and issues in conservation
2. Genetic diversity- occurrence and distribution
3. Exploration, collection, characterization, documentation and cataloging of germplasm
4. Present status of national and international gene banks
5. Role of national institutes in conservation- TBGRI, NBPGR
6. Germplasm exchange, Material Transfer Agreement and current quarantine protocols
7. Methods for *ex situ* conservation of germplasm and *in situ* conservation of germplasm
8. Use of GIS and documentation of local biodiversity

9. Horticultural cropping system and implication on biodiversity
10. Impact of climate change on biodiversity
11. Advances and issues in conservation of biodiversity through recalcitrant and orthodox seeds
12. Advances and issues in conservation of biodiversity through vegetative propagation
13. Intellectual Property Rights, Plant Variety Protection Authority
14. Origin, Distribution - Biodiversity, Propagation, Conservation and Utilization. Plantation Crop
15. Tea, Coffee, Coconut
16. Cashew, cocoa, rubber
- 17. Mid-semester Examination**
18. Palmyrah, oil palm and Arecanut
19. Origin, Distribution - Biodiversity, Propagation, Conservation and Utilization Spices crop
20. Black Pepper and Cardamom
21. Ginger and Turmeric
22. Coriander and Fennel
23. Nutmeg and Cinnamon Clove
24. Origin, Distribution - Biodiversity, Propagation, Conservation and Utilization Medicinal and Aromatic Plants
25. *Aloevera*, *Senna*, *Coleus*
26. *Kalmegh*, *gymnema*, *glory lilly*
27. *Isabgol*, *Phyllanthus* and *stevia*
28. *periwinkle* and *ashwagandha*
29. *Geranium* and *Vetiver*
30. *Lemon grass* and *Ocimum*
31. *Palmarosa* and *Citronella*
32. *Eucalyptus*, *Artemisia* and *Mint*.
33. *Rosemary* and *thyme*
34. *Lavender* and *patchouli*

### **Practical**

1. Field exploration trips- exercise in collection and characterization
2. Visit to field germplasm Unit and documentation of germplasm
3. Practices in maintenance of passport data
4. Practical study of ex situ conservation methods
5. Practical study of in situ conservation methods
6. Methods of seed storage for short- and long-term conservation
7. Methods of conservation using vegetative propagules
8. In vitro conservation protocols
9. Study of species diversity in horticultural cropping system
10. Visit to regional conservation centres
11. Visit to subtropical and temperate zone medicinal & aromatic crop fields
12. Characterization of coffee germplasm
13. Characterization of cardamom germplasm
14. Characterization of *Ocimum*. Germplasm
15. Identification of minor plantation and spices crops and their description.
16. Use of molecular tools for characterizing species diversity
17. Estimating extent of diversity through collection and analysis of data

## Course outcome

### CO

1: The students will be able to understand the strategies in conservation and utilization of Plantation crops biodiversity

### CO

2: The students will be able to understand the strategies in conservation and utilization of spice crops biodiversity

### CO

3: The students will be able to understand the strategies in conservation and utilization of medicinal crops biodiversity

### CO

4: The students will be able to understand the strategies in conservation and utilization of aromatic crops biodiversity

CO 5: They will be able to demonstrate different techniques in *ex-situ* conservation.

### CO-PO Mapping matrix

	PO1	PO2	PO3	PO4	PO5
CO1	-	-	-	-	3
CO2	-	-	-	-	3
CO3	-	-	-	-	3
CO4	-	-	-	-	2
CO5	-	-	-	-	3

### References

1. Devi AR, Sharangi AB, Acharya SK and Mishra GC. 2017. Coriander in Eastern India: The landraces and genetic diversity. KrishiSanskriti Publications. New Delhi. ISBN: 978-93-85822-48-3.
2. Khan JB and Singh GP. 2012. Biodiversity Management and Conservation LAMBERT
3. Panda H. 2016. The Complete Book on Cultivation and Manufacture of Tea (2nd Revised Edition). Asia Pacific Business Press Inc.
4. Panda H. 2017. Herbal and Aromatic Plants Cultivation, Processing, Utilisation and Applications. Discovery publishing house, New Delhi
5. Peter, K.V. (Ed). 2008. Biodiversity in Horticultural Crops. Vol.2 Daya Publishers, New Delhi.
6. Ponnuswami et al. 2018. Medicinal Herbs and herbal cure. Narendra Publishing House, New Delhi
7. Ponnuswami et al. 2018. Spices. Narendra Publishing House, New Delhi
8. Peter, K.V. (Ed). 2010. Biodiversity in Horticultural Crops. Vol.3 Daya Publishers, New Delhi.
9. Ramakrishnan N. 2018. Biodiversity in Indian Scenario. Daya publishing house.
10. Thirugnanakumar. 2018. Genetic diversity and phenotypic stability in crop plants. New India Publishing Agency, New Delhi

### E-Resources

1. [www.nmpb.nic.in](http://www.nmpb.nic.in)
2. <https://www.cimap.res.in/english/index.php>
3. <https://dmapr.icar.gov.in/>
4. <https://www.ayush.gov.in/>
5. <http://www.nbpgr.ernet.in/>
6. <http://nbaindia.org/>
7. <https://cgspace.cgiar.org/>

## SUPPORTING COURSES

### STA 501 Statistical Methods for Applied Sciences (2+1)

#### Learning objectives

- To acquaint the students about the basics of statistics and design of experiments

#### Theory

##### Unit - I

Box - Plot, Descriptive Statistics, Exploratory data analysis, Theory of Probability, Random variable and Mathematical Expectations. Concept of Discrete and Continuous Probability Distributions: Binomial, Poisson, Normal Distributions and their applications.

##### Unit - II

Concept of Sampling distribution; Chi - Square, t and F distributions. Tests of Significance based on Normal, Chi - Square, t and F distributions.

##### Unit - III

Simple, Multiple and Partial Correlation Coefficient; Rank Correlation, Simple and Multiple Linear Regression, Test of Significance of Correlation of Coefficient and Regression Coefficient and Coefficient of Determination

##### Unit - IV

Need for Design of Experiments, Characteristics of a good design, Basic Principles of Design of Experiments, Completely Randomized Design, Randomized Block Design and Latin Square Design Layout and their analysis.

##### Unit - V

Concepts of Factorial experiments  $2^n$ ,  $3^2$  factorial experiments; Concepts of Confounding in factorial experiments - Confounding in  $2^3$  factorial experiments; partial and total confounding; Split - plot design and Strip - plot design.

#### Lecture schedule

1. Meaning of Box-Plot
2. Descriptive Statistics - Concepts
3. Exploratory data analysis
4. Theory of Probability
5. Random variable and Mathematical Expectation
6. Discrete probability distributions - binomial and poison distribution
7. Continuous probability distributions - normal distribution and their application
8. Concept of sampling distribution - Standard Error
9. **First Test**
10. t distribution , F and Chi square distribution
11. Tests of significance based on t, z, (mean and equality of means only).  $\chi^2$  test for goodness of fit.
12. Definition of correlation, significance and types
13. Properties of correlation coefficient
14. Definition of regression - measuring and uses of regression analysis properties.
15. Differences between correlation and regression.
16. Regression co - efficient - simple, linear.
17. **Mid- semester examination**
18. Multiple linear regression co - efficient - standard error of estimate
19. Test of significance of observed regression co -efficient and co - efficient of determination.
20. Characteristics of agricultural experiments: concepts - field studies.

21. Characteristics of agricultural experiments -pot-culture – quantitative and qualitative variables.
22. Sources of errors and estimate of errors
23. Design of Experiments– Basic principles
24. Completely Randomized Design
25. Randomized Block Design
26. Latin Square Design
27. Comparison of treatments – least significant difference method
28. Duncan’s Multiple Range Test (DMRT)
29. Concept of factorial experiments
30.  $2^n$ ,  $3^2$  Factorial experiments
31. Principle of confounding in factorial experiments
32. Confounding in  $2^3$  Factorial experiments
33. Split-pot design
34. strip – plot design

#### **Practical schedule**

1. Estimation of samples statistic viz., means, SD, SE and CV.
2. Fitting of distributions – binomial and poisson
3. Z-test, t-test and paired t-test
4. Comparison of two variances using F-test
5. Bartlett’s test for homogeneity of variances
6. Chi-square test for test of goodness of fit and homogeneity of ratio test for independence of attributes
7. Computation of correlation co-efficient and it’s significance
8. Fitting of simple linear regression and testing the significance of regression coefficient
9. Multiple linear regressions fitting and testing
10. Determination of optimum plot size using uniformity trial.
11. Analysis of CRD and RBD
12. Analysis of LSD and DMRT
13.  $2^2$  Factorial Experiment
14.  $2^3$  Factorial Experiment
15. Complete confounding in  $2^3$  Factorial Experiment
16. Analysis of Split-plot and Strip-plot design
17. Final practical Examination

#### **Reference Books**

1. Bhattacharyya, G.K. and R.A. Johnson. 1997. Statistical concepts and methods, John Wiley and Sons, New York.
2. Crozon, F.E. and D.J. Cowden . 1986. Applied General Statistics, Prentice Hall of India, New Delhi.
3. Gomez, K.A. and A.A. Gomez. 1984. Statistical procedure for Agricultural Research, John Wiley and Sons, New York.
4. Panse, V.G. and P.V. Sukhatme. 1961. Statistical methods for Agricultural Workers, ICAR, New Delhi.
5. Ramaswamy, R. 1995. A text book of Agricultural Statistics, Wiley Limited, New Delhi.

### **COM-501 Information Technology in Agriculture (2+1)**

#### **Learning objectives**

1. Introduction to Networking and Internet Applications that aims at exposing the students to understand analogy of computer, basic knowledge of MS Office.
2. Give students an in-depth understanding of why computers are essential components in business, education and society.
3. Provide hands-on use of Microsoft Office applications Word, Excel, Access and PowerPoint. Completion of the assignments will result in MS Office applications knowledge and skills.
4. To get familiar with basics of the Internet Programming and different IT tools in Agriculture.

## **Theory**

### **Unit I**

Introduction to Computers, Anatomy of computer, Operating Systems, definition and types, Applications of MS Office for document creation & Editing, Data presentation, interpretation and graph creation, statistical analysis, mathematical expressions.

### **Unit II**

Database, concepts and types, uses of DBMS in Agriculture, World Wide Web Statistical Sciences: Computer Application.

(WWW): Concepts and components, Introduction to computer programming languages, concepts and standard input/output operations. e-Agriculture, concepts and applications,

### **Unit III**

Programming fundamentals with C - Constants and Variables - Data Types - Arithmetic expressions - assignment statements - Logical expressions - Control flow - Arrays and Structures.

### **Unit IV**

Hyper Text Markup Language (HTML), DHTML, web based application development. Static websites, dynamic websites. Client Side processing - scripting languages.

### **Unit V**

Use of ICT in Agriculture, Computer Models for understanding plant processes. IT application for computation of water and nutrient requirement of crops, Computer controlled devices (automated systems) for Agri-input management, Smartphone Apps in Agriculture for farm advises, market price, postharvest management etc.,

## **Lecture Schedule**

1. Introduction to Computers, Anatomy of Computers.
2. Memory concepts.
3. Booting sequence of operating system.
4. Operating systems.
5. DOS, Windows, Unix
6. Types of VIRUS.
7. MS Office word, Creating, Editing, Formatting a document and saving a document.
8. MS Excel Data Presentation, Data graph creation.
9. MS Power Point Presentation.
10. MS Access Concepts of Database, Creating Database.
11. Statistical analysis and mathematical expressions.
12. Database Concepts.
13. Database in Agriculture.
14. Internet - World Wide Web (WWW)
15. Programming Languages, Computer programming languages.



16. e-Agriculture concepts and applications.
17. Programming Fundamentals with C.
18. Mid Semester Examination
19. Constant and Variable.
20. Data Types.
21. Operators.
22. Arrays and Structures.
23. HTML-DHTML.
24. Web based applications development.
25. Client side processing.
26. Scripting Languages
27. ICT in Agriculture.
28. IT application.
29. Computer Control devices.
30. Agri input management.
31. Smartphone Apps in Agriculture.
32. Agriculture for farm advises.
33. Agri-input management.
34. Postharvest management.

#### **Practical Schedule**

1. 1 MSWORD- Creating, Editing and Presenting a Scientific Document
2. MS POWER POINT- creating, editing and presenting a scientific Document
3. MSEXCEL- Creating a spreadsheet, writing expressions, Entering formula expression through the formula tool bar and use of inbuilt statistical, mathematical functions
4. MSEXCEL- Creating graphs, analysis of scientific data- Data analysis t-test, Regression, ANOVA
5. MSACCESS: Creating Database, preparing queries and reports
6. MSACCESS: Demonstration of Agri-information system
7. C program to find addition and subtraction of two numbers
8. C Program to find whether the given input is palindrome or not
9. C program to find the given number is Armstrong or not
10. C program for finding Fibonacci series.
11. C Program to find Factorial of a given number.
12. C Program for calculating student grade using if-else and switch statement
13. Introduction to World Wide Web (WWW) and its components
14. HTML: Creation of website
15. HTML: Creation of Scientific Calculator
16. Internet: Presentation and management agricultural information through web
17. Practical Exam

#### **COURSE OUTCOMES**

At the end of the course students will be able to

- CO 1:** Describe the usage of computers and why computers in society.
- CO2:** E-Agriculture concepts and applications
- CO 3:** Learn categories of programs.
- CO 4:** Web based application development

CO 5: Information Technology applications and systems.

#### CO-PO MAPPING MATRIX

	PO 1	PO2	PO3	PO4
CO1	3	3	3	3
CO2	0	1	3	1
CO3	0	3	2	3
CO4	3	0	0	0
CO 5	0	3	2	0

#### REFERENCES

1. Satish Jain, M Geetha, Kratika,( 2012) Computer Course Windows 7 With Ms Office 2010, Bpb Publications.
2. Anupama Jain and Avneet Mehra( 2012), Computer Fundamental MS Office: Including Internet & Web Technology 2010.
3. Programming in Ansi C Paperback – 8 May 2012, by E Balagurusamy (Author).
4. Cox V, Wermers L and Reding E.E. 2006. *HTML Illustrated Complete*. 3rd Ed. Course Technology.
5. Meera SN 2008 ICTs in agricultural extension: Tactical to practical.

#### COMMON COMPLUSORY COURSES

##### PGS 501 - LIBRARY AND INFORMATION SERVICES (0+1)

#### 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; e-resources access methods.

#### Practical Schedule

1. Introduction to library and its services
2. Role of libraries in education, research and technology transfer;
3. Classification systems and organization of library
4. Sources of information- Primary Sources, Secondary Sources and Tertiary Sources
5. **First test**

6. Intricacies of abstracting and indexing services
7. Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.);
8. Tracing - information from reference sources; Literature survey
9. **Mid- Semester**
10. Citation techniques/Preparation of bibliography;
11. Use of CD-ROM Databases,
12. Online Public Access Catalogue and other computerized - library services
13. Online Public Access Catalogue and other computerized - library services
14. Use of Internet including search engines and its resources
15. Use of Internet including search engines and its resources
15. e-resources access methods.
16. Final practical examination.

### **PGS 502 - TECHNICAL WRITING AND COMMUNICATION SKILLS (0+1)**

#### **Objective**

- To equip the students with skills *Viz.*, writing of dissertations, research papers, etc. and to communicate and articulate in English

#### **Practical**

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. Proof reading. Technical Writing - Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Structure 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.

#### **Practical schedule**

1. Grammar (Tenses, parts of speech)
2. Grammar (clauses, punctuation marks)
3. Error analysis (Common errors); Concord; Collocation;
4. Phonetic symbols and transcription;
5. **First test**
6. Accentual pattern: Weak forms in connected speech
7. Participation in group discussion, Facing an interview; presentation of scientific papers.
8. Technical Writing- Various forms of scientific writings- theses, technical papers
9. **Mid -semester examination**
10. Technical Writing- reviews, manuals
11. Structure of thesis and research communications
12. Writing of abstracts, summaries, précis, citations etc
13. Commonly used abbreviations in the theses and research communications
14. Illustrations, photographs and drawings with suitable captions
15. Pagination, numbering of tables and illustration, numbers and dates in scientific write-ups

16. Editing and proof-reading, Writing of a review article.
17. Final practical examination

### **Suggested Readings**

1. Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.
2. Mohan K. 2005. Speaking English Effectively. MacMillan India.
3. Richard WS. 1969. Technical Writing. Barnes & Noble.
4. Robert C. (Ed.). 2005. Spoken English: Flourish Your Language. Abhishek.
5. Wren PC & Martin H. 2006. High School English Grammar and Composition. S.Chand& Co.

## **PGS 503 INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE (1+0) (e-course)**

### **Objectives**

The objective of the course is to create awareness about intellectual property rights in agriculture. The course deals with management of patents, trademark, geographical indications, copy rights, designs, plant variety protection and biodiversity protection. The students will be taught on the marketing and commercialization of intellectual properties.

### **Theory**

#### **Unit - I- World trade organization - introduction**

World Trade Organization - Agreement on Agriculture (AoA) and Intellectual Property Rights (IPR) - importance of intellectual property management - IPR and economic growth - IPR and bio diversity - major areas of concern in intellectual property management - technology transfer and commercialization - forms of different intellectual properties generated by agricultural research.

#### **Unit - II- Patent document**

Discovery *versus* invention - patentability of biological inventions - procedure for patent protection - preparatory work - record keeping, writing a patent document, filing the patent document - types of patent application - patent application under the Patent Cooperation Treaty ( PCT ).

#### **Unit - III- Plant genetic resources**

Plant genetic resources - importance and conservation - sui generic system - plant varieties protection and farmers' rights act - registration of extinct varieties registration and protection of new varieties / hybrids / essentially derived varieties - dispute prevention and settlement - farmers' rights.

#### **Unit - IV- Trademark**

Trademark - geographical indications of goods and commodities - copy rights designs - biodiversity protection.

#### **Unit - V- Benefit sharing**

Procedures for commercialization of technology - valuation, costs and pricing of technology - licensing and implementation of intellectual properties - procedures for commercialization - exclusive and non exclusive marketing rights - research exemption and benefit sharing.

### **Lecture schedule**

1. World Trade Organization - Agreement on Agriculture (AoA) and Intellectual Property Rights (IPR)
2. Importance of intellectual property management - IPR and economic growth - IPR and bio diversity
3. Major areas of concern in Intellectual property management - technology transfer and commercialization
4. Forms of different intellectual properties generated by agricultural research
5. **First test**
6. Discovery versus invention patentability of biological inventions
7. Procedure for patent protection, Preparatory work - record keeping, writing a patent document, filing the patent document
8. Types of patent application - patent application under the Patent Cooperation Treaty ( PCT )
9. **Mid semester examination**
10. Plant genetic resources - importance and conservation
11. Sui generic system - plant varieties protection and farmers' rights act registration of extant varieties
12. Registration and protection of new varieties / hybrids / essentially derived varieties - dispute prevention and settlement - farmers' rights
13. Trade mark - geographical indications of goods and commodities - copy rights - designs ,Biodiversity protection,
14. Procedures for commercialization of technology - valuation, costs and pricing of technology
15. Licensing and implementation of intellectual properties - procedures for commercialization
16. Exclusive and non exclusive marketing rights - research exemption and benefit sharing
17. **Final practical examination**

#### **Reference books**

1. Arun Goyal and Moor Mohamed, 2001. *WTO in the New Millennium*, Academy of Business Studies, New Delhi.
2. BilekDebroj, 2004. *Intellectual Property Rights*, BR World of books, New Delhi.
3. Ganguli, P., 2001. *Intellectual Property Rights - Unleashing the Knowledge Economy*. Tata McGraw Hill, New Delhi.
4. Narayanan, R., 2006. *Patent Law*, Eastern Law House, New Delhi.
5. Ramappa, T., 2000. *Intellectual Property Rights under WTO - Tasks before India*, Wheeler Publishing, New Delhi.

### **PGS 504- BASIC CONCEPTS IN LABORATORY TECHNIQUES (0 + 1)**

#### **Objective**

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

#### **Practical**

##### **Unit-I-Safety measures and common laboratory equipment's**

Safety measures while in labs; Handling of chemical substances; use of burettes, pipettes, measuring cylinders, flasks, separator funnel, condensers and micropipettes. Washing, drying and sterilization of glassware; drying of solvents/ chemicals.

##### **Unit-II - Preparation of standard solutions**

Weighing and preparation of solutions of different strengths and their dilution ; Handling techniques of solutions; preparations of different Agro-chemical 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.

### **Unit-III-Use and handling of laboratory equipment's**

Use and handling of vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sand bath and water bath.

### **Unit-IV - Microscopy and media preparation**

Use and handling of microscope and laminar flow-preparation of media- differential, selective and enriched media. Methods of sterilization -physical methods-dry and moist heat, cold, filtration and radiation, chemical methods and disinfectants.

### **Unit-V - In-vitro culture techniques**

Description of flowering plants in botanical terms in relation to taxonomy- seed viability test-pollen fertility test-tissue culture media-composition of media-media preparation -instant media-aseptic manipulation-procedure for in vitro culture of explants-leaf bit-stem bit-anthers-pollen -microspores-ovule and embryo.

### **Practical schedule**

1. Safety measures in labs and handling of chemical substances.
2. Common laboratory equipment's. Calibration and cleanliness of volumetric glass wares.
3. Methods of expressing strength of solutions.
4. Preparation of primary standard solutions and buffer solutions.
5. **First test**
6. Preparation of standard solutions for nutrient analysis of soil, plant and water.
7. Preparation of different Agro-chemical doses for field experiments, Preparation of buffer solutions,
8. Handling of instruments-vacuum pumps, thermometers, and magnetic stirrer.
9. **Mid semester Examination**
10. Handling of instruments-ovens, sand bath and water bath.
11. Handling and uses of microscopes and laminar flow.
12. Sterilization by physical methods and Sterilization by chemical methods.
13. Preparation of different media for culturing the micro-organisms.
14. Description of flowering plants-seed viability test and pollen fertility test.
15. Aseptic manipulations and media.
16. In vitro culture of different explants.
17. Final practical examination

### **References**

1. Furr, A.K.2000.Handbook of laboratory safety. CRC press.
2. Jackson, M.L. 1997. Soil Chemical Analysis. Prentice Hall of India pvt. Ltd., New Delhi.
3. Prescott.L.M, Harley, P and Klein, A. 2003. Microbiology, 5<sup>th</sup> Edition, McGraw Hill, USA.
4. Gupta, P.K. 1997.Elements of Biotechnology, Rastogi Publications. Meerut.
5. Singh, B.D. 2005.Biotechnology, Expanding Horizons, Kalyani Publications, New Delhi.

### **e-Reference**

1. Analytical chemistry vol.1 (pdf) [www.freebookcentre.net](http://www.freebookcentre.net).
2. MichealZehfusAnalytical chemistry [www.freebookcentre.net](http://www.freebookcentre.net).
3. Introduction to Instrumental Analytical Chemistry Roger Terri[www.freebookcentre.net](http://www.freebookcentre.net).
4. Analytical Chemistry lecture notes sadhu malyadri[www.freebookcentre.net](http://www.freebookcentre.net).

5. Manfred Sietz and Andreas Sonnenberg. Short introduction into analytical chemistry [www.freebookcentre.net](http://www.freebookcentre.net).

## **PGS 505 - AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES (1+0)**

### **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.

### **Unit IV**

Research prioritization and selection of research problem - Research planning - review of literature - setting of objectives and hypothesis - research design and techniques - data collection - analysis - formulation of tables - interpretation of results- Computer software in tabulation, presentation - Thesis writing - writing of research articles- projects and report writing - Formulation and preparation of research / scheme proposal - Impact factor and citation index - citation and references- Guidelines for oral / poster presentations - Internet in scientific research.

### **Unit V**

Authorship and copy right - Plagiarism - Scientific misconduct - Falsification of research results, data fabrication - Peer review, informed consent attribution of authorship and adequacy of peer review publication process -Responsibility of society and self - Public interest in research, relevance to society and motivation - Conflict of interest, moral commitment - Social trends on research ethics, adequate codes of conduct to regulate research activity

### **Lecture schedule**

1. History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment
2. National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR); International Agricultural Research Centres (IARC)
3. 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.
4. Research ethics: research integrity, research safety in laboratories
5. **First test**
6. Welfare of animals used in research, computer ethics, standards and problems in research ethics.
7. Concept and connotations of rural development, rural development policies and strategies.
8. 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.
9. **Mid semester examination**
10. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.
11. Research prioritization and selection of research problem - Research planning - review of literature - setting of objectives and hypothesis - research design and techniques
12. Data collection -- analysis - formulation of tables - interpretation of results- Computer software in tabulation and presentation
13. Thesis writing - writing of research articles- projects and report writing - Formulation and preparation of research / scheme proposal
14. Impact factor and citation index - citation and references- Guidelines for oral / poster presentations - Internet in scientific research.
15. Authorship and copy right - Plagiarism - Scientific misconduct - Falsification of research results, data fabrication - Peer review, informed consent attribution of authorship and adequacy of peer review publication process
16. Responsibility of society and self - Public interest in research, relevance to society and motivation - Conflict of interest, moral commitment
17. Social trends on research ethics, adequate codes of conduct to regulate research activity

#### **Reference**

1. Bhalla GS and Singh G. 2001. *Indian Agriculture - Four Decades of Development*. Sage Publ.
2. Punia MS. *Manual on International Research and Research Ethics*. CCS Haryana Agricultural University, Hisar.
3. Rao BSV. 2007. *Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives*. Mittal Publ.
4. Singh K. 1998. *Rural Development - Principles, Policies and Management*. Sage Publ.



**NGC 001\* DISASTER MANAGEMENT (1+ 0)**  
**(e-Course)**

**Objectives**

- To introduce students to the key concepts and practices of mitigation for natural disasters and calamities and to equip them for disaster preparedness to conduct thorough assessment of hazards, risks vulnerability and capacity building strategies.

**Theory**

**Unit I – Natural disaster**

Natural Disasters - meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, heat and cold waves.

**Unit II – Climate change**

Climatic change - Global warming, sea level rise, ozone depletion, Manmade disasters - Nuclear disasters, chemical disasters, biological disasters.

**Unit III – Man – made disaster**

Building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, disaster management- efforts to mitigate natural disasters at national and global levels – India’s key hazards, vulnerabilities and disaster response mechanisms in India.

**Unit IV – Disaster warning, response and preparedness**

Concept of disaster management, national disaster management framework; financial arrangements, role of NGOs, community-based organizations, and media central, state, district and local administration. Dissemination of disaster warning, response to natural disasters, national, state, district level, relief – food and nutrition – water – health – mental health services.

**Unit V – Rehabilitation**

Rehabilitation – food - clothing - utensils - fuel – shelter – relief camp – sanitation and hygiene. Resilient farming concepts – reclamation and revival of the agriculture system after natural disaster (Bio-shield). Preparedness – Emergency Operations Centres (EOCS).

**Lecture schedule**

1. Natural Disaster - meaning and nature of natural disasters, their types and effects.
2. Flood, drought, cyclone, earthquakes landslides, avalanches, volcanic eruptions, Heat and cold waves.
3. Climatic change- Global warming, sea level rise, ozone depletion
4. **First test**
5. Manmade disaster - Nuclear disasters, chemical disasters, biological disasters.
6. Building fire, coal fire, forest fire. oil fire.
7. Air pollution, water pollution, deforestation, industrial wastewater pollution.
8. Disaster management- efforts to mitigate natural disasters. India’s key hazards, vulnerabilities and disaster response mechanism in India.
9. **Mid-Semester examination**
10. Concept of disaster management, national disaster management framework.
11. Financial arrangements, role of NGOs, community-based organizations and media.
12. Central, state, district and local administration.
13. Dissemination of disaster warning - response to natural disasters, national, state, district level.
14. Relief – food and nutrition – water – health – mental health services.

15. Rehabilitation – tolerant and resistant crops- resilient farming concepts – bioshields - livelihood options – insurance and compensation.
16. Disaster preparedness - clothing and utensils and fuel – shelter – relief camp – sanitation and hygiene.
17. Preparedness – Emergency Operations Centers ( EOCS ).

## References

1. Gautam, D R. 2009. *Community based disaster risk reduction*. Mercy Corps, Lalitpur, Nepal.
2. Gupta, HK. 2003. *Disaster management*. Indian National Science Academy. Orient Blackswan.
3. Hodgkinson, PE and Stewart, M. 1991. *Coping with Catastrophe: A handbook of disaster management*. Routledge.
4. Ministry of Home Affairs. 2010. *Standard operating procedure for responding to natural disasters*, Ministry of Home Affairs – Disaster management Division, New Delhi.
5. Sharma, VK. 2001. *Disaster management*. National Centre for Disaster Management, India.
6. Das, H.P. 2016. *Climate change and agriculture implications for global food security*. BS Publications, Hyderabad.
7. Kelkar, R.R. 2010. *Climate change -A Holistic view*. BS Publications, Hyderabad.

## e resources

[http:// research.un.org/en/disaste](http://research.un.org/en/disaste)  
<https://searchworks.stanford.edu/>  
<http://guodes.litrary.illinois.edu>c.php>  
<http://libguides.aau.edu.au>c.php>  
[www.wcpt.org](http://www.wcpt.org)

## NGC 512\* CONSTITUTION OF INDIA (1+0)

### Objectives

- To Understand the basic feature of Indian constitution
- To gain knowledge about basic rights and duties of Indian citizens
- To ponder over the form of Indian Political system
- To have broad understanding about the pivotal provision related with liberty, quality and fraternity

### Theory

#### Unit I: Constitution of India and Basic features and Fundamental Principles

Meaning of the Constitution and Constitutionalism - Origin & Development of the Constitution of India - salient features of the Constitution of India.

#### Unit II: Fundamental Rights and Duties

Fundamental Rights - Fundamental Duties - The Directive Principles of state policy

#### Unit III- Union Government

Executive: President, Prime Minister and Council of Ministers. –Legislature, Parliament- Judiciary: Supreme Court

#### Unit IV: State Government and Local Government

Executive: Governor, Chief Minister and Council of Ministers -Legislature- High Courts - Local Governments

#### Unit V: Constitutional Commissions

Election Commission -UPSC- Finance Commission

### Lecture schedule

1. Constitution of India – Definition, Basic features
2. Fundamental principles
3. Difference between constitution and constitutionalism
4. **First test**
5. Origin and development of constitution
6. Salient features of constitution of India
7. Fundamental rights and Fundamental duties
8. Direct principles of state policy
9. **Mid Semester Examination**
10. Union government - President, Prime Minister and Council of Ministers
11. Legislature, Parliament
12. Judiciary: Supreme Court
13. Executive: Governor
14. Chief Minister and Council of Ministers and Legislature
15. High Courts and Local Governments
16. Election Commission and UPSC
17. Finance Commission

#### **References**

1. The Constitution of India **2017** Kindle Edition- Government of India
2. Bahkshi P. M. 2015 The Constitution of India. Universal Law Publishing Co Ltd
3. Pylle M.V. 2018 An Introduction to The Constitution of India. Vikas Publishing
4. Bhansali S.R.2015. Textbook on The Constitution of India. Universal LexisNexis