

**M.Sc. (Ag.) Horticulture**  
**[2-Year, 4- Semester]**

**CHOICE BASED CREDIT SYSTEM (CBCS)**  
**Effective from Academic Year, 2021-2022**

**H.N.B. GARHWAL UNIVERSITY**  
**(A Central University)**  
**Srinagar – Garhwal**  
**Uttarakhand**

## DEPARTMENT OF HORTICULTURE

H.N.B. Garhwal University, Srinagar (Garhwal), Uttarakhand, India-246 174  
Course Curriculum for M. Sc. (Ag.) Horticulture, 2021-22

### Course offered

#### Core Courses

Course No.	Course Title	Credits
SOA/HC/PG 01	Plant Propagation and Nursery Management	3 (2-0-1)
SOA/HC/PG02	Advances in Orchard Management	3(2-0-1)
SOA/HC/PG03	Systematic Horticulture	3(2-0-1)
SOA/HC/PG04	Advances in Pomology: Tropical and Subtropical Fruits	3 (2-0-1)
SOA/HC/PG 05	Advances in Medicinal, Aromatic and Spices Crops	3 (2-0-1)
SOA/HC/PG 06	Statistical Methods and Experimental Designs	3 (2-0-1)
SOA/HC/PG 07	Advances in Temperate- Zone Pomology	3 (2-0-1)
SOA/HC/PG 08	Advances in Olericulture	3 (2-0-1)
SOA/HC/PG 09	Canopy Management in Fruits Crops	3 (2-0-1)
SOA/HC/PG 10	Biotechnology of Horticultural Crops	3(2-0-1)
SOA/HC/PG 11	Advances in Breeding of Fruits and Plantation Crops	3(2-0-1)
SOA/HC/PG 12	Biodiversity and Conservation of Horticultural Crops	3(2-0-1)
SOA/HC/PG 13	Advances in Post- Harvest Technology and Management of Fruits and Vegetables	3(2-0-1)
SOA/HC/PG 14	Protected Cultivation of Horticultural Crops	3 (2-0-1)
SOA/HC/PG 15	Advances in Floriculture and Landscaping	3(2-0-1)
SOA/HC/PG 16	Seminar	1 (0-0-1)
SOA/HC/PG 17	Thesis Research	12 (0-0-12)
	<b>Total</b>	<b>58(30-0-28)</b>

#### Elective Courses

Course No.	Course Title	Credits
SOA/HE/PG01	Growth and Development of Plants	3 (2-0-1)
SOA/HE/PG02	Advances in Breeding of Vegetable Crops	3(2-0-1)
SOA/HE/PG03	Dry Land Horticulture	3(2-0-1)
SOA/HE/PG04	Biotic and Abiotic Stress Management in Horticultural Crops	3 (2-0-1)
SOA/HE/PG05	Advances in Breeding of Ornamental Crops	3 (2-0-1)
SOA/HE/PG06	Organic Horticulture	3(2-0-1)
	<b>Total</b>	<b>18 (12-0-6)</b>

#### Self Study Courses

Course No.	Course Title	Credits
SOA/HS/PG01	Self Study Courses (Project Preparation and Presentation on Advances in Horticulture)	3
	<b>Total</b>	<b>3</b>

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**Course Curriculum for M. Sc. (Ag.) Horticulture, 2021-22**

### Course offered

Course no.	Paper Title	Total marks	Theory marks		Practical marks	Credits
			I	E		
<b>Semester I</b>						
<b>Core</b>						
SOA/HC/PG01	Plant Propagation and Nursery Management	100	80 (20	+ 60)	20	2+1
SOA/HC/PG02	Advances in Orchard Management	100	80 (20	+ 60)	20	2+1
SOA/HC/PG03	Systematic Horticulture	100	80 (20	+ 60)	20	2+1
SOA/HC/PG04	Advances in Pomology: Tropical and Subtropical Fruits	100	80 (20	+ 60)	20	2+1
SOA/HC/PG05	Advances in Medicinal, Aromatic and Spices Crops	100	80 (20	+ 60)	20	2+1
SOA/HC/PG06	Statistical Methods and Experimental Designs	100	80 (20	+ 60)	20	2+1
<b>Total</b>		<b>600</b>	<b>480(120</b>	<b>+ 360)</b>	<b>120</b>	<b>18 (12+6)</b>
<b>Semester II</b>						
<b>Core</b>						
SOA/HC/PG07	Advances in Temperate-Zone Pomology	100	80 (20	+ 60)	20	2+1
SOA/HC/PG08	Advances in Olericulture	100	80 (20	+ 60)	20	2+1
SOA/HC/PG09	Canopy Management in Fruits Crops	100	80 (20	+ 60)	20	2+1
SOA/HC/PG10	Biotechnology of Horticultural Crops	100	80 (20	+ 60)	20	2+1
SOA/HC/PG11	Advances in Breeding of Fruits and Plantation Crops	100	80 (20	+ 60)	20	2+1
SOA/HC/PG12	Biodiversity and Conservation of Horticultural Crops	100	80 (20	+ 60)	20	2+1
<b>Total</b>		<b>600</b>	<b>480 (120</b>	<b>+ 360)</b>	<b>120</b>	<b>18 (12+6)</b>

Course no.	Paper Title	Total marks	Theory marks		Practical marks	Credits
			I	E		
<b>Semester III</b>						
<b>Core</b>						
SOA/HC/PG13	Advances in Post- Harvest Technology and Management of Fruits and Vegetables	100	80 (20	+ 60)	20	2+1
SOA/HC/PG14	Protected Cultivation of Horticultural Crops	100	80 (20	+ 60)	20	2+1
SOA/HC/PG15	Advances in Floriculture and Landscaping	100	80 (20	+ 60)	20	2+1
<b>Elective</b>						
SOA/HE/PG01	Growth and Development of Plants	100	80 (20	+ 60)	20	2+1
SOA/HE/PG02	Advances in Breeding of Vegetable Crops	100	80 (20	+ 60)	20	2+1
SOA/HE/PG03	Dry Land Horticulture	100	80 (20	+ 60)	20	2+1
<b>Self Study Course</b>						
SOA/HS/PG01	Self Study Course	100	80 (20	+ 60)	20	03
<b>Total</b>		<b>600</b>	<b>480 ((120 + 360)</b>		<b>120</b>	<b>18 (12+6)</b>
<b>Semester IV</b>						
<b>Core</b>						
SOA/HC/PG16	Seminar	100	80 (20	+ 60)	20	0+1
SOA/HC/PG 17	Thesis	100	80 (20	+ 60)	20	0+12
<b>Elective</b>						
SOA/HE/PG04	Biotic and Abiotic Stress Management in Horticultural Crops	100	80 (20	+ 60)	20	2+1
SOA/HE/PG05	Advances in Breeding of Ornamental Crops	100	80 (20	+ 60)	20	2+1
SOA/HE/PG06	Organic Horticulture	100	80 (20	+ 60)	20	2+1
<b>Total</b>		<b>500</b>	<b>400 (100 + 300)</b>		<b>100</b>	<b>22 (6+16)</b>

I - Internal Assessment, E - External Assessment

**Summary of credits:**

Semester	Core	SSC	Elective	TOTAL
I	18	-	-	<b>18</b>
II	18	-	-	<b>18</b>
III	09	03	09	<b>18</b>
IV	13	-	09	<b>22</b>
<b>TOTAL</b>	<b>58</b>	<b>03</b>	<b>18</b>	<b>76</b>

**Note: Practicals in affiliated colleges/ institute shall be conducted by the university appointed examiner.**

## Syllabus for M.Sc.(Ag.) Horticulture 2021-22

Course No.	Course Title	Credits
SOA/HC/PG 01	Plant Propagation and Nursery Management	3(2+1)

### SOA/HC/PG 01: Plant Propagation and Nursery Management

Introduction, life cycle in plants, cellular basis for propagation, apomixis, polyembryony, germination process and environmental factors affecting it, quality of seeds, seed dormancy, treatments to facilitate germination, seed testing, diseases control during germination.

Clone and phase variation, genetic variation in asexually propagated plants, production and maintenance of pathogen free clones, cutting- anatomical, physiological and biochemical aspects of root initiation in cuttings, types of cuttings, use of bio-regulators, mist systems of rooting cuttings, planting and care, layering- principles and methods.

Reasons for grafting and budding, categories of root-stock, formation of graft and bud union, factors influencing the healing of graft union, limits of grafting, graft incompatibility, scion-stock relationship, techniques of grafting, budding and layering.

Micro propagation: Introduction, objectives, merits and demerits, facilities and equipments, aseptic techniques and use of antibiotics, media preparation, micro propagation techniques- clonal propagation, direct organogenesis, embryogenesis, meristem culture, micro grafting, hardening, packing and transport of micro-propagules.

Nursery Management: types of nursery, location, components planning and layout of a commercial nursery, structures, media mixtures, nursery management practices.

**Practicals-** Practice of grafting, budding, cutting and layering, anatomical studies of rooting of cuttings and grafting union, planning and layout for commercial nursery, sample seed testing, use of bio-regulators in propagation, sterilization of equipments and laboratory, media preparation, selection and preparation of explants, meristem culture and micro grafting, planning and layout of experiments on various aspects of propagation. Visit to tissue culture labs and nurseries.

#### Suggested Readings:

- ❖ Acquaah, G., Principles and practices of Horticulture.
- ❖ Bose, T.K., Mitra, S.K. and Sadhu, M.K., 1991. Propagation of Tropical and Subtropical Horticultural Crops. Naya Prokash.
- ❖ Hartmann, H.T. and Kester, D.E., 1989. Plant Propagation: Principles and Practices. Prentice Hall of India.
- ❖ Peter, K.V. 2008. Basic of Horticulture. New India Publ. Agency.
- ❖ Radha, T. and Mathew, L. 2007. Fruit Crops. New India Publ. Agency.
- ❖ Rajan, S. and Baby, L.M. 2007. Propagation of Horticultural Crops. New India Publ. Agency.
- ❖ Shanker, G. 1966. Practical Manual in Horticulture. Kitabistan Publication, Allahabad.
- ❖ Singh, S.P. 1989. Mist Propagation. Metropolitan Book Co.

Course No.	Course Title	Credits
SOA/HC/PG 02	Advances in Orchard Management	3(2+1)

### SOA/HC/PG 02: Advances in Orchard Management

Importance and scope of orchard management, constraint in fruit production, concept of high density planting.

Orchard soil management systems, water requirement of fruit trees, factors affecting water requirement, classification of soil moisture, effect of soil moisture on fruit trees, disorders due to excess and deficient moisture, various factors affecting moisture supply to plants, drip and sprinkler irrigation, fertigation, multistory cropping, drainage systems, organic manures, fertilizers and bio fertilizers, role of elements in fruit production, disorders due to excess and deficiency of elements, evaluating need for nutrients/tissue analysis; integrated nutrient management(INM),

Recent techniques of training and pruning, fruit thinning, splitting of fruits, pre-harvest fruit drop, rejuvenation of old orchards. Internal and external factors of unfruitfulness, practices to induce flowering; irregular bearing of fruit trees.

Hardiness, winter killing, injuries and their protection, IPM, protection from important insects and diseases.

**Practicals-** Study of different systems of layout, planting, study of drip and sprinkler irrigation, identification and control of important diseases and insects, soil and foliar application of fertilizers, study of deficiency symptoms of elements, practice of pruning and training, rejuvenation of old orchards, tissue analysis, physical practices to induce flowering, use of bio-regulators, cost of cultivation of an orchard, visit to important orchards and Fruit Research Stations.

**Suggested Reading:**

- ❖ Dhillon, W.S. and Bhatt. 2011. Fruit Tree Physiology. Narendra Publishing House, New Delhi.
- ❖ Kumar, 1990. Introduction to Horticulture Crops. Rajyalakshmi Publications, Nagercoil, Tamilnadu.
- ❖ Kumar, T.P. Suma, B. Bhaskar, J. and Satheson, K. N. 2008. Management of Horticultural Crops. New India Publishing Agency, New Delhi.
- ❖ Mazumdar, B.C. 2004. Orchard Irrigation and Soil Management Practices. Daya Publishing Agency, New Delhi.
- ❖ Mazumdar, B.C. 2004. Principles and Methods of Orchard Establishment. Daya Publishing House, New Delhi.
- ❖ Palaniappan, S. P. and Sivaraman, K. 1996. Cropping Systems in the Tropics. New Age International (P) Ltd., New Delhi.
- ❖ Shanmugavelu, K.G.1989. Production Technology of Fruit Crops. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

Course No.	Course Title	Credits
SOA/HC/PG 03	Systematic Horticulture	3(2+1)

**SOA/HC/PG 03: Systematic Horticulture**

Introduction, importance and scope, botanical terminology. Plant classification history and systems- artificial, natural and modern systems. Nomenclature: importance, binomial classification and its salient features.

Morphological description of (vegetative, floral and fruit features) of the following important families of fruits, vegetables and ornamental crops:-

Anacardiaceae- Mango, Cashewnut; Rutaceae- Citrus, Murrayas, Kamini; Musaceae- Banana; Myrtaceae- Guava, Bottle brush; Rosaceae- Apple, Pear, Plum, Peach, Apricot, Loquat, Rose; Apocyanaceae- Karonda, Kaner, Chandini; Vitaceae- Grapes; Sepindaceae- Litchi; Caricaceae-

Papaya; Brassicaceae- cauliflower, cabbage, Radish, Turnip; Cucurbitaceae- Cucurbits; Solanaceae- Brinjal, Tomato, Chillies, Potato, Rat-ki-rani; Leguminaceae- Peas, Beans, Kachnar, Ashok, Cassia; Malvaceae- Bhindi, Hibiscus; Euphorbiaceae- Achalipha, Poinsettia, Croton; Nyctaginaceae- Bougainvillea; Rubiaceae- Hamelia, Mussanda, Ixoraparviflora; Rhamnaceae- Ber; Amaryllidaceae- Onion, Garlic.

**Practicals-** Identification and botanical description (vegetative and floral features) of available fruits, vegetables and ornamental plants.

**Suggested Reading:**

- ❖ Bhattacharyya, B. 2009. Systematic Botany. Alpha Science International Ltd.
- ❖ Pandey, B.P. 2010. Botany for Degree Students. S. Chand & Company Ltd, New Delhi-110055.
- ❖ Pandey, B.P. 2010. Modern Practical Botany. Chand & Company Ltd, New Delhi-110055.
- ❖ Ponnuswami, V., Padmadevi, K. and Muthu, S. K. 2012. Botany of Horticultural Crops. Narendra Publishing House, Delhi-110006.
- ❖ Singh, G. 2004. Plant Systematics: An Integrated Approach. Science Publishers.
- ❖ Spichiger, R.E., Savolainen, V., Figeat, M. and Jeanmond, D. 2004. Systematic Botany of Flowering Plants, 2<sup>nd</sup> Edition. Enfield, New Hampshire Science Publishers.

Course No.	Course Title	Credits
SOA/HC/PG 04	Advances in Pomology: Tropical and Subtropical Fruits	3(2+1)

**SOA/HC/PG 04: Advances in Pomology: Tropical and Subtropical Fruits**

Introduction, prospects and scope, constraints of fruit industry.

Origin and distribution, area and production, taxonomy, classification and description of important cultivars, nutrition, bearing habit, pollination and fruit set, use of bio-regulators, special problems and physiological disorders in the production of the following fruits:

Tropical and subtropical fruits- Mango, Citrus fruits, Banana, Guava, Grape, Litchi, Papaya, Pineapple, Jack-fruit.

Minor fruits- Ber, Aonla, Pomegranate, Loquat, Sapota, Phalsa, Bael, Karonda,

**Practicals-** Identification and morphological features of important cultivars of fruit, effect of bio-regulators, practice of commercial propagation techniques, moisture conservation techniques, pollen germination, study of mango malformation, guava wilt, citrus decline, blossom biological studies, visit to Fruit Research Centers.

**Suggested Readings:**

- ❖ Bose, T.K., Mitra S.K. and Sanyal, D. 2001. Fruits- Tropical and Subtropical. Naya Udyog.
- ❖ Bose, T.K., Mitra, S.K. and Sanyal, D. 2002. Fruits of India-Tropical and sub-Tropical. Naya Udyog.
- ❖ Chadha, K.L. and Pareek, O.P. 1996. Advances in Horticulture(Vols. III). Malhotra Publ. House.
- ❖ Nakasone, H.Y. and Puul, R.E. 1998. Tropical Fruits. CABI.
- ❖ Peter, K.V. 2008. Basic of Horticulture. New India Publ. Agency.
- ❖ Pradeep K.T., Suma B. J. and Satheesan, K.N. 2008. Management of Horticultural Crops (Parts I & II). New India Publ. Agency.
- ❖ Radha, T. and Mathew, L. 2007. Fruit Crops. New India Publ. Agency.
- ❖ Singh, H.P., Negi, J.P. and Samuel, J.C. 2002. Approaches for Sustainable Development of Horticulture. National Horticultural Board.

- ❖ Singh, H.P., Singh, G., Samuel, J.C. and Pathak, R.K. 2003. Precision Farming in Horticulture NCPAH, DAC/ PFDC, CISH, Lucknow.

Course No.	Course Title	Credits
SOA/HC/PG 05	Advances in Medicinal, Aromatic and Spices Crops	2(1+1)

### **SOA/HC/PG 05: Advances in Medicinal, Aromatic and Spices Crops**

Introduction, prospectus and scope, opportunities and constraints in the cultivation and maintenance of medicinal, aromatic and spices in India.

Origin and distribution, area and production, taxonomy, classification and description of cultivars, use of bio-regulators, seed production, specific problems and physiological disorders of the following:

Medicinal Plants: Withania, periwinkle, Rauwolfia, Dioscorea, Isabgol, opium poppy, Belladonna, Cinchona, Pyrethrum and other species relevant to local conditions.

Aromatic Plants: Citronella grass, khus grass, flag (baje), lavender, geranium, patchouli, mentha, occimum and other species relevant to the local conditions.

Spices crops: Pepper, cardamom, ginger, turmeric, clove, nutmeg, cinnamon, coriander, fenugreek, and other species relevant to local conditions.

**Practicals**-Identification and morphological features of medicinal, aromatic and spices, seed production techniques, study of disorders, use of bio-regulators, basal and foliar application of nutrients, cost of cultivation, experimental trials, visit to processing units.

### **Suggested Readings:**

- ❖ Atal, C.K. and Kapur, B.M. 1982. Cultivation and Utilization of Aromatic Plants. RRL, CSIR, Jammu.
- ❖ Brown, P., Green, E.G., Robbins, G.Z., London, S.R.J. and Longman, 1981. Spices Vol. I & II. Longman Group Ltd.
- ❖ Farooqui, A.A., Khan, M.M. and Vasundhara, M. 2001. Production Technology of Medicinal and Aromatic Crops. Natural Remedies Pvt, Ltd.
- ❖ Farooqui, A.A. and Sriram, A.H. 2000. Cultivation Practices for Medicinal and Aromatic Crops. Orient Longman Publ.
- ❖ Hota, D. 2007. Bio Active Medicinal plants. National Book Trust.
- ❖ Joseph. 2007. Aromatic Plants. New India Publ. Agency.
- ❖ Khan, I.A. and Khanum, A. 2007. Role of Bio Technology in Medicinal and Aromatic plants. Vol. XV. Ukaaz Publ.
- ❖ Kumar, N. 2017. Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants. Medtech
- ❖ Kumar, N.J.B.M., Khaddar, M. A., Ranga, S.P. and Irulappan, I. 1997. Introduction to Spices, Plantation Crops, and aromatic crops. Oxford & IBH, New Delhi.
- ❖ Kurian, A. and Sankar, M. 2007. Medicinal Plants. Horticulture Science Series, New India Publ. Agency.
- ❖ Panda, H. 2002. Medicinal Plants Cultivation and Their Uses. Asia Pacific Business Press.
- ❖ Prajapati, S.S., Paero, H., Sharma, A.K. and Kumar, T. 2006. A Hand Book of Medicinal Plants. Agro Bios.



- ❖ Pruthi, J. S. 1980. Spices and Condiments. Academic Press, New York.
- ❖ Pruthi, J. S. 1993. Major Spices of India- Crop Management Postharvest Technology. ICAR, New Delhi.
- ❖ Pruthi, J. S. 2001. Minor Spices and Condiments-Crop Management Post Harvest Technology. ICAR, New Delhi.
- ❖ Ramawat, K.G. and Merillon, J.M. 2003. Bio Technology-Secondary Metabolites. Oxford and IBH.
- ❖ Shanmugavelu, K. G. and Madhava, R. 1977. Spices and Plantation Crops. Madras Popular Book Depot.
- ❖ Shanmugavelu, K.G., Kumar, N and Peter, K.V. 2005. Production Technology of Spices and Plantation Crops. Agrosis, Jodhpur.

Course No.	Course Title	Credits
SOA/HC/PG 06	Statistical Methods and Experimental Designs	3(2+1)

### **SOA/HC/PG 06: Statistical Methods and Experimental Designs**

Sampling theory- introduction, simple random sampling, estimates of sampling variance, stratified random sampling, two stage sampling, systematic sampling, estimate of proportions.

Test of hypothesis- introduction, one sample t-test and two sample t- test. Chi-square test-properties, testing significance of properties, testing independence of tributes Bartlett test, (F-Test).

Correlation- coefficient of correlation, test of significant, Fisher's Z- transformation, rank correlation, intra-class correlation. Regression- regression curve, fitting of line regression.

Need for an experiments, designing of an experiment, experimental error, principles of experimental design, analysis of designed experiments- analysis of variance, mathematical details, assumptions, transformation and ANOVA table, pair-wise comparisons and specific comparisons of treatments.

Completely randomized design- layout, application, merits and demerits, analysis of equal and unequal observations. Randomized block design- layout, application, merits and demerits, analysis, efficiency of blocking. Latin square design- layout, application, merits and demerits, analysis, change over design. Analysis of covariance for reduction of experimental error in CRD, RBD and L. S. designs. Split plot and related designs layout, application, merits and demerits, analysis, efficiency, variants of split plot design, strip plot design. Factorial experiments- concept of factorial treatments, definition of main effects and interrelations, analysis of series using Yates method.

**Practicals-** Practicals based on above topics.

### **Suggested Reading:**

- ❖ Gupta, S. C. and Kapoor, V. K. 2014. Fundamentals of Mathematical Statistics. Sultan Chand and Sons, New Delhi
- ❖ Nageswara Rao, G. 2007. *Statistics for Agricultural Sciences*. B.S. Publications, Hyderabad.
- ❖ Panse, V. G. and Sukhatme, P. V. 1961. Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research.
- ❖ Rangaswamy, R. 1995. *A Text Book of Agricultural Statistics*. New Age International Publishing Limited, Hyderabad.

- ❖ S.R.S. Chandel. 2007. A Handbook of Agricultural Statistics. AnchalPrakashanMadir, Kanpur-208005.
- ❖ Snedecor, G. W. and Cochran, W.G. 1989. Statistical Methods 8th Edition. Iowa State University Press.

Course No.	Course Title	Credits
SOA/HC/PG07	Advances in Temperate-Zone Pomology	3(2+1)

### **SOA/HC/PG 07: Advances in Temperate-Zone Pomology**

Introduction, scope, area and production, temperate regions, contour planting, rest period and chilling requirement.

Origin and distribution, area and production, taxonomy, classification and description of important cultivars, clonal rootstocks, training techniques, bearing habit, pollination and fruit set, use of bio-regulators, special problems and physiological disorders of the following fruits:

Pome Fruits- Apple and Pear

Stone Fruits- Peach, Plum, Apricot, Cherry and Almond

Nut Fruits- Walnut, Pecannut, Hazelnut and Pistachio etc.

Berries- Strawberry, Raspberry, Gooseberry, Kiwi fruit

Exposure to wild fruits of Uttarakhand hills.

**Practicals-** Identification and morphological features of temperate fruits, practice of contour planting, commercial propagation methods, pollen collection and germination, pruning and training, use of bio-regulators, visit to Temperate Fruit Research Stations.

#### **Suggested Reading:**

- ❖ Bose, T.K., Mitra, S.K. and Sanyol, D. 2002. Temperate Fruits. Naya Udyog.
- ❖ Chadha, K.L. and Pareek, O.P., 1996. Advance in Horticulture(Vol. II & VIII) Malhotra Publ. House.
- ❖ Crombie, E. 2016. Textbook of Pomology. Syrawood Publishing House.
- ❖ Misra, K.K. 2014. Textbook of Advance Pomology. Biotech
- ❖ Radha, T. and Mathew, L. 2007. Fruit Crops. New India publ. Agency.
- ❖ Westwood, M. N. 1988. Temperate-zone Pomology. Timber Press.
- ❖ Westwood,M.N. 2009. Temperate-Zone Pomology: Physiology and Culture, Third Edition. Timber Press.

Course No.	Course Title	Credits
SOA/HC/PG 08	Advances in Olericulture	3(2+1)

### **SOA/HC/PG 08: Advances in Olericulture**

Introduction, types of vegetable farming, vegetable forcing, bio-regulators in vegetable production, principles of vegetable seed production.

Origin and distribution, area and production, taxonomy, classification and description of cultivars, use of bio-regulators, seed production, specific problems and physiological disorders of the following vegetables:

Solanaceous Vegetables- Potato, Tomato, Brinjal, Chilli, Capsicum

Root Vegetables- Radish, Turnip, Carrot

Cole Vegetables- Cauliflower, Cabbage, Knol-khol

Legume Vegetables- Peas and French bean

Bulb Vegetables- Onion, Garlic

Cucurbits- Cucumber, Water melon, Bottle gourd, Sponge gourd, Musk melon, Pumpkin

Leafy Vegetables- Spinach, Amaranthus

Okra and Sweet Potato

**Practicals-** Identification and morphological features of vegetables, seed production techniques, study of disorders, use of bio-regulators, basal and foliar application of nutrients, cost of vegetable cultivation, experimental trials, visit to vegetable seed production centers and processing units.

**Suggested Reading:**

- ❖ Bose, T.K. and Som, M.G. 1986. Vegetables Crops in India. Naya Prokash.
- ❖ Bose, T.K., Kabir, J., Maity, T.K., Parthasarathy, V.A. and Som, M.G. 2003. Vegetables Crops (Vols. I to III). Naya Udyog.
- ❖ Bose, T.K., Som, M.G. and Kabir, J. 2002. Vegetables Crops in India. Naya Prokash.
- ❖ Chadha, K.L. 2002. Hand Book of Horticulture. ICAR, New Delhi.
- ❖ Chadha, K.L. and Kalloo, G. 1994. Advances in Horticulture (Vol. V to X). Malhotra Publ. House.
- ❖ Chauhan, D.V.S. 1986. Vegetable Production in India. Ram Prasad and Sons.
- ❖ Decoteau, D.R. 2000. Vegetable Crops. Prentice Hall.
- ❖ Edmond, J.B., Musser, A.M. and Andrews, F.S. 1951. Fundamentals of Horticulture. Blakiston Co.
- ❖ Fageria, M.S., Choudhary, B.R. and Dhaka, R.S. 2000. Vegetable Crops: Production Technology (Vol. II). Kalyani Publishers.
- ❖ Gopalakrishanan, T.R. 2007. Vegetable Crops. New India Publ. Agency.
- ❖ Hazra, P. and Som, M.G. 1999. Technology for Vegetable Production and Improvement. Naya Prokash.
- ❖ Rabatzky, V.E. and Yamaguchi, M. 1997. World Vegetable: Principal, Production and Nutritive Values. Chapman and Hall.
- ❖ Rana, M.K. 2008. Olericulture in India. Kalyani Publication.
- ❖ Rana, M.K. 2008. Scientific Cultivation of Vegetables. Kalyani Publication
- ❖ Saini, G.S. 2001. A Text Book of Olericulture and Floriculture. Aman Publication House.
- ❖ Salunkhe, D.K. and Kadam, S.S. 1998. Hand Book of Vegetables Science and Technology Production, Composition, Storage and processing. Marcel Dekker.
- ❖ Shanmugavelu, K.G. 1989. Production Technology of Vegetable Crops. Oxford and IBH.
- ❖ Singh, D.K. 2007. Modern Vegetable Varieties and Production Technology. International Book Distributing Co.
- ❖ Singh, S.P.1989. Production Technology of Vegetable Crops. Agri. Comm. Res. Centre.
- ❖ Thamburaj, S. and Singh, N. 2004. Vegetables, Tuber Crops and Spices. ICAR.
- ❖ Thompson, H.C. and Kelly, W.C.1978. Vegetables Crops. Tata McGraw-Hill.

Course No.	Course Title	Credits
SOA/HC/PG 09	Canopy Management in Fruits Crops	3(2+1)

### **SOA/HC/PG 09: Canopy Management in Fruits Crops**

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

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

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

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

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

**Practicals-**Study of different types of canopies, training of plants for different canopy types, canopy development through pruning, use of plant growth inhibitors, geometry of planting; study on effect of different canopy types on production and quality of fruits.

#### **Suggested Reading:**

- ❖ Cadha, K.L. and Shikhamany, S.D. 1999. The Grape, Improvement, Production and Post Harvest Management. Malhotra Publication House.
- ❖ Pradeepkumar T., Suma B., Jyothibhaskar and Satheesan, K.N. 2008. Management of Horticultural Crops. New India Publishing Agency.
- ❖ Singh, G. 2010. Practical Manual on Canopy Management in Fruit Crops. Department of Agriculture & Co. Ministry of Agriculture, Government of India.
- ❖ Srivastava, K.K. 2007. Canopy Management of Fruit Crops. International Book Distributing Co.

Course No.	Course Title	Credits
SOA/HC/PG10	Biotechnology of Horticultural Crops	3(2+1)

### **SOA/HC/PG 10: Biotechnology of Horticultural Crops**

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

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

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

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

Construction and identification of somatic hybrids and cybrids, wide hybridization, in vitro pollination and fertilization, haploids, in vitro mutation, artificial seeds, cryopreservation, rapid

clonal propagation, genetic engineering in horticulture crops, use of molecular markers. In vitro selection for biotic and abiotic stress, achievements of biotechnology in horticultural crops.

**Practicals-** An exposure to low cost, commercial and homestead tissue culture laboratories, media preparation, inoculation of explants for clonal propagation, callus induction and culture, regeneration of plantlets from callus, sub-culturing, techniques on anther, ovule, embryo culture, somaclonal variation, in vitro mutant selection against abiotic stress, protoplast culture, fusion technique, development of protocols for mass multiplication, project development for establishment of commercial tissue culture laboratory.

### Suggested Readings

- ❖ Bajaj, Y.P.S. 1989. Biotechnology in Agriculture and Forestry (Vol. V) Fruits. Springer.
- ❖ Brown, T.A. 2001. Gene Cloning and DNA Analysis and Introduction. Blackwell Publ.
- ❖ Chopra, V.L. and Nasim, A. 1990. Genetic Engineering and Biotechnology-Concepts, Methods and Applications. Oxford and IBH.
- ❖ Gorden, H and Rubsell, S. 1960. Hormones and Cell Culture. AB Book Publ.
- ❖ Keshavachandran, R and Peter, K.V. 2008. Plant Biotechnology: Tissue Culture and Gene Transfer. Orient and Longman (Universal Press).
- ❖ Keshavachandran, R., Nazeem, P.A., Girija, D., John, P.S. and Peter, K.V. 2007. Recent Trends in Biotechnology of Horticultural Crops (Vols. I & II). New India Publ. Agency.
- ❖ Parthasarathy, V.A., Bose, T.K., Deka, P.C., Das, P., Mitra, S.K. and Mohandas, S. 2001. Biotechnology of Horticultural Crops (Vols. I to III). Naya Prokash.
- ❖ Pierik, R.L.M. 1987. In vitro Culture of Higher Plants. MartinusNijhoff Publ.
- ❖ Skoog, F. and Miller, C.O. 1957. Chemical Regulation of Growth and Formation in Plant Tissue Culture in vitro. Symp. Soc. Exp. Biol. 11:118-131.
- ❖ Vasil, T.K., Vasi, M., While, D.N.R. and Bery, H.R. 1979. Somatic Hybridization and Genetic Manipulation in Plants: Plants Regulation and World Agricultural. Planum Press.
- ❖ Williamson, R. 1981-86. Genetic Engineering (Vol. I to V). Academic Press.

Course No.	Course Title	Credits
SOA/HC/PG 11	Advances in Breeding of Fruits and Plantation Crops	3(2+1)

### SOA/HC/PG 11: Advances in Breeding of Fruits and Plantation Crops

Importance, objectives of fruit breeding; principles, prospects and problems, methods of improvement- introductions, clonal selection, hybridization, mutation, polyploidy, heterosis and back cross.

Centre of diversity, germplasm resource, breeding objectives, early development, inheritance of characters, problems and advances made in the following fruits and plantation crops:

Fruits- Mango, Citrus fruits, Jackfruit, Grape, Apricot, Apple, Cherry, Banana, Litchi, Peach, Almond, Papaya, Guava, Aonla, Pomegranate, Plum and Strawberry.

Plantation crops- Tea, Coffee, Coconut, Arecanut, Cocoa, Rubber and Cashewnut

**Practicals-** Studies on floral biology, practice of pollination procedures, hybridization, and use of mutagens.

### Suggested Reading:

- ❖ Bose, T.K., Mitra, S.K. and Sanyol, D. 2002. Fruits of India: Tropical and Sub- Tropical 3<sup>rd</sup> Ed. Naya Udyog.
- ❖ Chadha, K.L. and Pareek, O.P. 1996. Advances in Horticulture (Vol. I.) Malhotra Publ.

House.

- ❖ Kumar, N. 1997. Breeding of Horticultural Crops: Principles and Practices. New India Publishing Agency, New Delhi.
- ❖ Nijar. 1985. Fruit Breeding in India. Oxford & IBH Publishing Co. New Delhi.
- ❖ Shukla, A.K. 2004. Fruit Breeding Approaches & Achievements. International Book Distributing Co. New Delhi.
- ❖ Singh, B.D. 1983. Plant Breeding Principles and Methods. Kalyani Publishers, New Delhi.

Course No.	Course Title	Credits
SOA/HC/PG 12	Biodiversity and Conservation of Horticultural Crops	3(2+1)

### **SOA/HC/PG 12: Biodiversity and Conservation of Horticultural Crops**

Biodiversity and conservation; issues and goals, primary and secondary centers of genetic diversity; centers of origin of cultivated horticultural crops. Present status of gene centers; exploration and collection of germplasm; conservation of genetic resources; *in situ* and *ex situ* conservation.

Inventory of germplasm, GIS and documentation of local biodiversity, introduction of germplasm, detection of genetic constitution of germplasm and maintenance of core group. Plant quarantine.

Germplasm Conservation- cryopreservation, problem of recalcitrance, cold storage of scions, tissue culture, pollen and seed storage.

Intellectual property rights with focus on Geographical indication with reference to available germplasm of horticultural crops of the region. Regulatory horticulture.

#### **Crops**

Fruits and plantation crops- Mango, Citrus, Guava, Banana, Papaya, Grapes, Aonla, Apple, Pear, Peach, Plum, Litchi, Nuts, Coffee, Tea, Rubber, Cashew, Coconut.

Vegetable crops- Potato, Tomato, Brinjal, Radish, Carrot, Cauliflower, Cabbage, Peas, French bean, Onion, Cucurbits and okra

Ornamental Plants- Rose, Marigold, Jasmine, Chrysanthemum, Bougainvillea, Carnation, Dahlia, Gerbera, gladiolus and orchids.

**Practicals-** Morphological evaluation of germplasm, collections and identification of wild relatives for fruit crops, vegetable crops, flower crops; spices, plantation crops, medicinal and aromatic plants. 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, visits to National Gene Bank and other centres of PGR activities. Detection of genetic constitution of germplasm, core sampling, germplasm characterization using molecular techniques.

#### **Suggested Reading:**

- ❖ Dhillon, B.S., Tyagi, R.K., Saxena, S. and Randhawa, G.J. 2005. Plant Genetic Resources: Horticulture Crops. Narosa Publishing House.
- ❖ Frankel, O.H. and Hawkes, J.G. 1975. Crop Genetic Resources for Today and Tomorrow. Cambridge University Press. U.K.
- ❖ Peter, K.V. 2008. Biodiversity of Horticultural Crops (Vol. 2). Daya Publ. House.
- ❖ Peter, K.V. 2013. Biodiversity in Horticultural Crops (Vol. 4). Daya Publ. House.
- ❖ Peter, K.V. 2017. Biodiversity in Horticultural Crops (Vol. 5). Daya Publ. House.
- ❖ Peter, K.V. and Abraham, Z. 2007. Biodiversity in Horticultural Crops (Vol. I). Daya Publ. House.

- ❖ Singh, A., Trevedi, P.C. and Singh, B.P. 2016. Plant Genetic Resources: An overview. Aavishkar Publisher.
- ❖ Singh, D. and Manivannan, S. 2009. Genetic Resources of Horticultural Crops. International Book Distributing Co.

Course No.	Course Title	Credits
SOA/HC/PG 13	Advances in Post- Harvest Technology and Management of Fruits and Vegetables	3(2+1)

### **SOA/HC/PG 13: Advances in Post- Harvest Technology and Management of Fruits and Vegetables**

Introduction, post harvest physico-biochemical changes; causes of post harvest losses, control of post harvest losses- proper cultural operations, pre-storage treatments, transportation, storage, environmental control, ionizing radiation, post harvest chemical treatments, storage of fresh fruits and vegetables, factor affecting storage quality, storage disorders, marketing of fruits and vegetables and their products.

History, objectives and scope of fruit and vegetable preservation, spoilage of fruits and vegetables, principles of preservation- temporary and permanent; vitamins and other nutrients in preserved products, food additives and their use in preservation. Principles and guidelines for establishing processing unit.

Containers: Types, merits and demerits, composition and manufacturing of tin and glass containers, failures in glass containers, general principles and procedures of canning and bottling, spoilage of canned products.

Principles and methods of jam, jelly and marmalade; theories of jelly formation, failures of jelly; unfermented fruit and vegetable beverages, juice extraction equipments, general methods of preparation and preservation, preservation of unfermented beverages.

General methods of making preserve and candy from some suitable fruits and vegetables, preparation of pickles, chutneys, sauces, ketchup, soup and cocktail from suitable fruits and vegetables, causes of spoilage.

Vinegar- quality standards, types, material processing and fermentation, methods of preparation, post-production processes, spoilage; pectin preparation.

Sun drying- merits and demerits, procedure; mechanical dehydration of fruits and vegetables, home and commercial dehydrators, packing and storage.

Preservation by freezing- objectives, freezing and growth of micro-organisms, freezing process, storage of frozen products; exposure on preservation by radiation.

Government policies, regulation and specifications for fresh and processed products.

**Practicals-** Identification of equipments used in preservation, canning of fruits and vegetables, cut out test for canned products, preparation of jam, jelly, squash, juice, preserve, chutney, ketchup, sauce, pickle; dehydration of potato, estimation of acidity, vitamin C, sugar, juice content and T.S.S., visit to processing factories.

### Suggested Reading:

- ❖ Battacharjee, S. K. and De, L. C. 2005. Post Harvest Technology of Flowers and Ornamentals Plants. Ponteer Publisher, Jaipur, India.
- ❖ Chadha, K. L. and Kalloo, G.1993. Advances in Horticulture (Vol. 4 to 10). MPH, New Delhi.
- ❖ Fellows, P. J. 1998. Food Processing Technology: Principles and Practices. Ellis Horwood.
- ❖ Hulme, A.C. 1970. Food Science & Technology- A Series of Monograph: The Biochemistry of Fruits and their Products (Vol. 1). Academic Press London & New York.
- ❖ Jacob, J. P. 2008. A Handbook on Post Harvest Management of Fruits and Vegetables. Daya Publishing House, Delhi.
- ❖ Kitinoja, L. and Kader, A. A. 2003. Small-Scale Postharvest Handling practice: A Manual for Horticulture Crops (4th ed.). US Davis, PHT Research and information Center.
- ❖ Mitra, S. K. 1997. Post Harvest Physiology and Storage of Tropical and Sub-tropical Fruits. CAB International.
- ❖ Pruthi, J. S. 2001. Minor Spices and Condiments – Crop Managements and Post Harvest Technology. ICAR, New Delhi.
- ❖ Ranganna, S. 2017. Handbook of Analysis and Quality Control for Fruit and Vegetable Products (2nd Edt.). McGraw Hill Education.
- ❖ Saraswathy, S. 2008. Post harvest Management of Horticultural Crops. Agribios(India).
- ❖ Shanmugavelu, K. G., Kumar, N. and Peter, K.V. 2002. Production Technology of Spices and Plantation Crops. Agrobios (India).
- ❖ Sharma, N. and Mashkoo, A. M. 1998. Post Harvest Diseases of HorticulturalPerishables. International Book Distributing Co., Lucknow.
- ❖ Srivastava,R.P. and Sanjeev, K. 2017. Fruit and Vegetable Preservation: Principles and Practices. CBS Publishers & Distributors.
- ❖ Stanley, J. K. 1998. Post Harvest Physiology of Perishable Plant Products. CBS, New Delhi.
- ❖ Thomposon, A. K. 1996. Post Harvest Technology of Fruits and Vegetables. Blackwell Science.
- ❖ Verma, L. R. and Joshi, V. K. 2000. Post Harvest Technology of Fruits and Vegetables (Vol. I & II). Indus Publishing Co., New Delhi
- ❖ Wiils, M. G. and Graham, J. 2007. Post Harvest- An Introduction to the Physiology and Handling of Fruits, Vegetables and ornamentals. Cab International

Course No.	Course Title	Credits
SOA/HC/PG 14	Protected Cultivation of Horticultural Crops	3(2+1)

### SOA/HC/PG 14: Protected Cultivation of Horticultural Crops

Introduction, history, present status, importance, problems and prospects of protected cultivation. Types and designs of protected structures and their management. Environment control in protected structures. Growing media and sterilization. Soilless cultivation, hydro ponics and aeroponics. Irrigation and fertigation. Integrated insect pest and disease management

Vegetable seedlings production under protection. Protected cultivation of crops (media, bed preparation, varieties, planting, irrigation and fertigation, harvesting, specific operation for different crops and economics) rose, carnation, gerbera, orchids, anthurium. liliun, chrysanthemum, capsicum, tomatoes, exotic vegetables, potted ornamental plants.



Post harvest management of flowers and vegetable (sorting, grading, packing, storage, transportation and marketing).

**Practicals-** Study of different protected structures, cladding materials used, installation and their management. Study of environment control devices used in protected structures and measurement of temperature, RH, light and CO<sub>2</sub>. Study of growing media and sterilization. Study of irrigation and fertigation system and their management. Soilless cultivation. Hydroponics and aeroponics. Vegetable seedlings production under protection. Cultivation of Crops under protected environment: Rose, Carnation. Gerbera, Orchid and Anthurium, Liliun and chrysanthemum, Capsicum, Tomatoes, Exotic vegetables. Post harvest management of flowers and vegetable. Study of insect pests and diseases and their control. Visit to commercial green house projects.

**Suggested Reading:**

- ❖ Aldrich, R.A. and Bartok, J.W. 1994. Green House Engineering. Cornell University, Ithaca, New York.
- ❖ Bose, T.K. and Yadav, L.P. 1989. Commercial Flowers. Naya prokash.
- ❖ Castilla, N. 2012. Greenhouse Technology and Management (2nd Edt.). CABI.
- ❖ Kumar, T. P., Suma, B., Bhaskar, J. and Satheson, K.N. 2008. Management of Horticultural Crops. New India Publishing Agency, New Delhi.
- ❖ Nelson, P.V. 1978. Green House Operation and Management. Reston Publ. Co.
- ❖ Nelson, P.V. 1991. Green House Operation and Management. Bali Publ.
- ❖ Parvatha, R.P. 2003. Protected Cultivation. Springer Publications, USA.
- ❖ Parvatha, R.P. 2011. Sustainable Crop Protection Under Protected Cultivation. Springer Publications, USA.
- ❖ Prasad, S. 2005. Greenhouse Management for Horticultural Crops. Agrobios, Jodhpur.
- ❖ Singh, B. 2006. Protected Cultivation of Vegetable Crops. Kalyani Publishers, Ludhiana.
- ❖ Singh, B. 2014. Advances in Protected Cultivation. New India Publishing Agency, New Delhi.

Course No.	Course Title	Credits
SOA/HC/PG15	Advances in Floriculture and Landscaping	3(2+1)

**SOA/HC/PG 15: Advances in Floriculture and Landscaping**

History, importance and scope, problems and prospects, styles of gardening, formal garden and its important parts.

Landscaping- general principles, planning and designing, important elements, landscaping public buildings, educational institutions, factories, historical places.

Bio-aesthetic planning, bonsai culture, flower forcing, role of colour in floriculture, exhibition, post harvest management.

Origin and distribution, area and production, taxonomy and morphological features, classification and description of some important cultivars, propagation, special practices and problems, use of bio-regulators:

Rose, Gladious, Carnation, Tuberose, Marigold, Gerbera, Chrysanthemum, Dahlia,  
Baugainvillea, Jaismines

**Practicals-** Identification of ornamental species, preparation of bonsai, use of bio-regulators,

judging, practice to conserve the life of cut flowers, morphological features of some ornamental plants, wintering in roses, preparation of shrubbery and herbaceous borders, propagation techniques, planning and layout for a garden, cost of cultivation of commercial flowers, visit to Ornamental Gardens.

### Suggested Readings

- ❖ Arora, J.S. 2006. Introductory Ornamental Horticulture. Kalyani Publishers, Ludhiana.
- ❖ Bhattacharjee, S.K. 2006. Advances in Ornamental Horticulture (Vol. 1 to 6). Pointer Publication.
- ❖ Bhattacharjee, S.K. and De, L.C. 2003. Advanced Commercial Floriculture. Aavishkar Publishers, Jaipur.
- ❖ Bose, T. K., Yadav, L. P., Patil, P., Das, P. and Sarthy, V. A. P. 2003. Commercial Flowers. Naya Udyog.
- ❖ Bose, T.K., Maiti, R.G., Dhua, R.S. and Das, P. 1999. Floriculture and Landscaping. Naya Prokash.
- ❖ Choudhary, D. and Mehta, A. 2010. Flower Crops Cultivation and Management. Oxford Book Company, Jaipur.
- ❖ Kumari, V. 2008. Floriculture in India. Publ. Agency.
- ❖ Laurie, A. and Victor, H.R. 2001. Floriculture-: Fundamentals and Practices. Agorbios.
- ❖ Nambisan, K.M.P. 1992. Design Elements of Landscape Gardening. Oxford and IBH.
- ❖ Randhawa, G.S. and Mukhopadhyay, A. 2004. Floriculture in India. Allied Publishers Pvt. Ltd.
- ❖ Sabina, G.T. and Peter, K.V. 2008. Ornamental Plants for Gardens. New India Publ. Agency.
- ❖ Sheela, V. L. 2008. Flower for Trade. New India Publishing Agency, New Delhi.
- ❖ Singh, K. 2006. Flower Crops, Cultivation and Management. New India publishing agency, New Delhi.
- ❖ Woodrow, M.G. 1999. Gardening in India. Biotech Books.

Course No.	Course Title	Credits
SOA/HE/PG01	Growth and Development of Plants	3(2+1)

### SOA/HE/PG 01: Growth and Development of Plants

Introduction- terminology, importance and scope, growth and its phases, growth curve, growth regions, environmental affecting growth, apical organization and meristems in growth, apical dominance. Seed germination, seed dormancy- types and causes, growth substances and seed dormancy, environmental controls, breaking dormancy; bud dormancy- hormonal control, morphological aspects; juvenility and vegetative growth

Study of Auxin, Gibberellins, Cytokinins, Ethylene, Inhibitors (ABA) under the following heads:

- (i) Origin and history (ii) Natural and synthetic forms (iii) Biosynthesis and chemical nature (iv) Extraction and identification (v) Mode of action (vi) Transport of growth regulators (vii) Functions or effects on plants.

Flower initiation and development: photo-periodism and its effects, florigen concept; vernalization-kinetics, response, types, vernalization stimulus, devernalization; physiology and chemical induction of flowering, sex expression and alteration; tuber, bulb and corm formation. Pollination and fruit-set, growth and development of fruits, parthenocarpy and seedlessness, maturity and ripening. Climacteric and non-climacteric fruits.

Senescence- chemical changes, causes, plant and organ senescence, regulating system in

senescence; abscissions. Tropism: phototropism and geotropism.

**Practicals-** Study of growth and its measurements, preparation and mode of application of bio-regulator solutions, effect of bio-regulators on morphological and anatomical changes in plants, growth regulators in fruit set and development, bio-regulators in breaking dormancy, induction of parthenocarpic fruits, fruit ripening, bioassays.

**Suggested Reading:**

- ❖ Acquaah, G. 2013. Principles and Practices of Horticulture. PHI Learning Pvt. Ltd., New Delhi.
- ❖ Basra, A. S. 2004. Plant Growth Regulators in Agriculture & Horticulture. Hawarth Press, New York.
- ❖ Basra, A.S. 2016. Plant Growth Regulators in Agriculture and Horticulture: Their Role & Commercial Uses. CRC Press.
- ❖ Bleasdale, J.K.A. 1983. Plant Physiology in Relation to Horticulture. Avi Publishing Co. Inc.
- ❖ Delvin, R. M. 1986. Plant Physiology. CBS, Delhi.
- ❖ Durna, E. E. 2014. Principles of Horticultural Physiology. CABI, UK.
- ❖ Jacobs, W. P. 1979. Plant Hormones and Plant Development. Cambridge Univ. London.
- ❖ Noggle, G.R and Fritz, T.G. 1944. Introductory Plant Physiology. Prentice Hall India Pvt. Ltd., New Delhi.
- ❖ Pandey, S.N. and Sinha, B.K. 2005. Plant Physiology. Vikas Publication House Pvt. Ltd.
- ❖ Rajendran, C., Ramamoorthy, K. and Hepziba, S. J. 2009. Nutritional and Physiological Disorders in Crop Plants. Scientific Pub.
- ❖ Richard, N. A. 2004. Plant Growth Substances. CBS, New Delhi.
- ❖ Salisbury, F.B. and Rose, C.W. 2017. Plant Physiology. CBS publishers and Distributors, Delhi.
- ❖ Sandhu, M.K. 2014. Plant Propagation. New Age International Publishers, Lucknow.
- ❖ Srivastava, H.N. 2012. Plant Physiology. Pradeep publishing, Jalandhar.
- ❖ Taiz, L. 2010. Plant Physiology. Sinaur, USA.
- ❖ Taiz, L. and Zeiger, E. 2010. Plant Physiology (5th Edition). Sinaur Associates, Inc.
- ❖ Zeiger. 2003. Plant Physiology. Panima, New Delhi.

Course No.	Course Title	Credits
SOA/HE/PG02	Advances in Breeding of Vegetable Crops	3(2+1)

**SOA/HE/PG 02: Advances in Breeding of Vegetable Crops**

History, principles, problems and prospects of vegetable improvement. Biodiversity and conservation. Introduction, selection including clonal selection and hybridization, mutation breeding, polyploidy and heterosis breeding for specific purposes like productivity, resistance to biotic and abiotic stresses and processing. Recent advances in breeding including biotechnological approaches. Cytogenetics, breeding objectives, inheritance, early achievement and advances made in the following vegetables:

Solanaceous, cole crops, legumes, bulb crops, root vegetables, tuber crops, leafy vegetables and cucurbits.

**Practicals-** Floral biology, pollination mechanism, selfing and crossing procedures, hybridization

techniques working out phenotypic and genotypic variability, pcv, gcv heritability, genetic advance, preparation and use of chemicals and physical mutagens, polyploidy breeding, techniques of F<sub>1</sub> hybrid seed production, maintenance of breeding record.

**Suggested Reading:**

- ❖ Bassett, M. 1986. Breeding Vegetable Crops. Springer, US.
- ❖ Dhaliwal, M.S. 2009. Vegetable Seed Production & Hybrid Technology. Kalyani Publishers, Ludhiana.
- ❖ Dhaliwal, M.S. 2012. Techniques of Developing Hybrids in Vegetable Crops. Agrobios, Jodhpur.
- ❖ Kallo, G. 1998. Vegetable Breeding (Vol.I to IV). CRC Press, Florida.
- ❖ Kallo, G. and Bergh, B.O. 1993. Genetic Improvement of Vegetable Crops. Pergamon Press.
- ❖ Peter, K. V. 2009. Genetics and Breeding of Vegetables. Directorate of Information and Publications of Agriculture, ICAR.
- ❖ Ram, H.H. 2013. Vegetable Breeding: Principle and Practices. Kalyani Publishers, Ludhiana.
- ❖ Singh, H.P. 2009. Vegetable Varieties of India. Studium Press (India) Pvt Ltd., New Delhi.
- ❖ Singh, P.K. 2005. Hybrid Vegetable Development. CRC Press, Florida.
- ❖ Swaroop, V. 2014. Vegetable Science & Technology in India. Kalyani Publishers, Ludhiana.

Course No.	Course Title	Credits
SOA/HE/PG03	Dry Land Horticulture	3(2+1)

**SOA/HE/PG 03: Dry Land Horticulture**

Definition, importance and limitations of dry land horticulture, present status and future scope.

Constraints encountered in dry lands. Agro-climatic features in rain shadow areas, scarce water resources, high temperature, soil erosion, run-off losses etc.

Techniques of development and management of dry land horticulture. Watershed development. Soil and water conservation methods - terraces, contour bunds etc; methods of control and impounding of run offwater - farm ponds, trenches, macro catch pits etc; in-situ water harvesting methods – micro-catchments, different types of tree basins etc.

Methods of reducing evapo-transpiration - use of shelter belts, mulches, anti-transpirants, growth regulators etc. Water use efficiency - need-based, economic and conjunctive use of water, micro systems of irrigation etc.

Selection of plants/crops having drought resistance/ tolerance characteristics. Special techniques of planting and after care - use of seedling races, root stocks, in situ grafting, deep pitting/planting, canopy reduction etc.

**Practicals-** Study of rainfall patterns. Contour bunding/trenching, micro catchments, soil erosion and its control. Study of evapo-transpiration, mulches and micro irrigation systems. Special techniques of planting and after care in dry lands. Study of morphological and anatomical features of drought tolerant crops.

**Suggested reading:**

- ❖ Chundawat, B. S. 1990. Arid Fruit Culture. Oxford and IBH, New Delhi.
- ❖ Hiwale, S. 2015. Sustainable Horticulture in Semiarid Dry Lands. Springer India.

- ❖ Jatav, M. K., Saroj, P. L. and Sharma, B. D. 2019. Dryland Horticulture. New India Publishing Agency.
- ❖ Korwar, G. R. 1988. Dryland Horticulture. Central Research Institute for Dryland Agriculture.
- ❖ Kumar, T. P., Suma, B., Bhaskar, J. and Sathesan, K. N. 2008. Management of Horticultural Crops. New India Publishing Agency.
- ❖ Sivamurugan, A. P. and Kumar, R. A. 2008. Dryland Horticulture. Kalyani Publishers.
- ❖ Sontakke, M.B. 2016. Production and Management of Fruit Crops in Arid/Dry Lands. Agrotech Publishing Academy.
- ❖ Taroj, P. L., Taroj, B. B. and Dhandar, D. G. 2004. Advances in Arid Horticulture. Internal Book Distributing Co., Lucknow.

Course No.	Course Title	Credits
SOA/HE/PG04	Biotic and Abiotic Stress Management in Horticultural Crops	3(2+1)

#### **SOA/HE/PG 04: Biotic and Abiotic Stress Management in Horticultural Crops**

Stress – definition, classification, stresses due to water (high and low), temperature (high and low), radiation, wind, soil conditions (salinity, alkalinity, ion toxicity, fertilizer toxicity, etc.).

Pollution - increased level of CO<sub>2</sub>, industrial wastes, impact of stress in horticultural crop production, stress indices, physiological and biochemical factors associated with stress, horticultural crops suitable for different stress situations.

Crop modeling for stress situations, cropping system, assessing the stress through remote sensing, understanding adaptive features of crops for survival under stress, interaction among different stress and their impact on crop growth and productivity.

Greenhouse effect and methane emission and its relevance to abiotic stresses, use of anti transpirants and PGRs in stress management, mode of action and practical use, HSP inducers in stress management techniques of soil moisture conservation, mulching, hydrophilic polymers.

Rain water harvesting, increasing water use efficiency, skimming technology, contingency planning to mitigate different stress situations, cropping systems, stability and sustainability indices.

**Practicals-** Seed treatment /hardening practices, container seedling production, analysis of soil moisture estimates (FC, ASM, PWP), analysis of plant stress factors, RWC, chlorophyll fluorescence, chlorophyll stability index, ABA content, plant waxes, stomatal diffusive resistance, transpiration, photosynthetic rate etc. under varied stress situations, influence of stress on growth and development of seedlings and roots, biological efficiencies, WUE, solar energy conversion and efficiency, crop growth sustainability indices, economics of stress management, visit to orchards and water shed locations.

#### **Suggested reading:**

- ❖ Dwivedi, P. and Dwivedi, R.S. 2005. Physiology of Abiotic stress in Plants. Agrobios.
- ❖ Gurusurthy, S and Jinus, S. 2020. Management of Abiotic Stress in Crop Plants. IP Innovative Publication Pvt. Ltd.
- ❖ Kumar, A., Rai, A. C., Rai, A., Rai, K. K. and Rai, V. P. 2021. Stress Tolerance in Horticultural Crops: Challenges and Mitigation Strategies. Woodhead Publishing.

- ❖ Maloo, S.R. 2003. Abiotic Stress and Crop Productivity. Agrotech Publ. Academy.
- ❖ Mussell, H. and Staples, R. 1979. Stress Physiology in Crop Plants. Wiley Inter. Science.
- ❖ Rao, N.K.S., Shivashankara, K.S. and Laxman, R. H. 2016. Abiotic Stress Physiology of Horticultural Crops. Springer India.
- ❖ Sinha, B. K and Reena. 2018. Abiotic and Biotic Stress Management in Plants: Biotic Stress, (Vol.02). New India Publishing Agency.
- ❖ Sinha, B. K and Reena. 2018. Abiotic and Biotic Stress Management in Plants: Abiotic Stress (Vol.01). New India Publishing Agency.

Course No.	Course Title	Credits
SOA/HE/PG05	Advances in Breeding of Ornamental Crops	3(2+1)

### **SOA/HE/PG 05: Advances in Breeding of Ornamental Crops**

Principles-Evolution of varieties, origin, distribution, genetic resources, genetic divergence- Patents

Genetic inheritance of flower colour, doubleness, flower size, fragrance, post harvest life.

Breeding methods suitable for sexually and asexually propagated flower crops and ornamental plants-- introduction, selection, domestication, polyploid and mutation breeding for varietal development, Role of heterosis, Production of hybrids, Male sterility, incompatibility problems, seed production of flower crops.

Breeding constraints and achievements made in commercial flowers - rose, jasmine, chrysanthemum, marigold, tuberose, crossandra, carnation, dahlia, gerbera, gladioli, orchids, anthurium, aster, heliconia, lilioms, nerium.

Breeding constraints and achievements made in ornamental plants – petunia, hibiscus, bougainvillea, Flowering annuals (zinnia, cosmos, dianthus, snap dragon, pansy) and ornamental foliages– Introduction and selection of plants for waterscaping and xeriscaping.

**Practicals-** Description of botanical features– Cataloguing of cultivars, varieties and species in flowers, floral biology, selfing and crossing, evaluation of hybrid progenies, seed production- Induction of mutants through physical and chemical mutagens, induction of polyploidy, screening of plants for biotic, abiotic stresses and environmental pollution, *in vitro* breeding in flower crops and ornamental plants.

#### **Suggested Reading:**

- ❖ Agarwal, P.K. 1994. Principles of Seed Technology. ICAR Publication, New Delhi
- ❖ Agarwal, R.L. 1996. Seed Technology. Oxford & IBH Publishers, New Delhi
- ❖ Bhattacharjee, S.K. and De, L.C. 2003. Advanced Commercial Floriculture. Aavishkar Publishers, Jaipur.
- ❖ Bose, T.K., Yadav, L.P., Patil, P., Das, P. and Sarthy, V.A. P. 2003. Commercial Flowers. Naya Udyog.
- ❖ Callaway, D.J. and Callaway, M.B. 2000. Breeding Ornamental Plants. Timber Press
- ❖ Harding, J., Singh, F. and Mol, J.N. 1991. Genetics and Breeding of Ornamental Species. Springer Publishers
- ❖ Huylenbroeck, J. V. 2018. Ornamental Crops. Springer International Publishing.
- ❖ Pal, B.P. 1966. The Rose in India. Indian Council of Agriculture Research, New Delhi.
- ❖ Roy, D. 2019. Breeding of Ornamental Crops. Alpha Science International Ltd.
- ❖ Singh, B.D. 1983. Breeding Principles and Methods. Kalyani Publishers, New Delhi.

- ❖ Vainstein. 2002. Breeding for Ornamental: Classical and Molecular Approaches. SpringerPublishers.

Course No.	Course Title	Credits
SOA/HE/PG06	Organic Horticulture	3(2+1)

### **SOA/HE/PG 06:Organic Horticulture**

Organic horticulture – definition, synonyms and misnomers, principles, methods, merits and demerits.Organic farming systems, components of organic horticultural systems, different organic inputs,their role in organic horticulture, role of biofertilizers, biodynamics and the recent developments.EM technology and its impact in organic horticulture, indigenous practices of organic farming, sustainable soil fertility management, and weed management practices in organic farming, biological/natural control of pests and diseases, organic horticulture in quality improvement. GAP - Principles and management, HACCP exercise, certification of organic products and systems, agencies involved at national and international levels, standards evolved by different agencies.

Constraints in certification, organic horticulture and export, IFOAM and global scenario of organic movement, post-harvest management of organic produce.

**Practicals-** Features of organic orchards, working out conversion plan, Input analysis manures, nutrient status assessment of manures, biocomposting, biofertilizers and their application, panchagavya preparation and other 20 organic nutrients application, methods of preparation of compost, vermicompost, green manuring, preparation of neem products and application, BD preparations and their role, EM technology and products, biological/natural control of pests and diseases, soil solarization, frame work for GAP, case studies, HACCP analysis, residue analysis in organic products, documentation for certification, visit to fields cultivated under organic practices.

### **Suggested Reading:**

- ❖ Claude, A., Vandana, S., Sultana, I., Vijaya, L., Korah, M. and Bernard, D. 2000. The OrganicFarming Reader. Other Indian Press, Goa.
- ❖ Dahama, K. 2007. Organic Farming for Sustainable Agriculture. Agrobios (India), Jodhpur.
- ❖ Gaur, A.C., Neblakantan, S. and Dargan, K.S. 1984. Organic Manures. ICAR.
- ❖ Lampkin, N. and Ipswich. 1990. Organic Farming. Farming Press. London.
- ❖ Lampkin, N.H. and Padel, S. 1992. The Economic of Organic Farming: An International Perspective. CABI.
- ❖ Palaniappan and Annadural. 2008. Organic Farming: Theory and Practice. Scientific Publ.
- ❖ Palaniappan, S.P. and Annadurai, K. 2010. Organic Farming: Theory and Practice. Scientific Publishers, Jodhpur.
- ❖ Peter, K.V. 2008. Basis of Horticulture. New Indian Publ. Agency, New Delhi.
- ❖ Purshit, S.S. 2006. Trends in Organic Farming in India. Agros Bios (INDIA), Jodhpur.
- ❖ Rao, S. 1977. Soil Microorganism and Plant Growth. Oxford and IBH.
- ❖ Sathe, T. V.2004. Vermiculture and Organic Farming. Daya Publishing House, New Delhi.
- ❖ Sharma, A. K. 2011. Handbook of Organic farming. Agrobios (India), Jodhpur.
- ❖ Thampan, P. K. 1995. Organic Agriculture. PeckayTree Crops Development Foundation, Cochin, Kerala.

- ❖ Thapa, U. and Tripathy, P. 2006. Organic Farming in India: Problems and Prospects. AgrotechPublishing Agency, Udaipur.
- ❖ Veeresh, G.K. 2006. Organic Farming. Foundation Books, New Delhi.

Course No.	Course Title	Credits
SOA/HC/PG 17	Thesis: Objective and evaluation	12 (0+12)

### **SOA/HC/PG 17:Thesis: Objective and evaluation**

Aim of introducing thesis in M. Sc.(Ag.) Horticulture is to give the students preliminary exposure for conducting the research and presenting its findings systematically and scientifically in a manuscript shape. To fulfill this goal, a specific topic for thesis research shall be assigned to each M. Sc. student by the teacher(s)/supervisor(s) of the department, in the first semester. The student will carry out the research for thesis under the respective supervisor(s) and finally present it in a book shape called thesis.

Each student will submit the thesis to the department/university towards the end of fourth semester of M. Sc. (Ag.) Horticulture degree.

### **Evaluation of Thesis:**

The procedure will be as under:

- i. Critical examination of thesis by the external expert appointed by the university as per specialization of thesis work.
- ii. Each student shall give open presentation of thesis work before external/internal examiners, faculty members and students in the department.