FACULTY OF AGRICULTURAL SCIENCES

COURSE ORDINANCE

Ph.D

Horticulture (Vegetable Science)

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

Preamble

Vegetables are important constituents of Indian diet and play an important role ensuring nutritional security. They are generally of short duration, high yielding, nutraceuitically rich, economically viable and generating substancial on-farm and off-farm employment. Vegetables have aprestine place in Indian agricultural economy. The country is being blessed with diverse agro-climatic conditions ranged from the tempearate to arid more than 60 cultivated and 30 lesser known vegetables are being grown.

The country has witnessed a tremendous growth in vegetable production and productivity as a result of improved varieties/ F1 hybrids/ technologies through systematic research coupled with their large scale adoption by the farmers and developmental policies of government compared to area (2.84 m ha), production (16.5 mt) and productivity (5.8 t/ha) in 1950–51 there had been phenomenal increase in area (>3 folds; 10.1 m ha), production (>10 folds; 185 mt) and productivity (>3 folds; 18.0 t/ha) during 2017–18. Increasing per capita income, health conciousness, urbanisation, shifting of farmers to high value vegetables due to higher income, favourable income elasticity of demand and annual growth rate of domestic demand for vegetables are also important factors fueling its growth in the country.

During 2016–17, the total exports including potato and onion accounted for ₹ 5,922 crores sharing 35% of total horticultural exports. With the current level of vegetable production in the country (171 mt), population (1.3 billion) and considering 25% post harvest losses and 5% export and processing, the per capita availability of vegetable production in our country is 250 g as against 300 g recommended dietary allowance (RDA). With projected population of 1.45 billion by 2030, India has to produce 210 mt of vegetables. The targeted production needs to be achieved through utilizing scientific technological and traditional strength in a sustainable manner without much increasing area under vegetables.

Looking in to the above scenario in vegetable production, there is a need to update the knowledge among the post-graduates of Vegetable Science. An effort is therefore made to encompass the adavances made in the vegetable production by revisting the post-graduate curriculum for delivering and assuring quality education. The proposed curriculum aims to develop a competent human resource equipped with holistic and updated knowledge and skill in the field of Vegetable Science.

The course curriculum has been restructured to cover the current requirement of vegetable production and post harvest management to increase capabilities of students. In order to accomplish the task, either new courses have been formulated or existing course contents are upgraded to include latest developments in vegetables production.

In line with national policies, the existing course contents have been upgraded and five new courses, viz., Principles of vegetable breeding, Breeding for special triats in Vegetable crops, Biodiversity and conservation of Vegetable crops, Biotechnological approaches in Vegetable crops and

Advanced laboratory techniques for vegetable crops have been added. A course on Vegetable Breeding has been divided into two courses one for self-pollinated crops and another for cross pollinated vegetable crops. New components, *viz*., hydroponics, aeroponics, grafting technique and precision farming have been added in appropriate courses. The overall upgradation of course contents as well as addition of courses are in line with national policy priorities like doubling of farmer's income, more crop per drop, jaivik krishi, soil health, skill development, entrepreneurship development, startup initiatives, etc.

Course Title with Credit Load

Ph.D. Horticulture (Vegetable Science)

Course Code (ICAR)	SGTU Code	Course Title	Credits
VSC 601*	11240202	Recent Trends in Vegetable Production	3+0
VSC 602*	11240101	Advances in Breeding of Vegetable Crops	3+0
VSC 603	11240301	Abiotic Stress Management in Vegetable Crops	2+1
VSC 604	11240201	Seed Certification, Processing and Storage of Vegetable Crops	2+1
VSC 605	11240102	Breeding for Special Traits in Vegetable Crops	2+0
VSC 606	11240103	Biodiversity and Conservation of Vegetable Crops	2+1
VSC 607	11240302	Biotechnological Approaches in Vegetable Crops	2+1
VSC 608	11240104	Advanced Laboratory Techniques for Vegetable Crops	1+2
		Minor courses	06
		Supporting courses	05
VSC 691	11240209	Seminar I	0+1
VSC 692	11240311	Seminar II	0+1
VSC 699	11240312	Doctoral Research	15
VSC 699	11240401	Doctoral Research	20
VSC 699	11240501	Doctoral Research	20
VSC 699	11240601	Doctoral Research	20
		Total Credits	**100**

*Compulsory among major courses

COURSE CONTENTS

COURSE CONTENTS

Ph.D. Horticulture (Vegetable Science)

1. Course Title : Recent Trends in Vegetable Production

Course Code : 11240202

Credit Hours : (3+0)

Why this course ?

India is the second largest producer of vegetables in the world, next only to China. Most challenging task is to ensure for continuous and enough supply of vegetables to growing population. Urban areas are experiencing substantial increase in population; this growth is accompanied with change in food habits and rising concerns for food quality. Here, food quality refers to the optimum levels of the nutrition in the food along with the minimized amount of the chemical (pesticides/ fertilizers) residues used in the production of the vegetables. Vegetables are being highly seasonal, perishable are also capital and labour intensive and need care in handling and transportation. Environmental stress (climate change) and shortage of water and land resources are major constraints haunting the production. Though the advances in science and information technology has resulted in more comfortable world with global linkages, these advances has led to changes in production practices. Thus, the students of vegetable science need to have an understanding of recent trends in production technology of vegetable crops and their management.

Aim of the course

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

The course is constructed given as under:

1. Solanaceous crops production
2. Cole crops , Okra, onion, peas and beans, amaranth and drumstick.
3.Root crops and cucurbits
4.Tuber crops

Theory

Present status and prospects of vegetable cultivation; nutritional, antioxidant and medicinal values; climate and soil as critical factors in vegetable production; choice of varieties; Hi-tech 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; Protected cultivation of vegetables, containerized culture

Horticultural Sciences–Vegetable Science for year round vegetable production; low cost polyhouse; net house production; crop modelling, organic gardening; vegetable production for pigments, export and processing of:

Unit I

Solanaceous crops: Tomato, brinjal, chilli, sweet pepper and potato.

Unit II

Cole crops: Cabbage, cauliflower and knol-khol, sprouting broccoli.

Unit III

Okra, onion, peas and beans, amaranth and drumstick.

Unit IV

Root crops and cucurbits: Carrot, beet root, turnip and radish and cucurbits

Unit V

Tuber crops: Sweet potato, Cassava, elephant foot yam, Dioscorea and taro.

Teaching Methods/ Activities

Classroom Lectures

Assignment (written and speaking)

Student presentation

Group discussion

Learning outcome

After successful completion of this course, the students are exposed to:

Acquire the knowledge about recent trends in production technology of vegetable crops

Suggested Reading

- Bose TK and Som NG. 1986. Vegetable crops of India. Naya prokash.
- Bose TK, Kabir J, Maity TK, Parthasarathy VA and Som MG. 2003. Vegetable crops. Vols. I-III. Naya Udyog.
- Brewster JL. 1994. Onions and other vegetable alliums. CABI.
- Chadha KL and 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 and Sons.

- Fageria MS, Choudhary BR and Dhaka RS. 2000. Vegetable crops: production technology. Vol.
- Kalyani.
- FFTC. Improved vegetable production in Asia. Book Series No. 36.
- Ghosh SP, Ramanujam T, Jos JS, Moorthy SN and Nair RG. 1988. Tuber crops. Oxford and IBH.
- Gopalakrishanan TR. 2007. Vegetable crops. New India Publ. Agency.
- Hazra P and Som MG. 2015. Seed production and hybrid technology of vegetable crops. Kalyani publishers, Ludhiana.
- Hazra P. 2016. Vegetable science. 2ndedn, Kalyani publishers, Ludhiana.
- Hazra P. 2019. Vegetable production and technology. New India publishing agency, New Delhi. Kallo G and Singh K. (Ed.). 2001. Emerging scenario in vegetable research and development.
- Research periodicals and Book Publ. House.
- Kurup GT, Palanisami MS, Potty VP, Padmaja G, Kabeerathuma S and Pallai SV. 1996. Tropical tuber crops, problems, prospects and future strategies. Oxford and IBH.
- Rana MK. 2008. Olericulture in India. Kalyani Publishers, New Delhi.
- Rana MK. 2008. Scientific cultivation of vegetables. Kalyani Publishers, New Delhi nutritive values. Chapman and Hall.
- Saini GS. 2001. A Text Book of oleri and flori culture. Aman Publishing House.
- Salunkhe DK and 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 and IBH. Sin MT and Onwueme IC. 1978. The tropical tuber crops. John Wiley and Sons.
- Singh DK. 2007. Modern vegetable varieties and production technology. International book distributing Co.
- Singh NP, Bhardwaj AK, Kumar A and Singh KM. 2004. Modern technology on Vegetable production. International book distr. Co.
- Singh PK, Dasgupta SK and Tripathi SK. 2006. Hybrid vegetable development. International book distr. Co.
- Singh SP. (Ed.). 1989. Production technology of vegetable crops. Agril. Comm. Res. Centre. Thamburaj S and Singh N. (Eds.). 2004. Vegetables, tuber crops and spices. ICAR. Thompson HC and Kelly WC. (Eds.). 1978. Vegetable crops. Tata McGraw-Hill.

2. Course Title : Advances in Breeding of Vegetable Crops

Course Code : 11240101

Credit Hours : (3 +0)

Why this course ?

The improvement of vegetable crops has until recently, been largely confined to conventional breeding approaches and such programmes rely on hybridization of plants which have desirable heritable characteristics and on naturally or artificially induced random mutations. The introduction of new genetic information can result in increased resistance to insect pest, diseases tolerance to environmental condition, improved quality, etc. The modern biotechnological tools like molecular assisted selection, double haploidy, genetic engineering, etc. can be of immense importance for rapid development of superior varieties with desirable qualitative and quantitative traits. Therefore, conventional breeding in conjunction with molecular biology has bright prospects of developing high yielding vegetable varieties with high nutraceuticals and bio active compounds suitable for fresh as well as processed market. The students of vegetable science who are having breeding as major subject need to have an understanding of recent technologies in vegetable crops.

Aim of the course

To impart knowledge on the recent research trends and advances in breeding of vegetable crops.

The course is constructed given as under:

Unit

1 Advances in Breeding of vegetable

1. Solanaceous crops and okra crops

2. Cucurbits and Cole crops

3.Legumes and leafy vegetables

4.Root crops and onion

5.Tuber crops

Theory

Evolution, distribution, cytogenetics, Genetics and genetic resources, wild relatives, genetic divergence, hybridization, inheritance of qualitative and quantitative traits, heterosis breeding, plant idotype concept and selection indices, breeding mechanisms, pre breeding, mutation breeding, ploidy breeding, breeding for biotic and abiotic stresses, breeding techniques for improving quality and processing characters, bio- fortification, in-vitro breeding, marker assisted breeding, haploidy, development of transgenic.

Unit I

Solanaceous crops—Tomato, Brinjal, Hot Peeper, Sweet Pepper, Okra and Potato

Unit II

Cucurbits and Cole crops

Unit III

Legumes and leafy vegetables—Peas and Beans, Amaranth, Palak, Chenopods and Lettuce.

Unit IV

Root crops and onion—Carrot, Beetroot, Radish, Turnip, Onion

Unit V

Tuber crops—Sweet potato, Tapioca, Elephant foot yam, Colocasia, Dioscorea

Teaching Methods/ Activities

Classroom Lectures

Assignment (written and speaking)

Student presentation

Group discussion

Learning outcome

After successful completion of this course, the students are exposed to:

Breeding objectives and trends

Recent Advances in vegetable breeding

Suggested Reading

- Allard RW. 1999. Principle of plant breeding. John Willey and Sons, USA. Basset MJ. (Ed.). 1986. Breeding vegetable crops. AVI Publ.
- Dhillon BS, Tyagi RK, Saxena S and Randhawa GJ. 2005. Plant genetic resources: horticultural crops. Narosa Publ. House.
- Fageria MS, Arya PS and Choudhary AK. 2000. Vegetable crops: Breeding and seed production.
- Vol. I. Kalyani.
- Gardner EJ. 1975. Principles of genetics. John Wiley and Sons.
- Hayes HK, Immer FR and Smith DC. 1955. Methods of plant breeding. McGraw-Hill.
- Hayward MD, Bosemark NO and Romagosa I. (Eds.). 1993. Plant Breeding-principles and prospects. Chapman and Hall.
- Hazra P and Som MG. 2015. Vegetable science (Second revised edition), Kalyani publishers, Ludhiana, 598 p
- Hazra P and Som MG. 2016. Vegetable seed production and hybrid technology (Second revised edition), Kalyani Publishers, Ludhiana, 459 p
- Kalloo G. 1988. Vegetable breeding (Vol. I, II, III). CRC Press, Fl, USA.
- Kalloo G. 1998. Vegetable breeding. Vols. I-III (Combined Ed.).

Panima Edu. Book Agency. Kumar JC and Dhaliwal MS. 1990. Techniques of developing hybrids in vegetable crops. Agro

- Botanical Publ.
- Paroda RS and Kalloo G. (Eds.). 1995. Vegetable research with special reference to hybrid technology in Asia-Pacific Region. FAO.
- Peter KV and Pradeepkumar T. 2008. Genetics and breeding of vegetables. Revised, ICAR.
- Peter KV and Hazra P. (Eds). 2012. Hand book of vegetables. Studium press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 678p.
- Peter KV and Hazra P. (Eds). 2015. Hand book of vegetables Volume II.Studium Press LLC,
- P.O. Box 722200, Houston, Texas 77072, USA, 509p.
- Peter KV and Hazra P. (Eds). 2015. Hand book of vegetables Volume III.Studium Press LLC,
- P.O. Box 722200, Houston, Texas 77072, USA, 634p.
- Rai N and Rai M. 2006. Heterosis breeding in vegetable crops. New India Publ. Agency.
- Ram HH. 1998. Vegetable breeding: principles and practices. Kalyani Publishers, New Delhi. Simmonds NW. 1978. Principles of crop improvement. Longman. Singh BD. 1983. Plant Breeding.
- Kalyani Publishers, New Delhi.
- Singh BD. 1983. Plant breeding. Kalyani Publishers, New Delhi.
- Singh PK, Dasgupta SK and Tripathi SK. 2004. Hybrid vegetable development. International Book Distributing Co.
- Swarup V. 1976. Breeding procedure for cross-pollinated vegetable crops. ICAR.

3.Course Title : Abiotic Stress Management in Vegetable Crops

Course Code : 11240301

Credit Hours : (2+1)

Why this course ?

Improvement of vegetable crops has traditionally focused on enhancing a plant's ability to resist diseases or insects. That is evidenced by the large number of disease- or insect-resistant cultivars or germplasm released and used. Research on crop resistance or tolerance to abiotic stresses (heat, cold, drought, flood, salt, pH, etc.) has not received much attention. However, that is changing as a result of the research and publicity of global warming. The changing environments pose serious and imminent threats to vegetable production and place unprecedented pressures on the sustainability of vegetable production. The challenges and opportunities coexist for our dynamic and resilient industry. In addition to conserving resources, we should mitigate abiotic stresses and adapt to the warming

planet. The student of vegetable science need to know the different methods involved to mitigate the abiotic stress in vegetable crops.

Aim of the course

To update knowledge on the recent research trends in the field of abiotic stress management in vegetables.

To teach management practices to mitigate abiotic stress in vegetable crops

The course is constructed given as under:

1 Abiotic stress management in

1. Environmental stress vegetable crops

2.Mechanism and measurements of tolerance

3.Soil-plant-water relations

4.Techniques of vegetable growing under high stress condition

5.Use of chemicals

Theory

Unit I

Environmental stress—its types, soil parameters including pH, classification of vegetable crops based on susceptibility and tolerance to various types of stress.

Unit II

Mechanism and measurements—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

Use of chemicals—techniques of vegetable growing under high and low temperature conditions, use of chemicals and antitranspirants 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;

Use of chemicals for alleviation of different stresses.

Teaching Methods/ Activities

Classroom Lectures

Assignment (written and speaking)

Student presentation

Hands on training of different procedure

Group discussion

Learning outcome

After successful completion of this course, the students are expected to:

Acquire the knowledge about effect of different abiotic stresses on vegetables

Methods to mitigate abiotic stress in vegetables

Suggested Reading

- Dhillon BS, Tyagi RK, Saxena S and Randhawa GJ. 2005. Plant genetic resources: horticultural crops. Narosa Publ. House.
- Dwivedi P and Dwivedi RS. 2005. Physiology of abiotic stress in plants. Agrobios. Janick JJ. 1986. Horticultural science. 4th Ed. WH Freeman and Co.
- Kaloo G and 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.
- Lerner HR. (Eds.). 1999. Plant responses to environmental stresses. Marcel Decker. Maloo SR. 2003. Abiotic stresses and crop productivity.Agrotech Publ. Academy.
- Narendra T. et al. 2012. Improving crops resistance to abiotic stress. Wiley and Sons.US. Peter KV and Pradeep Kumar T. 2008. Genetics and breeding of vegetables. (Revised Ed.). ICAR. Peter KV and Hazra P. (Eds). 2015. Hand book of vegetables volume II.Studium Press LLC,
- P.O. Box 722200, Houston, Texas 77072, USA, 509p.
- Peter KV and Hazra P. (Eds). 2015. Hand book of vegetables volume III. Studium Press LLC,
- P.O. Box 722200, Houston, Texas 77072, USA, 634p. Ram HH. 2001. Vegetable breeding. Kalyani.
- Rao NK. (Eds.). 2016. Abiotic stress physiology of horticultural crops. Springer publication.

4. Course Title : Seed Certification, Processing and Storage of Vegetable Seeds

Course Code : 11240201

Credit Hours : (2+1)

Why this course ?

Every farmer should able to access healthy seeds which are genetically pure, with high seed vigour and good germination percentage. Timely availability of good quality seeds at reasonable price ensures good yield and profit to the farmers. The seeds plays a vital role in agriculture and acts as a carrier of the genetic potential of varieties. Quality seed production which follows efficient certification procedures plays a major role in the increase of food production of our country. To ensure this, the Government has prescribed standards and has brought in seed production techniques, testing, certification and marketing procedures through the Seeds Act, 1966. In the current scenario, the demand for good quality certified seeds far exceed the availability in the market. This manual provides details about production and procurement of good quality seeds.

Aim of the course

To impart the knowledge on seed certification, processing and storage of vegetable seeds

Theory

Unit I

Seed certification, history, concepts and objectives, seed certification agency, phases of seed certification, Indian Minimum seed Certification standards, Planning and management of seed certification programmes.

Unit II

Principles and procedures of field inspection, seed sampling, testing and granting certification, OECD certification Schemes.

Unit III

Principles of seed processing, Methods of seed drying and cleaning, seed processing plant- Layout and design, seed treatment, seed quality enhancement, packaging and marketing.

Unit IV

Principles of Seed Storage, orthodox/ recalcitrant seeds, types of storage (open, bulk, controlled, germplasm, cryopreservation), factors affecting seed longevity in storage (Pre and post harvest factors).

Unit V

Seed aging and deterioration, maintenance of seed viability and vigor during storage, storage methods, storage structures, transportation and marketing of seeds.

Practical

General procedures of seed certification;

Field inspection and standards;

Isolation and rouging;

Inspection and sampling at harvesting, threshing and processing;

Testing physical purity, germination and moisture, grow-out test;

Visit to regulatory seed testing and plant quarantine laboratories;

Seed processing plants and commercial seed stores.

Teaching Methods/ Activities

Classroom Lectures

Assignment (written and speaking)

Student presentation individual or in group

Hands on training of different procedure

Group discussion

Learning outcome

After successful completion of this course, the students are expected to:

Acquire the knowledge on seed certification

Acquire the knowledge on seed processing and storage

Suggested Reading

- Agarwaal PK and Anuradha V. 2018. Fundamentals of seed science and technology. Brilliant publications, New Delhi.
- Basra AS. 2000. Hybrid seed production in vegetables. CRC press, Florida, USA.
- Bench ALR and Sanchez RA. 2004. Handbook of seed physiology. Food products press, NY/ London.
- Chakraborty SK, Prakash S, Sharma SP and Dadlani M. 2002. Testing of distinctiveness, uniformity and stability for plant variety protection. IARI, New Delhi
- Copland LO and McDonald MB. 2004. Seed science and technology, Kluwer academic press. Fageria MS, Arya PS and Choudhry AK. 2000. Vegetable crops: breeding and seed production
- Vol 1. Kalyani publishers, New Delhi.
- George RAT. 1999. Vegetable seed production (2nd Edition). CAB International.
- Hazra P and Som MG. 2016. Vegetable seed production and hybrid technology (Second revised edition), Kalyani publishers, Ludhiana, 459p
- Kalloo G, Jain SK, Vari AK and Srivastava U. 2006. Seed: A global perspective. Associated publishing company, New Delhi.
- Singhal NC. 2003. Hybrid seed production. Kalyani publishers, New Delhi.

5. Course Title : Breeding for Special Traits in Vegetable Crops

Course Code : 11240102

Credit Hours : (2+0)

Why this course ?

Many epidemiological studies reveal that people having a high level of consumption of vegetables presents a better health and lower risk of chronic diseases, including cardiovascular diseases and different types of

cancer. Vegetables contain many bioactive compounds and represent a major source of antioxidants and other compounds that are beneficial to human health. Consumers are increasingly demanding vegetables with bioactive properties that contribute to maintaining a good health and preventing diseases. In consequence, breeding programmes in vegetables are increasingly considering the content in bioactive compounds as a major breeding objective. In this way, there is an increasing number of breeding programmes and scientific studied aimed at improving the content in bioactive compounds of vegetables, and the trend seems that will be continuing in the coming years. In this respect, the particular course has been designed for students of Vegetable Science department.

To impart knowledge on recent developments in breeding for improved nutritional quality in important vegetable crops

Theory

Important nutrient constituents in vegetables and their role in human diet. Genetics of nutrients. Genetic and genomic resources for improving quality traits in vegetables, breeding strategies for developing varieties with improved nutrition for market and industrial purposes. Molecular and biotechnological approaches in breeding suitable cultivars of different crops for micronutrients and color content.

Unit I

Brassica group, carrot and beetroot.

Unit II

Tomato, brinjal, peppers and potato.

Unit III

Green leafy vegetables, Legume crops and okra.

Unit IV

Cucurbitaceous vegetable crops and edible Alliums.

Unit V

Biofortification in vegetable crops, genetic engineering for improvement of quality traits in vegetable crops, bioavailability of dietary nutrients from improved vegetable crops and impact on micronutrient malnutrition, achievements and future prospects in breeding for quality traits in vegetables.

Teaching Methods/ Activities

Classroom Lectures

Assignment (written and speaking)

Student presentation

Hands on training of different procedure

Group discussion

Learning outcome

After successful completion of this course, the students are expected to:

Know about various special characters of vegetables

The recent breeding methods to achieve special characters in vegetables

Suggested Reading

- Allard RW. 1999. Principles of plant breeding. John Wiley and Sons. Basset MJ. (Ed.). 1986. Breeding vegetable crops. AVI Publ.
- Dhillon BS, Tyagi RK, Saxena S and Randhawa GJ. 2005. Plant genetic resources: horticultural crops. Narosa Publ. House.
- Fageria MS, Arya PS and Choudhary AK. 2000. Vegetable crops: Breeding and seed production.
- Vol. I. Kalyani.
- Gardner EJ. 1975. Principles of genetics. John Wiley and Sons.
- Hayes HK, Immer FR and Smith DC. 1955. Methods of plant breeding. McGraw-Hill.
- Hayward MD, Bosemark NO and Romagosa I. (Eds.). 1993. Plant Breeding-principles and prospects. Chapman and Hall.
- Hazra P and Som MG. 2015. Vegetable science (Second revised edition), Kalyani publishers, Ludhiana, 598p.edition), Kalyani Publishers, Ludhiana, 459p
- 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 and Dhaliwal MS. 1990. Techniques of developing hybrids in vegetable crops. Agro
- Botanical Publ.
- Paroda RS and Kalloo G. (Eds.). 1995. Vegetable research with special reference to hybrid technology in Asia-Pacific Region. FAO.
- Peter KV and Pradeepkumar T. 2008. Genetics and breeding of vegetables. Revised, ICAR. Peter KV and Hazra P. (Eds). 2012. Hand book of vegetables. Studium press LLC, P.O. Box
- 722200, Houston, Texas 77072, USA, 678p
- Peter KV and Hazra P. (Eds). 2015. Hand book of vegetables Volume II.Studium Press LLC,
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- Peter KV and Hazra P. (Eds). 2015. Hand book of vegetables Volume III.Studium Press LLC,
- P.O. Box 722200, Houston, Texas 77072, USA, 634p.
- Rai N and Rai M. 2006. Heterosis breeding in vegetable crops. New India Publ. Agency.
- Ram HH. 1998. Vegetable breeding: principles and practices. Kalyani Publishers, New Delhi. Rout GR and Peter KV. 2008.

Genetic engineering of horticultural crops. Academic press, Elsevier,

- USA
- Simmonds NW. 1978. Principles of crop improvement. Longman. Singh BD. 1983. Plant Breeding.
- Kalyani Publishers, New Delhi.
- Singh PK, Dasgupta SK and Tripathi SK. 2004. Hybrid vegetable development. International Book Distributing Co.
- Swarup V. 1976. Breeding procedure for cross-pollinated vegetable crops. ICAR.

6. Course Title : Biodiversity and Conservation of Vegetable Crops

Course Code : 11240103

Credit Hours : (2+1)

Why this course ?

The availability of pertinent gene pool is of utmost importance to mitigate adverse climate and to counter diseases and pests. In addition, specific gene sources (germplasm) would always be necessary to develop superior genotypes. Considering the importance of conserving biodiversity in vegetable crops for future use, the course has been designed.

Aim of the course

To understand the status and magnitude of biodiversity and strategies in germplasm conservation of vegetable crops.

The course is organised as follows:

Units

Biodiversity and conservation of

1.General Aspects: Issues, Goals and Current vegetable crops Status

2. Germplasm Conservation: Collection, Maintenance and Characterization

3.Regulatory Horticulture: Germplasm Exchange, Quarantine and Intellectual Property Rights

Unit I

General aspects: issues, goals and current status: Biodiversity and conservation; issues and goals- needs and challenges; present status of gene centres; world's major centres of fruit crop domestication; current status of germplasm availability/ database of fruit crops in India

Unit II

Germplasm conservation: collection, maintenance and characterization: Exploration and collection of germplasm; sampling frequencies; size and forms of fruit and nut germplasm collections; active and base collections. Germplasm conservation- in situ and ex situ strategies, on farm

conservation; problem of recalcitrance- cold storage of scions, tissue culture, cryopreservation, pollen and seed storage.

Unit III

Regulatory horticulture: Germplasm exchange, quarantine and intellectual property rights germplasm exchange, quarantine and intellectual property rights regulatory horticulture, inventory and exchange of fruit and nut germplasm, plant quarantine, phytosanitary certification, detection of genetic constitution of germplasm and maintenance of core collection. IPRs, Breeder's rights, Farmer's rights, PPVandFR Act. GIS and documentation of local biodiversity, Geographical indications, GIS application in horticultural mapping and spatial analyses of field data; benefits of GI protection; GI tagged fruit varieties in India.

Practical

Documentation of germplasm- maintenance of passport data and other records of accessions;

Field exploration trips and sampling procedures;

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;

Germplasm characterization using a standardised DUS test protocol;

Special tests with biochemical and molecular markers.

Teaching Methods/ Activities

Class room lectures

Laboratory/ field practicals

Student seminars/ presentations

Field tours/ demonstrations

Assignments

Learning outcome

The student would be expected to learn about the significance of germplasm

Various strategies to conserve it in the present context.

Suggested Reading

- Dhillon BS, Tyagi RK, Lal A and Saxena S. 2004. Plant genetic resource management. – horticultural crops. Narosa publishing house, New Delhi.
- Engles JM, Ramanath RV, Brown AHD and Jackson MT. 2002. Managing plant genetic resources, CABI, Wallingford, UK. University Press, USA.
- Hancock J. 2012. Plant evolution and the origin of crops species. CAB International.

- Jackson M, Ford-Lloyd B and Parry M. 2014, Plant genetic resources and climate change. CABI, Wallingford, UK
- Moore JN and Ballington JR. 1991. Genetic resources of temperate Fruit and nut crops. ISHS, Belgium.
- Peter KV. 2008. Biodiversity of horticultural crops. Vol. II. Daya Publ. House, Delhi. Peter KV. 2011. Biodiversity in horticultural crops. Vol.III. Daya Publ. House, Delhi.
- Rajasekharan PE, Rao V and Ramanatha V. 2019. Conservation and utilization of horticultural genetic resources. Springer.
- Rana JC and Verma VD. 2011. Genetic resources of temperate minor fruits (indigenous andexotic).
- NBPGR, New Delhi.
- Sthapit et al. 2016. Tropical fruit tree diversity (good practices for in situ and ex situ conservation).
- Bioversity international. routledge, Taylor and Francis Group.
- Virchow D. 2012. Conservation of genetic resources, Springer Verlag, Berlin

7. Course Title : Biotechnological Approaches in Vegetable Crops

Course Code : 11240302

Credit Hours : (2+1)

Why this course ?

Biotechnology is a rapidly developing area of contemporary science. It can bring new ideas, improved tools and novel approaches to the solution of some persistent, seemingly intractable problems in vegetable production. Given the pressing need to enhance and stabilize the vegetable production in response to mounting population pressures and increasing awareness, there is an urgent need to explore novel technologies that will break traditional barriers.

Aim of the course

To impart latest knowledge in biotechnical advancement in vegetable crops
The course is organised as follows:-

Units

1 Biotechnological approaches in

I Importance and scope of Biotechnology vegetable crops

II Somatic embryogenesis

III Blotting techniques, DNA finger printing,

IV Plant genetic engineering

V Concepts and methods of next generation sequencing (NGS)

Theory

Unit I

Importance and scope of biotechnology – in vegetable crop improvement. In-vitro culture, micropropagation, anther culture, pollen culture, ovule culture, embryo culture, endosperm culture.

Unit II

Somatic embryogenesis – somaclonal variation and synthetic seed production, protoplast isolation, culture, manipulation and fusion. Somatic hybrids and cybrids and their application in vegetable improvement programme.

Unit III

Blotting techniques, DNA finger printing – Molecular markers/ DNA based markers and role. RFLP, AFLP, RAPD, SSR, SNPs, DNA probes. QTL mapping. MAS and its application in vegetable crop improvement. Allele mining by TILLING and Eco- TILLING.

Unit IV

Plant genetic engineering – Scope and importance, Concepts of cisgenesis, intragenesis and transgenesis. Gene cloning, direct and indirect methods of gene transfer. Role of RNAi based gene silencing in vegetable crop improvement. Bio- safety issue, regulatory issues for commercial approval.

Unit V

Concepts and methods of next generation sequencing (NGS)- Genome sequencing, transcriptomics, proteomics, metabolomics. Genome editing (ZFN, TALENS and CRISPER)

Crops

Solanaceous crops, cole crops, cucurbitaceous crops, root vegetables, garden pea, onion, potato and leafy vegetables

Practical

Micropropagation, Pollen- Ovule and Embryo culture- Synthetic seed production

(2) In-vitro mutation induction, in-vitro rooting – hardening at primary and secondary nurseries

(3) DNA isolation from economic vegetable crop varieties – Quantification and amplification.

DNA and Protein profiling – molecular markers, PCR Handling (2);

Vectors for cloning and particle bombardment (3);

DNA fingerprinting of flower crop varieties (3);

Project preparation for establishment of low, medium and high cost tissue culture laboratories (1).

Teaching Methods/ Activities

Class room lectures

Laboratory/ field practicals

Student seminars/ presentations

Field tours/ demonstrations

Assignments

Learning outcome

The student would be expected to learn

Different biotechnological tools

NGS, genetic engineering

Suggested Reading

- Bajaj YPS. (Ed.). 1987. Biotechnology in agriculture and forestry. Vol. XIX. Hitech and Micropropagation. Springer.
- Chadha KL, Ravindran PN and Sahijram L. (Eds.). 2000. Biotechnology of horticulture and plantation crops. Malhotra Publ. House.
- Debnath M. 2005. Tools and techniques of biotechnology. Pointer publication, New Delhi.
- Gorden H and Rubsell S. 1960. Hormones and cell culture. AB Book Publ.
- Keshavachandran R. 2007. Recent trends in biotechnology of horticultural crops. New India Publ. Agency.
- Keshavachandran R and Peter KV. 2008. Plant biotechnology; tissue culture and gene transfer.
- Orient and Longman, USA.
- Keshavachandran R. 2007. Recent trends in biotechnology of horticultural crops. New-India Publication Agency, New Delhi.
- Panopoulas NJ. (Ed.). 1981. Genetic engineering in plant sciences. Praeger Publ.
- Parthasarathy VA, Bose TK, Deka PC, Das P, Mitra SK and 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.
- Rout GR and Peter KV. 2018. Genetic engineering of horticultural crops. Academic Press Elsveer, USA.
- Sharma R. 2000. Plant tissue culture. Campus Books.
- Singh BD. 2010. Biotechnology- expanding horizons. Kalyani Publishers, New Delhi.
- Skoog Y and 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 and Bery HR. 1979. Somatic hybridization and genetic manipulation in plants, plant regulation and world agriculture. Planum Press.

8. Course Title : Advanced Laboratory Techniques for Vegetable Crops

Course Code : 11240104

Credit Hours : (1+2)

Why this course ?

Accurate quality analysis of vegetables warrants stringent measurement protocols besides requisite instruments/ tools and laboratory facilities. Consequently, a specialized course is designed for imparting basic and applied training on physical and biochemical assessment of the vegetable produce.

Aim of the course

To familiarize with the laboratory techniques for analysis of vegetable crops. The organisation of the course is as under:

Units

Advanced laboratory techniques for

1.Safety measures and laboratory maintenance vegetable crops

2.Qualitative and quantitative analysis

3.destructive and non-destructive analysis methods

Chromatographic and microscopic analysis

Sensory analysis

Theory

Unit I

Safety measures and laboratory maintenance – Safety aspects and upkeep of laboratory, sampling procedures for quantitative analysis, determination of proximate composition of horticultural produce. Standard solutions, determination of relative water content (RWC), physiological loss in weight (PLW), calibration and standardization of instruments, textural properties of harvested produce, TSS, Specific gravity, pH and acidity.

Unit II

Destructive and non-destructive analysis methods – Refractometry, spectrophotometry, non-destructive determination of colour, ascorbic acid, sugars, and starch in food crops.

Unit III

Chromatographic and microscopic analysis- basic chromatographic techniques, GC, HPLC, GCMS, Electrophoresis techniques, ultra filtration. Application of nuclear techniques in harvested produce. Advanced microscopic techniques, ion leakage as an index of membrane permeability, determination of biochemical components in horticultural produce.

Unit IV

Sensory analysis – Importance of ethylene, quantitative estimation of rate of ethylene evolution, using gas chromatograph (GC). Sensory analysis techniques, control of test rooms, products and panel.

Practical

Determination of moisture, relative water content and physiological loss in weight;

Determination of biochemical components in horticultural produce;

Calibration and standardization of instruments;

Textural properties of harvested produce;

Determination of starch index (SI);

Specific gravity for determination of maturity assessment, and pH of produce;

Detection of adulterations in fresh as well as processed products;

Non-destructive determination of colour, ascorbic acid, vitamins, carotenoids, sugars and starch;

Estimation of rate of ethylene evolution using gas chromatograph (GC);

Use of advanced microscopes (fluorescent, scanning electron microscope, phase contrast, etc.).

Teaching Methods/ Activities

Class room Lectures

Laboratory Practicals

Student Seminars/ Presentations

Field Tours/ Demonstrations

Assignments

Learning outcome

The students would be expected to develop skills and expertise on

Upkeep of laboratories and handling of research instruments

Principles and methods of various analysis

Suggested Reading

- AOAC International. 2003. Official methods of analysis of AOAC international. 17th Ed.
- Gaithersburg, MD, USA, association of analytical communities, USA.
- Clifton M and Pomeranz Y. 1988. Food analysis – laboratory experiments. AVI publication, USA.
- Linskens HF and Jackson JF. 1995. Fruit analysis. Springer.Horticultural Sciences–Vegetable Science
- Leo ML. 2004. Handbook of food analysis, 2nd Ed. Vols. I-III, USA.
- Pomrenz Y and Meloan CE. 1996. Food analysis – theory and practice. CBS, USA.

- Ranganna S. 2001. Handbook of analysis and quality control for fruit and vegetable products.
- 2nd Ed. Tata-McGraw-Hill, New Delhi.
- Thompson AK. 1995, Postharvest technology of fruits and vegetables. Blackwell sciences. USA.

Suggested journals

	Name of the Journal	ISSN No.
2.	American Journal of Horticultural Sciences	0003-1062
3.	American Potato Growers	
4.	American Scientst	1545-2786
5.	Annals of Agricultural Research	9703179
6.	Annual Review of Plant Physiology	0066-4294
7.	California Agriculture	1097-0967
8.	Haryana Journal of Horticultural Sciences	0970-2873
9.	HAU Journal of Research	0379-4008
10.	Horticulture Research	2052-7276
11.	HortScience	2327-9834
12.	IIVR Bulletins	1462-0316
13.	Indian Horticulture	0019-4875
14.	Indian Journal of Agricultural Sciences	0019-5022
15.	Indian Journal of Horticulture	0974-0112
16.	Indian Journal of Plant Physiology	2662-2548
17.	Journal of American Society for Horticutural Sciences	0003-1062
18.	Journal of Arecanut and Spice Crops	
19.	Journal of Food Science and Technology	0975-8402
20.	Journal of Plant Physiology	0176-1617
21.	Journal of Biology and Technology	0925-5214
22.	Postharvest Biology and Technology	0925-5214
23.	Scientia Horticulturae	0304-4238
24.	Seed Research	2151-6146
25.	Seed Science	23171537
26.	South Indian Horticulture	0038-3473
27.	Vegetable Grower	2330-2321
28.	Vegetable Science	2455-7552