B. A. College of Agriculture
Anand Agricultural University
Anand-388 110

Read: Resolution of 42nd meeting of the Academic Council held on 06-06-2016, Anand Agricultural University, Anand vide Item No. 42.17.

PG programme in Horticulture for Vegetable Science

NOTIFICATION

It is hereby notified to all concerned that vide Item No. 42.17 of the 42nd meeting held on 06-06-2016, the Academic Council of the Anand Agricultural University has resolved as under:

"It is resolved that the Academic Council approves PG programme leading to M.Sc. degree in Vegetable Science under Horticulture discipline adopting the syllabus of Navsari Agricultural University, Navsari (Appendix-I) w.e.f. academic year 2016-17".

No. AAU/BACA/PGT/ 2931 /2016
Date : 22/06/2016
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PRINCIPAL & DEAN

Copy F.W.Cs. to:

(1) All members of Academic Council of this University.
(2) All officers of this University
(3) All Deans and Principals, AAU, Anand

Office of the Registrar
A.A.U., ANAND
27 JUN 2016
INWARD NO. 5862

Copy to:

(1) P.S. to Vice-Chancellor, Anand Agricultural University, Anand
(2) P.A. to Registrar, Anand Agricultural University, Anand
(3) Office of Registrar (Examination), Legal and Academic Branch (10 copies)

23/6 23/6 27/6

320 27/6/16

Appendix - I

VEGETABLE SCIENCE

Course Structure – at a Glance

CODE	COURSE TITLE	CREDITS
VSC 501*	Production technology of cool season vegetable crops	2+1
VSC 502*	Production technology of warm season vegetable crops	2+1
VSC 503*	Breeding of vegetable crops	2+1
VSC 504*	Growth and development of vegetable crops	2+1
VSC 505	Seed production technology of vegetable crops	2+1
VSC 506	Systematics of vegetable crops	1+1
VSC 507	Production technology of underexploited vegetable crops	1+1
VSC 508	Organic vegetable production technology	1+1
VSC 509	Fundamentals of processing of vegetables	2+1
VSC 591	Master's seminar	1+0
VSC 599	Master's research	20
VSC 601**	Advances in vegetable production	2+1
VSC 602**	Advances in breeding of vegetable crops	2+1
VSC 603**	Protected cultivation of vegetable crops	1+1
VSC 604**	Biotechnology in vegetable crops	2+1
VSC 605	Seed certification, processing and storage of vegetable crops	2+1
VSC 606	Abiotic stress management in vegetable crops	2+1
VSC 691	Doctoral seminar i	1+0
VSC 692	Doctoral seminar ii	1+0
VSC 699	Doctoral research	45

* Compulsory for Master's programme

** Compulsory for Doctoral programme

Conti...

VSC 501 PRODUCTION TECHNOLOGY OF COOL SEASON VEGETABLE CROPS 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, knoll kohl, sprouting broccoli, Brussels 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 MG & Kabir J. (Eds.). 2002. *Vegetable Crops*. Naya Prokash.

Bose TK, Som MG & Kabir J. (Eds.). 1993. *Vegetable Crops*. Naya Prokash.

Bose TK, Kabir J, Maity TK, Parthasarathy VA & Som MG. 2003. *Vegetable Crops*. Vols. I-III. Naya Udyog.

Chadha KL & Kalloo G. (Eds.). 1993-94. *Advances in Horticulture* Vols. V-X. Malhotra Publ. House.

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.

Gopalakrishanan TR. 2007. *Vegetable Crops*. New India Publ. Agency.

Hazra P & Som MG. (Eds.). 1999. *Technology for Vegetable Productionand Improvement*. Naya Prokash.

Rana MK. 2008. *Olericulture in India*. Kalyani Publ.

Rana MK. 2008. *Scientific Cultivation of Vegetables*. Kalyani Publ.

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 Scienceand Technology: Production, Composition, Storage and Processing*. Marcel Dekker.

Shanmugavelu KG. 1989. *Production Technology of Vegetable Crops*. Oxford & IBH.

Singh DK. 2007. *Modern Vegetable Varieties and Production Technology*. International Book Distributing Co.

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.

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VSC 502 PRODUCTION TECHNOLOGY OF WARM SEASON VEGETABLE CROPS 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 and cowpea

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 & Som MG. (Eds.). 1986. *Vegetable Crops in India*. Naya Prokash.

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 & Kalloo G. (Eds.). 1993-94. *Advances in Horticulture*. Vols. V-X. Malhotra Publ. House.

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. 1964. *Fundamentals of Horticulture*. Blakiston Co

Fageria MS, Choudhary BR & Dhaka RS. 2000. *Vegetable Crops:Production Technology*. Vol. II. Kalyani.

Gopalakrishanan TR. 2007. *Vegetable Crops*. New India Publ. Agency.

Hazra P & Som MG. (Eds.). 1999. *Technology for Vegetable Production and Improvement*. Naya Prokash.

Kalloo G & Singh K (Ed.). 2000. *Emerging Scenario in Vegetable Research and Development*. Research Periodicals & Book Publ. House.

Nayer NM & More TA 1998. *Cucurbits*. Oxford & IBH Publ.

Palaniswamy & Peter KV. 2007. *Tuber Crops*. New India Publ. Agency.

Pandey AK & Mudranalay V. (Eds.). *Vegetable Production in India: Important Varieties and Development Techniques*.

Rana MK. 2008. *Olericulture in India*. Kalyani.

Rana MK. 2008. *Scientific Cultivation of Vegetables*. 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 DK. 2007. *Modern Vegetable Varieties and Production Technology*. International Book Distributing Co.

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Singh NP, Bharadwaj AK, Kumar A & Singh KM. 2004. *Modern Technology on Vegetable Production*. International Book Distributing Co.
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 503 BREEDING OF VEGETABLE CROPS 2+1

Objective

To educate principles and practices adopted for breeding of vegetable crops.

Theory

Origin, botany, taxonomy, cytogenetics, genetics, breeding objectives, breeding methods (introduction, selection, hybridization, mutation), varieties and varietal characterization, resistance breeding for biotic and abiotic stress, quality improvement, molecular marker, genomics, marker assisted breeding and QTLs, biotechnology and their use in breeding in vegetable crops-Issue of patenting, PPVFR act.

UNIT I Potato and tomato

UNIT II Eggplant, hot pepper, sweet pepper and okra

UNIT III Peas and beans, amaranth, chenopods and lettuce

UNIT IV Gourds, melons, pumpkins and squashes

UNIT V Cabbage, cauliflower, carrot, beetroot, radish, sweet potato and tapioca

Practical

Selection of desirable plants from breeding population observations and analysis of various qualitative and quantitative traits in germplasm, hybrids and segregating generations; induction of flowering, palanological studies, selfing and crossing techniques in vegetable crops; hybrid seed production of vegetable crops in bulk. screening techniques for insect-pests, disease and environmental stress resistance in above mentioned crops, demonstration of sib-mating and mixed population; molecular marker techniques to identify useful traits in the vegetable crops and special breeding techniques. Visit to breeding blocks.

Suggested Readings

Allard RW. 1999. *Principles of Plant Breeding*. John Wiley & Sons.
Basset MJ. (Ed.). 1986. *Breeding Vegetable Crops*. AVI Publ.
Dhillon BS, Tyagi RK, Saxena S. & Randhawa GJ. 2005. *Plant Genetic Resources: Horticultural Crops*. Narosa Publ. House.
Fageria MS, Arya PS & Choudhary AK. 2000. *Vegetable Crops: Breeding and Seed Production*. Vol. I. Kalyani.
Gardner EJ. 1975. *Principles of Genetics*. John Wiley & Sons.
Hayes HK, Immer FR & Smith DC. 1955. *Methods of Plant Breeding*. McGraw-Hill.
Hayward MD, Bosemark NO & Romagosa I. (Eds.). 1993. *Plant Breeding-Principles and Prospects*. Chapman & Hall.
Kalloo G. 1988. *Vegetable Breeding*. Vols. I-III. CRC Press.
Kalloo G. 1998. *Vegetable Breeding*. Vols. I-III (Combined Ed.). Panima Edu. Book Agency.
Kumar JC & Dhaliwal MS. 1990. *Techniques of Developing Hybrids in Vegetable Crops*. Agro Botanical Publ.
Paroda RS & Kalloo G. (Eds.). 1995. *Vegetable Research with Special Reference to Hybrid Technology in Asia-Pacific Region*. FAO.
Peter KV & Pradeepkumar T. 2008. *Genetics and Breeding of Vegetables*. Revised, ICAR.
Rai N & Rai M. 2006. *Heterosis Breeding in Vegetable Crops*. New India Publ. Agency.
Ram HH. 1998. *Vegetable Breeding: Principles and Practices*. Kalyani.
Simmonds NW. 1978. *Principles of Crop Improvement*. Longman.
Singh BD. 1983. *Plant Breeding*. Kalyani.
Singh PK, Dasgupta SK & Tripathi SK. 2004. *Hybrid Vegetable Development*. International Book Distributing Co.
Swarup V. 1976. *Breeding Procedure for Cross-pollinated Vegetable Crops*. ICAR.

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VSC 504 GROWTH AND DEVELOPMENT OF VEGETABLE CROPS 2+1 473

Objective

To teach the physiology of growth and development of vegetable crops.

Theory

UNIT I Cellular structures and their functions; definition of growth and development, growth analysis and its importance in vegetable production.

UNIT II Physiology of dormancy and germination of vegetable seeds, tubers and bulbs; Role of auxins, gibberellilns, cyktokinins and abscissic acid; Application of synthetic hormones, plant growth retardants and inhibitors for various purposes in vegetable crops; Role and mode of action of morphactins, antitranspirants, anti-auxin, ripening retardant and plant stimulants in vegetable crop production.

UNIT III Role of light, temperature and photoperiod on growth, development of underground parts, flowering and sex expression in vegetable crops; apical dominance.

UNIT IV Physiology of fruit set, fruit development, fruit growth, flower and fruit drop; parthenocarpy in vegetable crops; phototropism, ethylene inhibitors, senescence and abscission; fruit ripening and physiological changes associated with ripening.

UNIT V Plant growth regulators in relation to vegetable production; morphogenesis and tissue culture techniques in vegetable crops.

Practical

Preparation of solutions of plant growth substances and their application; experiments in breaking and induction of dormancy by chemicals; induction of parthenocarpy and fruit ripening; application of plant growth substances for improving flower initiation, changing sex expression in cucurbits and checking flower and fruit drops and improving fruit set in solanaceous vegetables; growth analysis techniques in vegetable crops.

Suggested Readings

Bleasdale JKA. 1984. *Plant Physiology in Relation to Horticulture*. 2nd Ed. MacMillan.

Gupta US. (Ed.). 1978. *Crop Physiology*. Oxford & IBH.

Krishnamoorti HN. 1981. *Application Plant Growth Substances and Their Uses in Agriculture*. Tata-McGraw Hill.

Peter KV. (Ed.). 2008. *Basics of Horticulture*. New India Publ. Agency.

Saini RS, Sharma KD, Dhankhar OP & Kaushik RA. (Eds.). 2001. *Laboratory Manual of Analytical Techniques in Horticulture*. Agrobios.

Wien HC. (Ed.). 1997. *The Physiology of Vegetable Crops*. CABI.

VSC 505 SEED PRODUCTION TECHNOLOGY OF VEGETABLE CROPS 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 VI 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; rouging of off-type; methods of hybrid seed production in important vegetable and spice crops;

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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.

VSC 506 SYSTEMATICS OF VEGETABLE CROPS 1+1

Objective

To teach morphological, cytological and molecular taxonomy of vegetable crops.

Theory

UNIT I

Principles of classification; different methods of classification; salient features of international code of nomenclature of vegetable crops.

UNIT II Origin, history, evolution and distribution of vegetable crops, botanical description of families, genera and species covering various tropical, subtropical and temperate vegetables.

UNIT II I Cytological level of various vegetable crops; descriptive keys for important vegetables.

UNIT IV Importance of molecular markers in evolution of vegetable crops; molecular markers as an aid in characterization and taxonomy of vegetable crops.

Practical

Identification, description, classification and maintenance of vegetable species and varieties; survey, collection of allied species and genera locally available; preparation of keys to the species and varieties; methods of preparation of herbarium and specimens.

Suggested Readings

Chopra GL. 1968. *Angiosperms - Systematics and Life Cycle*. S. Nagin

Dutta AC. 1986. *A Class Book of Botany*. Oxford Univ. Press.

Pandey BP. 1999. *Taxonomy of Angiosperm*. S. Chand & Co.

Peter KV & Pradeepkumar T. 2008. *Genetics and Breeding of Vegetables*. (Revised), ICAR.

Soule J. 1985. *Glossary for Horticultural Crops*. John Wiley & Sons.

Srivastava U, Mahajan RK, Gangopadyay KK, Singh M & Dhillon BS. 2001. *Minimal Descriptors of Agri-Horticultural Crops*. Part-II: *Vegetable Crops*. NBPGR, New Delhi.

Vasistha. 1998. *Taxonomy of Angiosperm*. Kalyani.

Vincent ER & Yamaguchi M. 1997. *World Vegetables*. 2nd Ed. Chapman & Hall.

VSC 507 PRODUCTION TECHNOLOGY OF UNDEREXPLOITED VEGETABLE CROPS 1+1

Objective

To educate production technology of underutilized vegetable crops.

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 Asparagus, artichoke and leek

UNIT II Brussels's sprout, Chinese cabbage, broccoli, kale and artichoke.

UNIT III Amaranth, celery, parsley, parsnip, lettuce, rhubarb, spinach, basella, bathu (chenopods) and chekurmanis.

UNIT IV Elephant foot yam, lima bean, winged bean, vegetable pigeon pea, jack bean and sword bean.

UNIT V Sweet gourd, spine gourd, pointed gourd, Oriental pickling melon and little gourd (kundru).

Practical

Identification of seeds; botanical description of plants; layout and planting; cultural practices; short-term experiments of underexploited vegetables.

Suggested Readings

Bhat KL. 2001. *Minor Vegetables - Untapped Potential*. Kalyani.

Indira P & Peter KV. 1984. *Unexploited Tropical Vegetables*. Kerala Agricultural University, Kerala.

Peter KV. (Ed.). 2007-08. *Underutilized and Underexploited Horticultural Crops*. Vols. I-IV. New India Publ. Agency.

Rubatzky VE & Yamaguchi M. (Eds.). 1997. *World Vegetables: Principles, Production and Nutritive Values*. Chapman & Hall

Srivastava U, Mahajan RK, Gangopadyay KK, Singh M & Dhillon BS. 2001. *Minimal Descriptors of Agri-Horticultural Crops*. Part-II: *Vegetable Crops*. NBPGR, New Delhi.

VSC 508 ORGANIC VEGETABLE PRODUCTION TECHNOLOGY 1+1

Objective

To educate principles, concepts and production of organic farming in vegetable crops.

Theory

UNIT I

Importance, principles, perspective, concept and component of organic production of vegetable crops.

UNIT II Organic production of vegetables crops, *viz.*, solanaceous crops, cucurbits, cole crops, root and tuber crops.

UNIT III Managing soil fertility, pests and diseases and weed problems in organic farming system; crop rotation in organic horticulture; processing and quality control for organic foods.

UNIT IV Methods for enhancing soil fertility, mulching, raising green manure crops. Indigenous methods of compost, Panchagavvya, Biodynamics, preparation etc Pest and disease management in organic farming; ITK's in organic farming. Role of botanicals and bio-control agents.

UNIT V GAP and GMP- Certification of organic products; organic production and export - opportunity and challenges.

Practical

Method of preparation of compost, vermicomposting, biofertilizers, soil solarization, bio pesticides in horticulture, green manuring, mycorrhizae and organic crop production, water management, organic soil amendment for root disease, weed management in organic horticulture. Visit to organic fields and marketing centers.

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Suggested Readings
Dahama AK. 2005. *Organic Farming for Sustainable Agriculture*. 2nd Ed. Agrobios.
Gehlot G. 2005. *Organic Farming; Standards, Accreditation Certification and Inspection*. Agrobios.
Palaniappan SP & Annadorai K. 2003. *Organic Farming, Theory and Practice*. Scientific Publ.
Pradeepkumar T, Suma B, Jyothibhaskar & Satheesan KN. 2008. *Management of Horticultural Crops*. New India Publ. Agency.
Shivashankar K. 1997. *Food Security in Harmony with Nature*. 3rd IFOAMASIA, Scientific Conf.. 1- 4 December, 1997, UAS, Bangalore.

VSC 509 FUNDAMENTALS OF PROCESSING OF VEGETABLES 2+1

Objective
To educate principles and practices of processing of vegetable crops.

Theory
UNIT I History of food preservation. Present status and future prospects of vegetable preservation industry in India.
UNIT II Spoilage of fresh and processed horticultural produce; biochemical changes and enzymes associated with spoilage of horticultural produce; principal spoilage organisms, food poisoning and their control measures. Role of microorganisms in food preservation.
UNIT III Raw materials for processing. Primary and minimal processing; processing equipments; Layout and establishment of processing industry, FPO licence. Importance of hygiene; Plant sanitation.
UNIT IV Quality assurance and quality control, TQM, GMP. Food standards – FPO, PFA, etc. Food laws and regulations.
UNIT V Food safety – Hazard analysis and critical control points (HACCP). Labeling and labeling act, nutrition labeling.
UNIT VI Major value added products from vegetables.Utilization of byproducts of vegetable processing industry; Management of waste from processing factory.
UNIT VII Investment analysis. Principles and methods of sensory evaluation of fresh and processed vegetables.

Practical
Study of machinery and equipments used in processing of horticultural produce; Chemical analysis for nutritive value of fresh and processed vegetables; Study of different types of spoilages in fresh as well as processed horticultural produce; Classification and identification of spoilage organisms; Study of biochemical changes and enzymes associated with spoilage; Laboratory examination of vegetable products; Sensory evaluation of fresh and processed vegetables; Study of food standards – National, international, CODEX Alimentarius; Visit to processing units to study the layout, equipments, hygiene, sanitation and residual / waste management.

Suggested Readings
Arthey D & Dennis C. 1996. *Vegetable Processing*. Blackie/Springer- Verlag.
Chadha DS. 2006. *The Prevention of Food Adulteration Act*. Confed. Of Indian Industry.
Desrosier NW. 1977. *Elements and Technology*. AVI Publ. Co. FAO. 1997. *Fruit and Vegetable Processing*. FAO.
FAO. *CODEX Alimentarius*: Joint FAO/WHO Food Standards Programme. 2nd Ed. Vol. VB. *Tropical Fresh Fruits and Vegetables*. FAO.
FAO. *Food Quality and Safety Systems – Training Manual on Food Hygiene and HACCP*. FAO.
Fellow's P. 1988. *Food Processing Technology*. Ellis Horwood International.
Frazier WC & Westhoff DC. 1995. *Food Microbiology*. 4th Ed. Tata McGraw Hill.
Giridharilal GS, Siddappa & Tandon GL. 1986. *Preservation of Fruits and Vegetables*. ICAR.
Gisela J. 1985. *Sensory Evaluation of Food – Theory and Practices*. Ellis Horwood.
Graham HD. 1980. *Safety of Foods*. AVI Publ. Co.

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Hildegrade H & Lawless HT. 1997. *Sensory Evaluation of Food*. CBS.
Joslyn M & Heid. *Food Processing Operations*. AVI Publ. Co.
Mahindru SN. 2004. *Food Safety: Concepts and Reality*. APH Publ. Corp.
Ranganna S. 1986. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*. 2nd Ed. Tata-McGraw Hill.
Shapiro R. 1995. *Nutrition Labeling Handbook*. Marcel Dekker.
Srivastava RP & Kumar S. 2003. *Fruit and Vegetable Preservation: Principles and Practices*. 3rd Ed. International Book Distri. Co.
Tressler & Joslyn MA. 1971. *Fruit and Vegetable Juice Processing Technology*. AVI Publ. Co.
Verma LR & Joshi VK. 2000. *Post-harvest Technology of Fruits and Vegetables: Handling, Processing, Fermentation and Waste Management*. Indus Publ. Co.

VSC 601 ADVANCES IN VEGETABLE PRODUCTION 2+1

Objective

To keep abreast with latest developments and trends in production technology of vegetable crops.

Theory

Present status and prospects of vegetable cultivation; nutritional and medicinal values; climate and soil as critical factors in vegetable production; choice of varieties; nursery management; modern concepts in water and weed management; physiological basis of growth, yield and quality as influenced by chemicals and growth regulators; role of organic manures, inorganic fertilizers, micronutrients and biofertilizers; response of genotypes to low and high nutrient management, nutritional deficiencies, disorders and correction methods; different cropping systems; mulching; containerized culture for year round vegetable production; low cost polyhouse; net house production; crop modeling, organic gardening; vegetable production for pigments, export and processing of:

UNIT I Tomato, brinjal, chilli, sweet pepper and potato

UNIT II Cucurbits, cabbage, cauliflower and knol-khol

UNIT III Bhendi, onion, peas and beans, amaranthus and drumstick

UNIT IV Carrot, beet root and radish

UNIT V Sweet potato, tapioca, elephant foot yam and taro

Practical

Seed hardening treatments; practices in indeterminate and determinate vegetable growing and organic gardening; portrays and ball culture; diagnosis of nutritional and physiological disorders; analysis of physiological factors like anatomy; photosynthesis; light intensity in different cropping situation; assessing nutrient status, use of plant growth regulators; practices in herbicide application; estimating water requirements in relation to crop growth stages, maturity indices; dryland techniques for rainfed vegetable production; production constraints; analysis of different cropping system in various situation like cold and hot set; vegetable waste recycling management; quality analysis ;marketing survey of the above crops; visit to vegetable and fruit mals and packing houses.

Suggested Readings

Bose TK & Som NG. 1986. *Vegetable Crops of India*. Naya Prokash.
Bose TK, Kabir J, Maity TK, Parthasarathy VA & Som MG. 2003. *Vegetable Crops*. Vols. I-III. Naya Udyog.
Brewster JL. 1994. *Onions and other Vegetable Alliums*. CABI.
FFTC. *Improved Vegetable Production in Asia*. Book Series No. 36.
Ghosh SP, Ramanujam T, Jos JS, Moorthy SN & Nair RG. 1988. *Tuber Crops*. Oxford & IBH.
Gopalakrishnan TR. 2007. *Vegetable Crops*. New India Publishing Agency.
Kallo G & Singh K. (Ed.). 2001. *Emerging Scenario in Vegetable Research and Development*. Research Periodicals & Book Publ. House.
Kurup GT, Palanisami MS, Potty VP, Padmaja G, Kabeerathuma S & Pallai SV. 1996. *Tropical Tuber Crops, Problems, Prospects and Future Strategies*. Oxford & IBH.
Sin MT & Onwueme IC. 1978. *The Tropical Tuber Crops*. John Wiley & Sons.

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Singh NP, Bhardwaj AK, Kumar A & Singh KM. 2004. *Modern Technology on Vegetable Production*. International Book Distr. Co.
Singh PK, Dasgupta SK & Tripathi SK. 2006. *Hybrid Vegetable Development*. International Book Distr. Co.

VSC 602 ADVANCES IN BREEDING OF VEGETABLE CROPS 2+1

Objective

To update knowledge on the recent research trends in the field of breeding of vegetable crops with special emphasis on tropical, subtropical and temperate crops grown in India.

Theory

Evolution, distribution, cytogenetics, genetic resources, genetic divergence, types of pollination and fertilization mechanisms, sterility and incompatibility, anthesis and pollination, hybridization, inter-varietal, interspecific and inter-generic hybridization, heterosis breeding, inheritance pattern of traits, qualitative and quantitative, plant type concept and selection indices, genetics of spontaneous and induced mutations, problems and achievements of mutation breeding, ploidy breeding and its achievements, *in vitro* breeding; breeding techniques for improving quality and processing characters; breeding for stresses, mechanism and genetics of resistance, breeding for salt, drought; low and high temperature; toxicity and water logging resistance, breeding for pest, disease, nematode and multiple resistance of:

UNIT I Tomato, brinjal, chilli, sweet pepper and potato

UNIT II Cucurbits, Cabbage, cauliflower and knol-khol

UNIT III Bhindi/okra, onion, peas and beans, amaranthus and drumstick

UNIT IV Carrot, beet root and radish

UNIT V Sweet potato, tapioca, elephant foot yam and taro

Practical

Designing of breeding experiments, screening techniques for abiotic stresses, screening and rating for pest, disease and nematode resistance, estimation of quality and processing characters, screening for-quality improvement, estimation of heterosis and combining ability, induction and identification of mutants and polyploids, distant hybridization and embryo rescue techniques.

Suggested Readings

Acta Horticulture. Conference on Recent Advance in Vegetable Crops. Vol. 127.
Chadha KL, Ravindran PN & Sahijram L. 2000. *Biotechnology in Horticultural and Plantation Crops*. Malhotra Publ. House.
Chadha KL. 2001. *Hand Book of Horticulture*. ICAR.
Dhillon BS, Tyagi RK, Saxena S & Randhawa GJ. 2005. *Plant Genetic Resources: Horticultural Crops*. Narosa Publ. House.
Janick JJ. 1986. *Horticultural Science*. 4th Ed. WH Freeman & Co.
Kaloo G & Singh K. 2001. *Emerging Scenario in Vegetable Research and Development*. Research Periodicals and Book Publ. House.
Kaloo G. 1994. *Vegetable Breeding*. Vols. I-III. Vedams eBooks.
Peter KV & Pradeep Kumar T. 2008. *Genetics and Breeding of Vegetables*. (Revised Ed.). ICAR.
Ram HH. 2001. *Vegetable Breeding*. Kalyani.

VSC 603 PROTECTED CULTIVATION OF VEGETABLE CROPS 1+1

Objective

To impart latest knowledge in growing of vegetable crops under protected environmental condition.

Theory

Crops: Tomato, capsicum, cucumber, melons and lettuce

UNIT I Importance and scope of protected cultivation of vegetable crops; principles used in protected cultivation, energy management, low cost structures; training methods; engineering aspects.

UNIT II Regulatory structures used in protected structures; types of greenhouse/polyhouse/nethouse, hot beds, cold frames, effect of environmental factors, *viz.*

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temperature, light, CO_2 and humidity on growth of different vegetables, manipulation of CO_2, light and temperature for vegetable production, fertigation.

UNIT III Nursery raising in protected structures like poly-tunnels, types of benches and containers, different media for growing nursery under cover.

UNIT IV Regulation of flowering and fruiting in vegetable crops, technology for raising tomato, sweet pepper, cucumber and other vegetables in protected structures, training and staking in protected crops, varieties and hybrids for growing vegetables in protected structures.

UNIT V Problem of growing vegetables in protected structures and their remedies, insect and disease management in protected structures; soil-less culture, use of protected structures for seed production.

Practical

Study of various types of structures, methods to control temperature, CO_2 light, media, training and pruning, maintenance of parental lines and hybrid seed production of vegetables, fertigation and nutrient management, control of insect-pests and disease in greenhouse; economics of protected cultivation, visit to established green/polyhouse/net house/shade house in the region.

Suggested Readings

Anonymous 2003. *Proc. All India Seminar on Potential and Prospects for Protective Cultivation.* Organised by Institute of Engineers, Ahmednagar. Dec.12-13, 2003.

Chandra S & SomV. 2000. *Cultivating Vegetables in Green House. Indian Horticulture* 45:17-18.

Prasad S & Kumar U. 2005. *Greenhouse Management for Horticultural Crops.* 2nd Ed. Agrobios.

Tiwari GN. 2003. *Green House Technology for Controlled Environment.* Narosa Publ. House.

VSC 604 BIOTECHNOLOGY IN VEGETABLE CROPS 2+1

Objective

To teach advances in biotechnology for improvement of vegetable crops.

Theory

Crops: Tomato, eggplant, hot and sweet pepper, potato, cabbage, cauliflower, tapioca, onion, cucurbits.

UNIT I *In vitro* culture methods and molecular approaches for crop improvement in vegetables, production of haploids, disease elimination in horticultural crops, micro grafting, somoclones and identification of somaclonal variants, *in vitro* techniques to overcome fertilization barriers, *in vitro*production of secondary metabolites.

UNIT II Protoplast culture and fusion; construction, identification and characterization of somatic hybrids and cybrids, wide hybridization, embryo rescue of recalcitrant species, *in vitro* conservation.

UNIT III *In vitro* mutation for biotic and abiotic stresses, recombinant DNA methodology, gene transfer methods, tools, methods, applications of rDNA technology.

UNIT IV Quality improvement, improvement for biotic and abiotic stresses, transgenic plants.

UNIT V Role of molecular markers in characterization of transgenic crops, fingerprinting of cultivars etc., achievements, problems and future thrusts in horticultural biotechnology.

Practical

Establishment of axenic explants, callus initiation and multiplication, production of suspension culture, cell and protoplast culture, fusion, regeneration and identification of somatic hybrids and cybrids; Identification of embryonic and non-embryonic calli, development of cell lines; *in vitro* mutant selection for biotic and abiotic stresses, *In vitro* production and characterization of secondary metabolites, isolated microspore culture, isolation and amplification of DNA, gene transfer methods, molecular characterization of transgenic plants.

Suggested Readings

Bajaj YPS. (Ed.). 1987. *Biotechnology in Agriculture and Forestry.* Vol.XIX. *Hitech and Micropropagation.* Springer.

Chadha KL, Ravindran PN & Sahijram L. (Eds.). 2000. *Biotechnology of Horticulture and Plantation Crops.* Malhotra Publ. House.

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Debnath M. 2005. *Tools and Techniques of Biotechnology*. Pointer Publ.
Glover MD. 1984. *Gene Cloning: The Mechanics of DNA Manipulation*. Chapman & Hall.
Gorden H & Rubsell S. 1960. *Hormones and Cell Culture*. AB Book Publ.
Keshavachandran R & Peter KV. 2008. *Plant Biotechnology: Tissue Culture and Gene Transfer*. Orient & Longman (Universal Press).
Keshavachandran R et al. 2007. *Recent Trends in Biotechnology of Horticultural Crops*. New India Publ. Agency.
Panopoulas NJ. (Ed.). 1981. *Genetic Engineering in Plant Sciences*. Praeger Publ.
Parthasarathy VA, Bose TK, Deka PC, Das P, Mitra SK & Mohanadas S. 2001. *Biotechnology of Horticultural Crops*. Vols. I-III. Naya Prokash.
Pierik RLM. 1987. *In vitro Culture of Higher Plants*. Martinus Nijhoff Publ.
Prasad S. 1999. *Impact of Plant Biotechnology on Horticulture*. 2nd Ed. Agro Botanica.
Sharma R. 2000. *Plant Tissue Culture*. Campus Books.
Singh BD.2001. *Biotechnology*. Kalyani.
Skoog Y & Miller CO. 1957. *Chemical Regulation of Growth and Formation in Plant Tissue Cultured in vitro*. Attidel. II Symp. On Biotechnology Action of Growth Substance.
Vasil TK, Vasi M, While DNR & Bery HR. 1979. *Somatic Hybridization and Genetic Manipulation in Plants. Plant Regulation and World Agriculture*. Planum Press.
Williamson R. 1981-86. *Genetic Engineering*. Vols. I-V.

VSC 605 SEED CERTIFICATION, PROCESSING AND STORAGE OF VEGETABLE CROPS 2+1

Objective

To educate the recent trends in the certification, processing and storage of vegetable crops.

Theory

UNIT I Seed certification, objectives, organization of seed certification, minimum seed certification standards of vegetable crops, field inspection, specification for certification.

UNIT II Seed processing, study of seed processing equipments seed cleaning and upgrading, Seed packing and handling, equipment used for packaging of seeds, procedures for allocating lot number.

UNIT III Pre-conditioning, seed treatment, benefits, types and products, general principles of seed storage, advances in methods of storage, quality control in storage, storage containers, seed longevity and deterioration, sanitation, temperature and relative humidity control.

UNIT IV

Seed testing; ISTA rules for testing, moisture, purity germination, vigor test, seed sampling, determination of genuineness of varieties, seed viability, seed health testing; seed dormancy and types of dormancy, factors responsible for dormancy.

UNIT V Seed marketing, demand forecast, marketing organization, economics of seed production; farmers' rights, seed law enforcement, seed act and seed policy.

Practical

Seed sampling, purity, moisture testing, seed viability, seed vigor tests, seed health testing, seed cleaning, grading and packaging; handling of seed testing equipment and processing machines; seed treatment methods, seed priming and pelleting; field and seed inspection, practices in rouging, seed storage, isolation distances, biochemical tests, visit to seed testing laboratories and processing plants, mixing and dividing instruments, visit to seed processing unit and warehouse, visit and know about sanitation standards.

Suggested Readings

Agrawal PK & Dadlani M. 1992. *Tecniques in Seed Science and Technology*. South Asian Publ.
Singh N, Singh DK, Singh YK & Kumar V. 2006. *Vegetable Seed Production Technology*. International Book Distr. Co.
Singh SP. 2001. *Seed Production of Commercial Vegetables*. Agrotech Publ. Academy.
Tanwar NS & Singh SV. 1988. *Indian Minimum Seed Certification Standards*. Central Seed Certification Board, GOI, New Delhi.
Rajan S & Baby L Markose 2007. *Propagation of Horticultural Crops*. New India Publ. Agency.

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VSC 606 ABIOTIC STRESS MANAGEMENT IN VEGETABLE CROPS 2+1

Objective

To update knowledge on the recent research trends in the field of breeding of vegetable crops with special emphasis on tropical, subtropical and temperate crops grown in India.

Theory

UNIT I Environmental stress and its types, soil parameters including pH, classification of vegetable crops based on susceptibility and tolerance to various types of stress; root stock, use of wild species, use of antitranspirants.

UNIT II Mechanism and measurements of tolerance to drought, water logging, soil salinity, frost and heat stress in vegetable crops.

UNIT III Soil-plant-water relations under different stress conditions in vegetable crops production and their management practices.

UNIT IV Techniques of vegetable growing under water deficit, water logging, salinity and sodicity.

UNIT V Techniques of vegetable growing under high and low temperature conditions, use of chemicals in alleviation of different stresses.

Practical

Identification of susceptibility and tolerance symptoms to various types of stress in vegetable crops, measurement of tolerance to various stresses in vegetable crops, short term experiments on growing vegetable under water deficit, water-logging, salinity and sodicity, high and low temperature conditions, and use of chemicals for alleviation of different stresses.

Suggested Readings

Dwivedi P & Dwivedi RS. 2005. *Physiology of Abiotic stress in Plants*. Agrobios.

Lerner HR (Ed.). 1999. *Plant Responses to Environmental Stresses*. Marcel Decker.

Maloo SR. 2003. *Abiotic Stresses and Crop Productivity*. Agrotech Publ. Academy.