FACULTY OF AGRICULTURAL SCIENCES

Syllabus

M.Sc. Ag. Horticulture (Fruit Science) **(2020-21)**

SHREE GURU GOBIND SINGH TRICENTENARY UNIVERSITY
GURUGRAM (DELHI-NCR)

CONTENTS

1. Executive Summary

Horticulture plays a pivotal role in the food and livelihood security in India.Though, horticultural crops occupy only 8.5% of arable land, they contribute 24.5% of theGDP in agriculture. Plantation crops (tea, coffee, rubber, etc.) occupying 0.95% of croppedarea and have stake of 15.1% of the total export earnings. Economists view thatcommercialization of agriculture and promotion of agri- business in India is correlated tothe progress in the plantation and horticulture sectors. Horticulture and Plantation sectorscover production, post-harvest management, marketing, processing and export of fruits,vegetables, flowers, medicinal and aromatic plants, plantation crops, spices, bamboo,mushroom, apiculture and sericulture. On the total production side, India leads the wholeworld in fruits and vegetables next to China. The performance in production is laudable however, in value addition, processing andexport segments, India's contribution is not as expected. In spite of having a 10% share in global production of both fruits and vegetables, just 1.8% of it is processed.Horticulture has gained importance in Haryana as a separate viable economic activity. With the sustained efforts of government, considerable progress has been made in fruits, vegetables, flowers and mushroom cultivation.Trough research studies it has also been concluded that horticulture can be a viable option for diversifying the irrigation water intensive field crop based systems, particularly the Rice-Wheat cropping system in the states of Punjab and Haryana, where the water table is going down at an alarming rate. Haryana has total 4.42 million ha land area out of which 3.55 m ha is cultivable. Of the total State Economy of Haryana horticulture share is 6 % and that of GDP is 15.3%.

The existing single M. Sc. (Hort.) programme running at national level is inadequate to meet thepresent and envisaged human resource requirement. The programme needs to be expandedas done in the Syllabus of Horticulture in Agricultural Scientists Recruitment Board(ASRB)Examinations. The envisaged M. Sc. programmes are:

1. M. Sc. (Horticulture) - Fruit Science
2. M. Sc. (Horticulture) - Vegetable Science
3. M. Sc. (Horticulture - Floriculture and Landscape Architecture
4. M. Sc. (Horticulture) - Plantation crops, Spices, Medicinal and Aromatic Crops

Keeping pace with the latest development in agriculture the SGTU started M.Sc. Horticulture (Fruit Science) in the first phase of starting Master's Degree programmes in Agriculture as per ICAR guidelines.

1.1. Organization of Course Contents & Credit Requirements

1.1.1. General Information about Course Code Numbers

i). All courses for M.Sc. Ag. Horticulture (Fruit Science) will be of 500-series.

ii). Credit seminar has been designated by code no. 591, while code no. 599 pertains for Master's Research.

1.1.2. General Information about Course Contents

The contents of each course have been organized into:

i). Objective (s) – to elucidate the basic purpose.

ii). Theory units – to facilitate uniform coverage of syllabus for paper setting.

iii). Suggested Readings – to recommend some standard books as reference material. This does not unequivocally exclude other such reference material that may be recommended according to the advancements and local requirements.

iv). E-Resources - This may be useful as study material for research topics/ for quick update on specific topics/events pertaining to the subject.

1.1.3. Minimum Credit Requirement

Subject*	**Master's Programme**
Major	20
Minor	09
Supporting	05
Seminar	01
Research	20
Total Credit	55
Compulsory Non-Credit Courses	Section 5

*****Major subject: The subject (department) in which the student takes admission

Minor subject: The subject closely related to student's major subject.

Supporting subject: The subject not related to the major subject. It could be any subject considered relevant for student's research work.

Compulsory Non-Credit Courses: Please see Annexure-I for details. Six courses (PGS 501 to PGS 506) are of general nature and are compulsory for Master's programme.

2. Major Subject Courses

2.1. Courses' Structure at a Glance

Course Code	**Course Code**	**Course Title**	**Credits**

(ICAR pattern)	(SGTU pattern)		
FSC 501*	11060101	TROPICAL AND DRY LAND FRUIT PRODUCTION	3(2+1)
FSC 502*	11060102	SUBTROPICAL AND TEMPERATE FRUIT PRODUCTION	3(2+1)
FSC 503*	11060201	BIODIVERSITY AND CONSERVATION OF FRUIT CROPS	3(2+1)
FSC 505	11060302	PROPAGATION AND NURSERY MANAGEMENT FOR FRUIT CROPS	3(2+1)
FSC 506*	11060301	BREEDING OF FRUIT CROPS	3(2+1)
FSC 507	11060103	POST HARVEST TECHNOLOGY FOR FRUIT CROPS	3(2+1)
FSC 512	11060303	GAP FOR HORTICULTURAL CROPS	1(1+0)
FSC 513	11060104	CLIMATE MANAGEMENT IN HORTICULTURAL PRODUCTION	1(1+0)
FSC 591	11060405	MASTER'S SEMINAR	1(1+0)
FSC 599	11060406	MASTER'S RESEARCH	20

***** Compulsory Course

2.1.1 Course Content

FSC 501/11060101: TROPICAL AND DRY LAND FRUIT PRODUCTION 3(2+1)

Objective

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

Theory

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

Crops

UNIT-I

Mango and Banana

UNIT-II

Citrus and Papaya

UNIT-III
Guava,Sapota and Jackfruit

UNIT-IV
Pineapple, Annonas and Avocado
UNIT-V
Ber, Aonla, Bael, Pomegranate, Phalsa, Karonda, Mulberry, Ker, Salvadora, Lasoda and, minor fruits of tropics

Practical
Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to tropical and arid zone orchards, project preparation for establishing commercial orchards.

Suggested Readings

- Bose TK, Mitra SK & Rathore DS. (Eds.). 1988. *Temperate Fruits -Horticulture*. Allied Publ.
- Bose TK, Mitra SK & Sanyal D. 2001. (Eds.). *Fruits -Tropical and Subtropical*. Naya Udyog.
- Chadha KL & Pareek OP. 1996. (Eds.). *Advances in Horticulture*. Vols. II–IV, Malhotra Publ. House.
- Nakasone HY & Paul RE. 1998. *Tropical Fruits*. CABI.
- Peter KV. 2008. (Ed.). *Basics of Horticulture*. New India Publ. Agency.
- Pradeepkumar T, Suma B, Jyothibhaskar&Satheesan KN. 2008. *Management of Horticultural Crops*. Parts I, II. New India Publ. Agency.
- Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.
- Singh HP, Negi JP & Samuel JC. (Eds.). 2002. *Approaches for Sustainable Development of Horticulture*. National Horticultural Board.
- Singh HP, Singh G, Samuel JC & Pathak RK. (Eds.). 2003. *Precision Farming in Horticulture*. NCPAH, DAC/PFDC, CISH, Lucknow.

FSC 502/11060102: SUBTROPICAL AND TEMPERATE FRUIT PRODUCTION 3(2+1)

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

Theory
Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, bioregulation, biotic factors limiting fruit production, physiology of flowering, fruit

set and development, abiotic factors limiting production, physiological disorders-causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, precooling, storage, transportation and ripening techniques; industrial and export potential, Agri Export Zones (AEZ) and industrial support.

Crops

UNIT-I

Apple, pear, quince, grapes

UNIT-II

Plums, peach, apricot, cherries, hazelnut

UNIT-III

Litchi, loquat, persimmon, kiwifruit, strawberry

UNIT-IV

Nuts- walnut, almond, pistachio, pecan

UNIT-V

Minor fruits- mangosteen, carambola, bael, wood apple, fig, jamun, rambutan, pomegranate

Practical

Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to subtropical and temperate orchards, Project preparation for establishing commercial orchards.

Suggested Readings

- Bose TK, Mitra SK &Sanyol D. (Ed.). 2002. *Fruits of India – Tropical and Sub-tropical*.3rd Ed. Vols. I, II. Naya Udyog.
- Chadha KL & Pareek OP. 1996. (Eds.). *Advances in Horticulture*. Vol. I. Malhotra Publ. House.
- *Chadha KL &Shikhamany SD. 1999. The Grape: Improvement, Production and Post-Harvest Management. Malhotra Publ. House.*
- Janick J & Moore JN. 1996. *Fruit Breeding*. Vols.I-III. John Wiley & Sons. Nijjar GS. 1977. (Eds.). *Fruit Breeding in India*. Oxford & IBH.
- Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.
- Singh S, Shivankar VJ, Srivastava AK & Singh IP. (Eds.). 2004. *Advances in Citriculture*. Jagmander Book Agency.

FSC 503/11060201: BIODIVERSITY AND CONSERVATION OF FRUIT CROPS 3(2+1)

Objective

Understanding the principles of biodiversity and strategies in germplasm conservation of fruit crops.

Theory

UNIT-I

Biodiversity and conservation; issues and goals, centers of origin of cultivated fruits; primary and secondary centers of genetic diversity.

UNIT-II

Present status of gene centers; exploration and collection of germplasm; conservation of genetic resources – conservation *in situ* and *ex situ.*

UNIT-III

Germplasm conservation- problem of recalcitrancy - cold storage of scions, tissue culture, cryopreservation, pollen and seed storage; inventory of germplasm, introduction of germplasm, plant quarantine.

UNIT-IV

Intellectual property rights, regulatory horticulture. Detection of genetic constitution of germplasm and maintenance of core group.

UNIT-V

GIS and documentation of local biodiversity, Geographical indication.

Crops

Mango, sapota, citrus, guava, banana, papaya, grapes, jackfruit, custard apple, ber, aonla, Malus spp., *Prunus* spp., litchi, nuts, coffee, tea, rubber, cashew, coconut, cocoa, palmyrah, arecanut, oil palm and betelvine.

Practical

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 centers of PGR activities. Detection of genetic constitution of germplasm, core sampling, germplasm characterization using molecular techniques.

Suggested Readings

- Frankel OH & Hawkes JG. 1975. *Crop Genetic Resources for Today and Tomorrow. Cambridge University Press.*
- Peter KV & Abraham Z. 2007. *Biodiversity in Horticultural Crops*. Vol.I. Daya Publ. House.
- Peter KV. 2008. *Biodiversity of Horticultural Crops*. Vol. II. Daya Publ. House.

FSC 505/11060302: PROPAGATION AND NURSERY MANAGEMENT FOR FRUIT CROPS 3(2+1)

Objective

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

Theory

UNIT-I

Introduction, life cycles in plants, cellular basis for propagation, sexual propagation, apomixis, polyembryony, chimeras. Principles factors influencing seed germination of horticultural crops, dormancy, hormonal regulation of germination and seedling growth.

UNIT-II

Seed quality, treatment, packing, storage, certification, testing. Asexual propagation – rooting of soft and hard wood cutting under mist by growth regulators. Rooting of cuttings in hotbeds. Physiological, anatomical and biochemical aspects of root induction in cuttings. Layering – principle and methods.

UNIT-III

Budding and grafting – selection of elite mother plants, methods. Establishment of bud wood bank, stock, scion and inter stock, relationship – Incompatibility. Rejuvenation through top working – Progeny orchard and scion bank.

UNIT-IV

Micro-propagation – principles and concepts, commercial exploitation in horticultural crops. Techniques - *in vitro* clonal propagation, direct organogenesis, embryogenesis, micrografting, meristem culture. Hardening, packing and transport of micro-propagules.

UNIT-V

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

Practical

Anatomical studies in rooting of cutting and graft union, construction of propagation structures, study of media and PGR. Hardening – case studies, micropropagation, explant preparation, media preparation, culturing – *in vitro* clonal propagation, meristem culture, shoot tip culture, axillary bud culture, direct organogenesis, direct and indirect embryogenesis, micro grafting, hardening. Visit to TC labs and nurseries.

Suggested Readings

- Hartmann HT & Kester DE. 1989. *Plant Propagation – Principles and Practices. Prentice Hall of India.*
- Bose TK, Mitra SK & Sadhu MK. 1991. *Propagation of Tropical and Subtropical Horticultural Crops. Naya Prokash.*
- Peter KV. (Ed.). 2008. *Basics of Horticulture*. New India Publ. Agency. Singh SP. 1989 *Mist Propagation*. Metropolitan Book Co.
- Rajan S & Baby LM. 2007. *Propagation of Horticultural Crops*. New India Publ. Agency.
- Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.

FSC 506/11060301: BREEDING OF FRUIT CROPS 3(2+1)

Objective

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

Theory

Origin and distribution, taxonomical status - species and cultivars, cytogenetics, genetic resources, blossom biology, breeding systems, breeding objectives, ideotypes, approaches for

crop improvement - introduction, selection, hybridization, mutation breeding, polyploidy breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, biotechnological interventions, achievements and future thrust in the following selected fruit crops.

Crops

UNIT-I

Mango, banana and pineapple

UNIT-II

Citrus, grapes, guava and sapota

UNIT-III

Jackfruit, papaya, custard apple, aonla, avocado and ber

UNIT-IV

Mangosteen, litchi, jamun, phalsa, mulberry, raspberry, kokam and nuts

UNIT-V

Apple, pear, plums, peach, apricot, cherries and strawberry

Practical

Characterization of germplasm, blossom biology, study of anthesis, estimating fertility status, practices in hybridization, ploidy breeding, mutation breeding, evaluation of biometrical traits and quality traits, screening for resistance, developing breeding programme for specific traits, visit to research stations working on tropical, subtropical and temperate fruit improvement.

Suggested Readings

- Bose TK, Mitra SK &Sanyol D. (Eds.). 2002. *Fruits of India – Tropical and Sub-tropical*.3rd Ed. Vols. I, II. Naya Udyog.
- Chadha KL & Pareek OP. 1996. (Eds.). *Advances in Horticulture*. Vol. I. Malhotra Publ. House.
- Chadha KL &Shikhamany SD. 1999. *The Grape: Improvement, Production and Post-Harvest Management. Malhotra Publ. House.*
- Janick J & Moore JN. 1996. *Fruit Breeding*. Vols.I-III. John Wiley & Sons. Nijjar GS. 1977. (Eds.). *Fruit Breeding in India*. Oxford & IBH.
- Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.
- Singh S, Shivankar VJ, Srivastava AK & Singh IP. (Eds.). 2004. *Advances in Citriculture*. Jagmander Book Agency.

FSC 507/11060103: POST HARVEST TECHNOLOGY FOR FRUIT CROPS 3(2+1)

Objective

To facilitate deeper understanding on principles and practices of postharvest management of fruit crops.

Theory

UNIT-I

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

UNIT-II

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

UNIT-III

Treatments prior to shipment, *viz*., chlorination, waxing, chemicals, biocontrol agents and natural plant products. Methods of storage ventilation, refrigeration, modified atmospheric storage, controlled atmospheric storage, physical injuries and disorders.

UNIT-IV

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

UNIT-V

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

Practical

Analyzing maturity stages of commercially important fruit crops, improved packing and storage of important fruit crops, physiological loss in weight of fruits, estimation of transpiration, respiration rate, estimation of quality characteristics in stored fruits, cold chain management visit to cold storage and CA storage units, visit to fruit processing units, project preparation, evaluation of processed fruit products.

Suggested Readings

- Bhutani RC. 2003. *Fruit and Vegetable Preservation*. Biotech Books.
- Chadha KL & Pareek OP. (Eds.). 1996 *Advances in Horticulture*. Vol. IV. Malhotra Publ. House.
- Haid NF &Salunkhe SK. 1997. *Post Harvest Physiology and Handling of Fruits and Vegetables. Grenada Publ.*
- Mitra SK. 1997. *Post Harvest Physiology and Storage of Tropical and Sub-tropical Fruits. CABI.*
- Ranganna S. 1997. *Hand Book of Analysis and Quality Control for Fruit and Vegetable Products. Tata McGraw-Hill.*
- Sudheer KP & Indira V. *2007. Post Harvest Technology of Horticultural Crops. New India Publ. Agency.*
- Willis R, Mc Glassen WB, Graham D & Joyce D. 1998. *Post Harvest. An Introduction to the Physiology and Handling of Fruits, Vegetables and Ornamentals*. CABI.

FSC 512/11060303: GAP FOR HORTICULTURAL CROPS 1(1+0)

Objective

To impart comprehensive knowledge about the principles and practices of Good Agricultural Practises (GAP) for horticultural crops.

Theory

UNIT-I

Genesis of GAP – definition/description, components listed by FAO, frame work.

UNIT-II

Management of site history and soil, crop and fodder production, IPM, INM, IWM, irrigation water, crop production and protection. Identification of ways of improving the productivity profitability, and resource efficiency. harvest and post-harvest handling.

UNIT-III

Animal production, product certification, animal waste management, animal health and welfare, harvest.

UNIT-IV

On farm processing, storage, energy and waste management, human health, welfare, safety, wild life benefits.

UNIT-V

Institutions involved in GAP certification. Indian agencies, EUREPGAP (European Retail Producers Group- Good Agricultural Practices), EUREP etc.

Suggested Readings

- Peter KV. 2008. *Basics in Horticulture*. New India Publ. Agency.

FSC 513/11060104: CLIMATE MANAGEMENT IN HORTICULTURAL PRODUCTION 1(1+0)

Objective

To develop understanding about the impact and management of climate in horticultural production.

Theory

UNIT-I

Introduction to climate change. Factors directly connected to climate change, average temperature, change in rainfall amount and patterns, rising atmospheric concentrations of CO2, pollution levels such as tropospheric ozone, change in climatic variability and extreme events like receding of glaciers in Himalayas.

UNIT-II

Sensors for climate registration and crop monitoring, phytomonitoring and biosensors, plants response to the climate changes, premature bloom, marginally overwintering or inadequate winter chilling hours, insect pests, longer growing seasons and shifts in plant hardiness for perennial fruit crops, flowering plants and other plant species.

UNIT-III

Impact of climate changes on invasive insect, disease, weed, pests, horticulture yield, quality and sustainability, climate management in field production – mulching - use of plastic- windbreak- spectral changes- frost protection. Climate management in greenhouse- heating - vents - CO_2 injection - screens - artificial light.

UNIT-IV

Climate management for control of pests, diseases, quality, elongation of growth and other plant processes- closed production systems around the world. Special protected cultivation now and in the future, growth chambers, production in space, biosphere, future aspects of close production, future greenhouse, use of LED as artificial light, future sensor types etc. clean development mechanism, role of tropical trees.

Suggested Readings

- Peter KV. 2008. (Ed.). *Basics of Horticulture*. New India Publ. Agency.
- Rao GSLHV, Rao GGSN, Rao VUM & Ramakrishnan YS. 2008. *Climate Change and Agriculture over India*. ICAR.
- Rao GSLHV. 2008. *Agricultural Meteorology*. Prentice Hall.

3. Minor Subject(s)

The student admitted for M.Sc. Ag. Horticulture (Fruit Science) Degree Programmewill study Vegetable Science as the minor subject.

3.1.Courses' Structure at a Glance

Course Code (ICAR pattern)	Course Code (SGTU pattern)	Course Title	Credits
VSC 501	11060202	PRODUCTION TECHNOLOGY OF COOL SEASON VEGETABLE CROPS	3(2+1)
VSC 502	11060304	PRODUCTION TECHNOLOGY OF WARM SEASON VEGETABLE CROPS	3(2+1)
VSC 505	11060401	SEED PRODUCTION TECHNOLOGY OF VEGETABLE CROPS	3(2+1)

3.1.1. Course Content

VSC 501/11060202: PRODUCTION TECHNOLOGY OF COOL SEASON VEGETABLE CROPS 3(2+1)

Objective

To educate production technology of cool season vegetables.

Theory

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological

disorders, harvesting, post-harvest management, plant protection measures and seed production of:

UNIT-I

Potato

UNIT-II

Cole crops: cabbage, cauliflower, knolkhol, sprouting broccoli, Brussel's sprout

UNIT-III

Root crops: carrot, radish, turnip and beetroot

UNIT-IV

Bulb crops: onion and garlic

UNIT-V

Peas and broad bean, green leafy cool season vegetables

Practical

Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control) of winter vegetable crops and their economics; Experiments to demonstrate the role of mineral elements, plant growth substances and herbicides; study of physiological disorders; preparation of cropping scheme for commercial farms; visit to commercial greenhouse/ polyhouse.

Suggested Readings

- Bose TK &Som MG. (Eds.). 1986. *Vegetable Crops in India*. Naya Prokash.
- Bose TK, Som G & Kabir J. (Eds.). 2002. *Vegetable Crops*. Naya Prokash.
- Bose TK, Kabir J, Maity TK, Parthasarathy VA &Som MG. 2003. *Vegetable Crops*. Vols. I-III. Naya Udyog.
- Chadha KL. (Ed.). 2002. *Hand Book of Horticulture*. ICAR.
- Chauhan DVS. (Ed.). 1986. *Vegetable Production in India*. Ram Prasad & Sons.
- Decoteau DR. 2000. *Vegetable Crops*. Prentice Hall.
- Edmond JB, Musser AM & Andrews FS. 1951. *Fundamentals of Horticulture*. Blakiston Co.
- Fageria MS, Choudhary BR & Dhaka RS. 2000. *Vegetable Crops: Production Technology*. Vol. II. Kalyani.
- Rubatzky VE & Yamaguchi M. (Eds.). 1997. *World Vegetables:Principles, Production and Nutritive Values*. Chapman & Hall.
- Saini GS. 2001. *A Text Book of Oleri and Flori Culture*. Aman Publ. House.
- Salunkhe DK & Kadam SS. (Ed.). 1998. *Hand Book of Vegetable Science and Technology: Production, Composition, Storage and Processing*. Marcel Dekker.
- Shanmugavelu KG. 1989. *Production Technology of Vegetable Crops*. Oxford & IBH.
- Singh SP. (Ed.). 1989. *Production Technology of Vegetable Crops*. Agril. Comm. Res. Centre.
- Thamburaj S & Singh N. (Eds.). 2004. *Vegetables, Tuber Crops and Spices*. ICAR.
- Thompson HC & Kelly WC. (Eds.). 1978. *Vegetable Crops*. Tata McGraw-Hill.

VSC 502/11060304: PRODUCTION TECHNOLOGY OF WARM SEASON VEGETABLE CROPS 3(2+1)

Objective

To teach production technology of warm season vegetables.

Theory

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures, economics of crop production and seed production of:

UNIT-I

Tomato, eggplant, hot and sweet peppers

UNIT-II

Okra, beans, cowpea and cluster bean

UNIT-III

Cucurbitaceous crops

UNIT-IV

Tapioca and sweet potato

UNIT-V

Green leafy warm season vegetables

Practical

Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control) of summer vegetable crops and their economics; study of physiological disorders and deficiency of mineral elements, preparation of cropping schemes for commercial farms; experiments to demonstrate the role of mineral elements, physiological disorders; plant growth substances and herbicides; seed extraction techniques; identification of important pests and diseases and their control; maturity standards; economics of warm season vegetable crops.

Suggested Readings

- Bose TK, Kabir J, Maity TK, Parthasarathy VA &Som MG. 2003. *Vegetable Crops*. Vols. I-III. Naya Udyog.
- Bose TK, Som MG & Kabir J. (Eds.). 2002. *Vegetable Crops*. Naya Prokash.
- Brown HD & Hutchison CS. *Vegetable Science*. JB Lippincott Co.
- Chadha KL. (Ed.). 2002. *Hand Book of Horticulture*. ICAR.
- Decoteau DR. 2000. *Vegetable Crops*. Prentice Hall.
- Fageria MS, Choudhary BR & Dhaka RS. 2000. *Vegetable Crops: Production Technology*. Vol. II. Kalyani.
- Nayer NM & More TA 1998. *Cucurbits*. Oxford & IBH Publ.
- Palaniswamy& Peter KV. 2007. *Tuber Crops*. New India Publ. Agency.
- Saini GS. 2001. *A Text Book of Oleri and Flori Culture*. Aman Publ. House.
- Salunkhe DK & Kadam SS. (Ed.). 1998. *Hand Book of Vegetable Science and Technology: Production, Composition, Storage and Processing*. Marcel Dekker.
- Shanmugavelu KG. 1989. *Production Technology of Vegetable Crops*. Oxford & IBH.
- Singh SP. (Ed.). 1989. *Production Technology of Vegetable Crops*. Agril. Comm. Res. Centre.

- Thamburaj S & Singh N. 2004. *Vegetables, Tuber Crops and Spices*. ICAR.
- Thompson HC & Kelly WC. (Eds.). 1978. *Vegetable Crops*. Tata Mc Graw Hill.

VSC 505/11060401: SEED PRODUCTION TECHNOLOGY OF VEGETABLE CROPS3(2+1)

Objective

To educate principles and methods of quality seed and planting material production in vegetable crops.

Theory

UNIT-I

Definition of seed and its quality, new seed policies; DUS test, scope of vegetable seed industry in India.

UNIT-II

Genetical and agronomical principles of seed production; methods of seed production; use of growth regulators and chemicals in vegetable seed production; floral biology, pollination, breeding behaviour, seed development and maturation; methods of hybrid seed production.

UNIT-III

Categories of seed; maintenance of nucleus, foundation and certified seed; seed certification, seed standards; seed act and law enforcement, plant quarantine and quality control.

UNIT-IV

Physiological maturity, seed harvesting, extraction, curing, drying, grading, seed processing, seed coating and pelleting, packaging (containers/packets), storage and cryopreservation of seeds, synthetic seed technology.

UNIT-V

Agro-techniques for seed production in solanaceous vegetables, cucurbits, leguminous vegetables, cole crops, bulb crops, leafy vegetables, okra, vegetatively propagated vegetables.

Practical

Seed sampling, seed testing (genetic purity, seed viability, seedling vigour, physical purity) and seed health testing; testing, releasing and notification procedures of varieties; floral biology; roguing of off-type; methods of hybrid seed production in important vegetable and spice crops; seed extraction techniques; handling of seed processing and seed testing equipments; seed sampling; testing of vegetable seeds for seed purity, germination, vigour and health; visit to seed processing units, seed testing laboratory and seed production farms.

Suggested Readings

- Agrawal PK &Dadlani M. (Eds.). 1992. *Techniques in Seed Science and Technology*. South Asian Publ.
- Agrawal RL. (Ed.). 1997. *Seed Technology*. Oxford & IBH.
- Bendell PE. (Ed.). 1998. *Seed Science and Technology: Indian Forestry Species*. Allied Publ.

- Fageria MS, Arya PS & Choudhary AK. 2000. *Vegetable Crops: Breeding and Seed Production*. Vol. I. Kalyani.
- George RAT. 1999. *Vegetable Seed Production*. 2nd Ed. CABI.
- Kumar JC & Dhaliwal MS. 1990. *Techniques of Developing Hybrids in Vegetable Crops*. Agro Botanical Publ.
- More TA, Kale PB &Khule BW. 1996. *Vegetable Seed production Technology*. Maharashtra State Seed Corp.
- Rajan S & Baby L Markose. 2007. *Propagation of Horticultural Crops*. New India Publ. Agency.
- Singh NP, Singh DK, Singh YK & Kumar V. 2006. *Vegetable Seed Production Technology*. International Book Distributing Co.
- Singh SP. 2001. *Seed Production of Commercial Vegetables*. Agrotech Publ. Academy.

4. Supporting Courses

4.1. Courses' Structure at a Glance

Course Code (ICAR pattern)	Course Code (SGTU pattern)	Course Title	Credits
FST455	11060203	EXPERIMENTAL DESIGNS	3(2+1)
PP501	11060107	PRINCIPLES OF PLANT PHYSIOLOGY	4(3+1)
*SOILS 511	11060105	ANALYTICAL TECHNIQUES AND INSTRUMENTAL METHODS IN SOIL AND PLANT ANALYSIS	2(0+2)

***** Compulsory for students having horticultural crop nutrition related research problem

4.1.1. Course Contents

FST 455/11060203: EXPERIMENTAL DESIGNS 3(2+1)

Objective

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

Theory

UNIT-I

Need for designing of experiments, characteristics of a good design. Basic principles of designs - randomization, replication and local control.

UNIT-II

Uniformity trials, size and shape of plots and blocks; Analysis of variance; Completely randomized design, randomized block design and Latin square design.

UNIT-III

Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.

UNIT-IV

Split plot and strip plot designs; Analysis of covariance and missingplot techniques in randomized block and Latin square designs;Transformations, crossover designs, balanced incomplete block design, Lattice design, Response surfaces.

UNIT-V

Bioassays- direct and indirect, potency estimation.

Practical

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

Suggested Readings

- Cochran WG & Cox GM. 1957. *Experimental Designs*. 2nd Ed. John Wiley.
- Dean AM & Voss D. 1999. *Design and Analysis of Experiments*. Springer. Federer WT. 1985. *Experimental Designs*. MacMillan.
- Fisher RA. 1953. *Design and Analysis of Experiments. Oliver & Boyd.*
- Nigam AK & Gupta VK. *1979. Handbook on Analysis of Agricultural Experiments. IASRI Publication*
- Pearce SC. 1983. *The Agricultural Field Experiment: A Statistical Examination of Theory and Practice. John Wiley.*
- Design Resources Server: www.iasri.res.in /design.

PP 501/ 11060107: PRINCIPLES OF PLANT PHYSIOLOGY4 (3+1)

Theory

Cell organelles and their physiological functions, structure and physiological functions of cell wall, cell inclusions; cell membrane structure and functions Soil and plant water relations, water and its role in plants, properties and functions of water in the cell water relations-cell water terminology, water potential of plant cells. Mechanism of water uptake by roots-transport in roots, aquaporins, movement of water in plants – Mycorhizal association on water uptake. Water loss from plants-Energy balance-Solar energy input-energy dissipation at crop canopy level-evapotranspiration transpiration –Driving force for transpiration, plant factors influencing transpiration rate. Stomata structure and function – mechanism of stomatal movement, antitranspirants. Physiology of water stress in plants: Influence of water stress at cell, organ,

plant and canopy levels. Indices for assessment of drought resistance. The role of mineral nutrients in plant metabolism: Essential elements, classification based on function of elements in plants. Uptake of mineral elements in plants –Mechanisms of uptake-translocation of minerals in plants. Physiological and metabolic functions of mineral elements, critical levels, deficiency symptoms, nutrient deficiency and toxicity. Foliar nutrition. Photosynthesis and its importance in bio productivity. Photochemical process, photochemical reactions, CO2 reduction in Calvin cycle, supplementary pathway of C fixation in C4 and CAM plants and its significance. Photorespiration and its relevance. Photosynthesis as a diffusive processeffect of environmental factors on photosynthetic rates. Synthesis of sucrose, starch, oligo and polysaccharides (composition of cell wall). Translocation of photosynthates and its importance in sink growth. Secondary metabolites and their significance in plant defence mechanism. Growth and differentiation. Hormonal concept of growth and differentiation, plant growth hormones and their physiological role synthetic growth regulators, growth retardants., Apical dominanace, senescence, fruit growth, abscission. Photo morphogenesis: Photo receptors, phytochrome, cryptochrome, physiology of flowering- Photoperiodism and Vernalisation. Practical Measurement of soil water status: Theory and principle of pressure plate apparatus, neutron probe,

Practical

Measurement of plant water status: Relative water content, water saturation deficits Chardakov's test. Theory and principle of pressure bomb, psychrometer and osmometer, Measurement of transpiration rate. Measurement of vapour pressure deficits, theory and principle of porometry, diffusion prometer and Steady state porometer, Stomatal physiology, influence of ABA on stomatal closing. Mineral nutrients: Demonstration of energy requirement for ion uptake. Deficiency symptoms of nutrients, Radiant energy measurements, separation and quantification of chlorophylls, O2 evolution during photosynthesis, Measurement of gas exchange parameters, conductance, photosynthetic rate, photorespiration, Respiration rates, Estimation of reducing sugars, starch. Estimation of NO3, free aminoacids in the xylem exudates, quantification of soluble proteins. Bioassays for different growth hormones- Auxins, Gibberellins, Cytokinins, ABA and ethylene. Demonstration of photoperiodic response of plants in terms of flowering.

Suggested Readings

- Hopkins WG &Huner NPA. 2004. Introduction to Plant Physiology. John Wiley & Sons.
- Salisbury FB & Ross C. 1992. Plant Physiology. 4th Ed. Wadsworth Publ.
- Taiz L & Zeiger E. 2006. Plant Physiology. 4th Ed. Sinauer Associates.

SOILS511/ 11060105: ANALYTICAL TECHNIQUES AND INSTRUMENTALMETHODS IN SOIL AND PLANT ANALYSIS 2(0+2)

Objective

To familiarize the students with commonly used instruments – their working, preparations of common analytical reagents for qualitative and quantitative analysis of both soil as well as plant samples.

Practical

UNIT-I

Preparation of solutions for standard curves, analytical reagents, qualitative reagents, indicators and standard solutions for acid-base, oxidation reduction and complexometric titration; soil, water and plant sampling techniques, their processing and handling.

UNIT-II

Determination of nutrient potentials and potential buffering capacities of soils for phosphorus and potassium; estimation of phosphorus, ammonium and potassium fixation capacities of soils.

UNIT-III

Principles of visible, ultraviolet and infrared spectrophotometery, atomic absorption, flame-photometry, inductively coupled plasma spectrometry; chromatographic techniques, mass spectrometry and X-ray refractrometery; identification of minerals by X-ray by different methods.

UNIT-IV

Electrochemical titration of clays; determination of cation and anion exchange capacities of soils; estimation of exchangeable cations (Na, Ca, Mg, K); estimation of root cation exchange capacity.

UNIT-V

Analysis of soil and plant samples for N, P, K, Ca, Mg, S, Zn, Cu, Fe, Mn, B and Mo; analysis of plant materials by digesting plant materials by wet and dry ashing and soil by wet digestion methods.

UNIT-VI

Determination of lime and gypsum requirement of soil; drawing normalized exchange isotherms; measurement of redox potential.

UNIT-VII

Analysis of soil extracts and irrigation waters for their soluble cations and anions and interpretation of results.

Suggested Readings

- Hesse P. 971. *Textbook of Soil Chemical Analysis*. William Clowes & Sons.
- Jackson ML. 1967. *Soil Chemical Analysis*. Prentice Hall of India.
- Keith A Smith 1991. *Soil Analysis; Modern Instrumental Techniques*. Marcel Dekker.
- Kenneth Helrich 1990. *Official Methods of Analysis*. Association of Official Analytical Chemists.
- Page AL, Miller RH & Keeney DR. 1982. *Methods of Soil Analysis*. Part II. SSSA, Madison.
- Piper CE. *Soil and Plant Analysis*. Hans Publ.
- Singh D, Chhonkar PK & Pandey RN. 1999. *Soil Plant Water Analysis - AMethods Manual*. IARI, New Delhi.
- Tan KH. 2003. *Soil Sampling, Preparation and Analysis*. CRC Press/Taylor & Francis.
- Tandon HLS. 1993. *Methods of Analysis of Soils, Fertilizers and Wat*ers. FDCO, New Delhi.
- Vogel AL. 1979. *A Textbook of Quantitative Inorganic Analysis*. ELBS Longman.

5. Compulsory Non-Credit Courses

5.1.Courses' Structure at a Glance

Course Code (ICAR pattern)	Course Code (SGTU pattern)	Course Title	Credits
PGS 501	11060111	LIBRARY AND INFORMATION SERVICES	1(0+1)
PGS 502	11060204	TECHNICAL WRITING AND COMMUNICATIONS SKILLS	1(0+1)
PGS 503	11060205	INTELLECTUAL PROPERTY & ITS MANAGEMENT IN AGRICULTURE (e-Course)	1(1+0)

5.1.1 Course Content

11060111: LIBRARY AND INFORMATION SERVICES 1(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.

11060204: TECHNICAL WRITING AND COMMUNICATIONS SKILLS 1(0+1)

Objective

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

Practical

Technical writing

Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of

literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

Communication skills

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

Suggested Readings

- Robert C. (Ed.). 2005. Spoken English: Flourish Your Language. Abhishek, Chandigarh. Chicago Manual of Style. 14th Ed. 1996. Prentice-Hall of India, New Delhi.
- Collins' Cobuild English Dictionary. 1995. Harper Collins, New York.
- Gibaldi, Joseph. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press, New Delhi.
- Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford UP, Oxford.
- Krishna Mohan 2005. Speaking English Effectively. Macmillan India, New Delhi.
- Mills Gordon H & John A Walter. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston, New York.
- Sethi J & Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice-Hallof India, New Delhi.
- Shelton James H. 1994. Handbook for Technical Writing. NTC Business Books, Chicago. Smith Richard W. 1969. Technical Writing. Barnes & Noble, New York.
- Wren PC & Martin H. 2006. High School English Grammar and Composition. S. Chand, New Delhi.

11060205: INTELLECTUAL PROPERTY & ITS MANAGEMENT IN AGRICULTURE (e-Course) 1(1+0)

Objective

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

Theory

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

Suggested Readings

- Erbisch FH & Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI, Wallingford.
- Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw- Hill, New Delhi. India,
- Intellectual Property Rights: Key to New Wealth Generation.2001. NRDC and Aesthetic Technologies, New Delhi.
- Ministry of Agriculture. GoI., 2004. State of Indian Farmer. Vol. 5. Technology Generation and IPR Issues. Academic Foundation.
- Rothschild, Max & Newman, Scott (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
- Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya, Delhi.
- The Indian Acts - Patents Act, 1970 & amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 & amendments; Layout Design Act, 2000; PPV & FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.

11060206: BASIC CONCEPTS IN LABORATORY TECHNIQUES 1(0+1)

Objective

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

Practical

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

Suggested Readings

- *Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.*
- Gabb MH & Latchem WE. 1968. *A Handbook of Laboratory Solutions*. Chemical Publ. Co.

11060306: AGRICULTURAL RESEARCH, RESEARCH ETHICS & RURAL DEVELOPMENT PROGRAMMES (e-Course) 1(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.

Theory

UNIT-I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International agricultural Research Centres (IARC),

partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

UNIT-II

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

UNIT-III

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

Suggested Readings

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

11060106: DISASTER MANAGEMENT (E-Course) 1(1+0)

Objective

To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

Theory

UNIT-I

Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion.

UNIT-II

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT-III

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations and media. Central, State, District and Local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

Suggested Readings

- Gupta HK. 2003. *Disaster Management*. Indian National Science Academy. Orient Blackswan.
- Hodgkinson PE & Stewart M. 1991. *Coping with Catastrophe: A Handbook of Disaster Management. Routledge.*

6. E- Resources for Information on Horticulture

1. Agricultural & Processed Food Products Export Development Authority (APEDA) http://www.apeda.com/
2. American Society for Horticultural Science http://www.ashs.org/Asian Vegetable Research and Development Center (AVRDC) http://www.avrdc.org.tw/
3. Australian Society for Horticultural Science http://www.aushs.org.au/
4. Central Food Technological Research Institute (CFTRI) http://www.cftri.com/
5. Central Institute of Medicinal & Aromatic Plants (CIMAP) http://www.cimap.org/
6. Central Institute of Post-harvest Engineering and Technology http://www.icar.org.in/ciphet.html
7. Central Plantation Crops Research Institute (CPCRI), Kasaragod, Kerala http://cpcri.nic.in/
8. Central Tuber Crops Research Institute (CTCRI),Thiruvananthapuram, Kerala http://www.ctcri.org/
9. Consultative Group on International Agricultural Research, CGIAR http://www.cgiar.org/
10. Coffee Board, India http://indiacoffee.org/Department of Agriculture and Co-operation, India http://agricoop.nic.in/
11. Department of Bio-technology, India http://dbtindia.nic.inDepartment of Scientific and Industrial Research, India http://dsir.nic.in/
12. FAO http://www.fao.org/Global Agribusiness Information Network: http://www.fintrac.com/gain/:
13. Greenhouse Vegetable Information: http://www.ghvi.co.nz/
14. Indian Agricultural Research Institute (IARI) http://www.iari.res.in/
15. Indian Council of Agricultural Research (ICAR) http://www.icar.org.in
16. Indian Institute of Horticultural Research (IIHR) www.iihr.res.in
17. Indian Institute of Spices Research (IISR),Calicut, Kerala http://www.iisr.org/
18. Indo-American Hybrid Seeds www.indamseeds.com
19. Institute of Vegetable and Ornamental Crops http://www.igzev.de/
20. Institute for Horticultural Development, Victoria, Australia http://www.nre.vic.gov.au/agvic/ih/
21. Kerala Agricultural University www.kau.edu
22. Iowa State University, Department of Horticulture http://www.hort.iastate.edu/
23. National Bureau of Plant Genetic Resources (NBPGR), India http://nbpgr.delhi.nic.in/
24. National Horticulture Board (NHB), India http://hortibizindia.nic.in/
25. National Institute of Agricultural Extension Management (MANAGE), India http://www.manage.gov.in/
26. National Research Centre for Cashew (NRCC), http://kar.nic.in/cashew/India
27. National Research Centre for Mushroom (NRCM), India http://www.nrcmushroom.com/
28. National Research Centre for Oil Palm (NRCOP), India http://www.ap.nic.in/nrcop
29. North Carolina State University, Dept. of Horticulture http://www2.ncsu.edu/cals/hort_sci/
30. Oregon State University, Dept. of Horticulture http://osu.orst.edu/dept/hort
31. Pineapple News http://agrss.sherman.hawaii.edu/pineapple/pineappl.htm

32. Pomology Resources Center http://www.bsi.fr/pomologie/english/pomology:Rubber board, India http://rubberboard.org.in/
33. Spice Paprika web site http://www.paprika.deltav.hu/:
34. Spices Board, India http://www.indianspices.com/
35. Sri Lanka Agri-business on-line http://www.agro-lanka.org/
36. Sustainable Apple Production: http://orchard.uvm.edu/
37. Tea Board, India http://tea.nic.in/
38. The Horticultural Taxonomy Group http://www.hortax.org.uk/
39. The International Society of Citriculture: http://www.lal.ufl.edu/isc_citrus_homepage.htm
40. The Internet Garden http://www.internetgarden.co.uk/
41. The Rose Resource http://rose.org/
42. The USDA Agricultural Research Service http://www.ars.usda.gov/
43. University of Florida, Dept. of Environmental Horticulture http://hort.ifas.ufl.edu/
44. University of California, Fruit & Nut Research http://fruitsandnuts.ucdavis.edu/
45. US Environmental Protection Agency http://www.epa.gov/:
46. USDA http://www.usda.gov/

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