



**Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore**  
**Shri Vaishnav Institute of Agriculture**  
**M.Sc. (Hort.) in Vegetable Science, I semester**

**Course Title with Credit Load**  
**M.Sc. (Hort.) in Vegetable Science**

Course Code	Course Title	Credit Hours
Major Courses (20 Credits)		
VSC 501	Production of Cool Season Vegetable Crops	2+1
VSC 502	Production of Warm Season Vegetable Crops	2+1
VSC 503	Growth and Development of Vegetable Crops	2+1
VSC 504	Principles of Vegetable Breeding	2+1
VSC 505	Breeding of Self Pollinated Vegetable Crops	2+1
VSC 506	Breeding of Cross Pollinated Vegetable Crops	2+1
VSC 507	Protected Cultivation of Vegetable Crops	1+1
VSC 508	Seed Production of Vegetable Crops	2+1
VSC 509	Production of Underutilized Vegetable Crops	2+1
VSC 510	Systematics of Vegetable Crops	1+1
VSC 511	Organic Vegetable Production	1+1
VSC 512	Production of Spice Crops	2+1
VSC 513	Processing of Vegetable	1+1
VSC 514	Postharvest Management of Vegetable Crops	2+1
	Minor Courses	08
	Supporting Courses	06
	Common Compulsory Courses	05
VSC 591	Seminar	0+1
VSC 599	Research	0+30
	Total Credits	70



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**Syllabus**

**VSC 501: Production of Cool Season Vegetable Crops (2+1)**

Course code	Course Name	TEACHING & EVALUATION SCHEME							
		THEORY			PRACTICAL		L	P	CREDITS
		End Sem University Exam	Mid Term Exam	Teachers Assessment*	End Sem University Exam	Teacher's Assessment*			
VSC 501	Production of Cool Season Vegetable Crops	50	30	00	15	05	2	1	3

**Legends: L** - Lecture; **P** – Practical

\*Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class etc.

**Objective**

To impart knowledge and skills on advancement in production technology of cool season vegetable crops.

**Theory**

Introduction, commercial and nutritional importance, origin and distribution, botany and taxonomy, area, production, productivity and constraints, soil requirements, climatic factors for yield and quality, commercial varieties/ hybrids, seed rate and seed treatment, raising of nursery, sowing/ planting time and methods, hydroponics and aeroponics, precision farming, cropping system, nutritional including micronutrients and irrigation requirements, intercultural operations, special horticultural practices, weed control, mulching, role of plant growth regulators, physiological disorders, maturity indices, harvesting, yield, post-harvest management (grading, packaging and marketing), pest and disease management and production economics of crops.

**UNIT I**

*Bulb and tuber crops*—Onion, garlic and potato.

**Unit II**

*Cole crops*—Cabbage, cauliflower, kohlrabi, broccoli, Brussels sprouts and kale.

**Unit III**

*Root crops*—Carrot, radish, turnip and beetroot.

**UNIT IV**

*Peas and beans*—Garden peas and broad bean.

**UNIT V**



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*Leafy vegetables*—Beet leaf, fenugreek, coriander and lettuce.

**Practical**

- Scientific raising of nursery and seed treatment.
- Sowing and transplanting.
- Description of commercial varieties and hybrids.
- Demonstration on methods of irrigation, fertilizers and micronutrients application.
- Mulching practices, weed management.
- Use of plant growth substances in cool season vegetable crops.
- Study of nutritional and physiological disorders.
- Studies on hydroponics, aeroponics and other soilless culture.
- Identification of important pest and diseases and their control.
- Preparation of cropping scheme for commercial farms.
- Visit to commercial farm, greenhouse/ polyhouses.
- Visit to vegetable market.
- Analysis of benefit to cost ratio.

**Suggested Readings**

- Bose TK, Kabir J, Maity TK, Parthasarathy VA and Som MG. 2003. Vegetable crops. Vols. I-III. Naya udyog.
- Bose TK, Som MG and Kabir J. (Eds.). 1993. Vegetable crops. Naya prokash.
- 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.II. Kalyani publishers.
- Gopalakrishanan TR. 2007. Vegetable crops. New India publ. agency. Singhal NC. 2010. Seed Science and Technology. Kalyani Publishers, New Delhi.
- Vanangamudi K, Prabhu M, Kalaivani S, Bhaskaran M and Manonmani V. 2010. Vegetable Hybrid seed Production and Management. Agrobios., Jodhpur, India.
- Hazra P and Banerjee MK and Chattopadhyay A. 2012. Varieties of vegetable crops in India, (Second edition), Kalyani publishers, Ludhiana, 199 p.
- Hazra P. 2016. Vegetable Science. 2nd edn, Kalyani publishers, Ludhiana.
- Hazra P. 2019. Vegetable production and technology. New India publishing agency, New Delhi.
- Hazra P, Chattopadhyay A, Karmakar K and Dutta S. 2011. Modern technology for vegetable production, New India publishing agency, New Delhi, 413p
- Rana MK. 2008. Olericulture in India. Kalyani publishers, New Delhi.
- Rana MK. 2008. Scientific cultivation of vegetables. Kalyani publishers, New Delhi.
- Rana MK. 2014. Technology for vegetable production. Kalyani publishers, New Delhi.



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- Rubatzky VE and Yamaguchi M. (Eds.). 1997. World vegetables: principles, production and 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.
- 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 and Singh N. (Eds.), 2004. Vegetables, tuber crops and spices. ICAR. Thompson HC and Kelly WC. (Eds.). 1978. Vegetable crops. Tata McGraw-Hill.

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**Syllabus**

**VSC 503: Growth and Development of Vegetable Crops (2+1)**

Course code	Course Name	TEACHING & EVALUATION SCHEME							
		THEORY			PRACTICAL		L	P	CREDITS
		End Sem University Exam	Mid Term Exam	Teachers Assessment*	End Sem University Exam	Teacher's Assessment*			
VSC 503	Growth and Development of Vegetable Crops	50	30	00	15	05	2	1	3

**Legends: L** - Lecture; **P** – Practical

\*Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class etc.

**Objective**

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

**Theory**

**Unit I**

Introduction and phytohormones—Definition of growth and development; Cellular structures and their functions; Physiology of phyto-hormones functioning/ biosynthesis and mode of action; Growth analysis and its importance in vegetable production.

**Unit II**

Physiology of dormancy and germination—Physiology of dormancy and germination of vegetable seeds, tubers and bulbs; Role of auxins, gibberellins, cytokinins and abscisic acid; Application of synthetic PGRs including 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**

Abiotic factors—Impact of light, temperature, photoperiod, carbon dioxide, oxygen and other gases on growth, development of underground parts, flowering and sex expression in vegetable crops; Apical dominance.

**Unit IV**

Fruit physiology—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**

Morphogenesis and tissue culture—Morphogenesis and tissue culture techniques in vegetable crops; Grafting techniques in different vegetable crops.



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**Practical**

Preparation of plant growth regulator's solutions 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.

Grafting techniques in tomato, brinjal, cucumber and sweet pepper.

**Suggested Readings**

- Bleasdale JKA. 1984. *Plant physiology in relation to horticulture* (2<sup>nd</sup> Edition) MacMillan. Gupta US. Eds. 1978. *Crop physiology*. Oxford and IBH, New Delhi.
- Kalloo G. 2017. *Vegetable grafting: Principles and practices*. CAB International Krishnamoorti HN. 1981. *Application growth substances and their uses in agriculture*. Tata McGraw Hill, New Delhi.
- Leopold AC and Kriedemann PE. 1981. *Plant growth and development*, Tata McGraw-Hill, New Delhi.
- 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. (Eds). 2008. *Basics of horticulture*. New India publication agency, New Delhi. Rana MK. 2011. *Physio-biochemistry and Biotechnology of Vegetables*. New India Publishing Agency, Pritam Pura, New Delhi.
- Saini *et al.* (Eds.). 2001. *Laboratory manual of analytical techniques in horticulture*. Agrobios, Jodhpur.
- Wien HC. (Eds.). 1997. *The physiology of vegetable crops*. CAB International.

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**Syllabus**

**VSC 504: Principles of Vegetable Breeding (2+1)**

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		THEORY			PRACTICAL		L	P	CREDITS
		End Sem University Exam	Mid Term Exam	Teachers Assessment*	End Sem University Exam	Teacher's Assessment*			
VSC 504	Principles of Vegetable Breeding	50	30	00	15	05	2	1	3

**Legends: L - Lecture; P – Practical**

\*Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class etc.

**Objective**

To teach basic principles and practices of vegetable breeding.

**Theory**

**Unit I**

Importance and history- Importance, history and evolutionary aspects of vegetable breeding and its variation from cereal crop breeding.

**Unit II**

Selection procedures- Techniques of selfing and crossing; Breeding systems and methods; Selection procedures and hybridization; Genetic architecture; Breeding for biotic stress (diseases, insect pests and nematode), abiotic stress (temperature, moisture and salt) resistance and quality improvement; Breeding for water use efficiency (WUE) and nutrients use efficiency (NUE).

**Unit III**

Heterosis breeding- Types, mechanisms and basis of heterosis, facilitating mechanisms like male sterility, self-incompatibility and sex forms.

**Unit IV**

Mutation and Polyploidy breeding; Improvement of asexually propagated vegetable crops and vegetables suitable for protected environment.

**Unit V**

Ideotype breeding- Ideotype breeding; varietal release procedure; DUS testing in vegetable crops; Application of In-vitro and molecular techniques in vegetable improvement.

**Practical**

- Floral biology and pollination behaviour of different vegetables.
- Techniques of selfing and crossing of different vegetables, viz., Cole crops, okra, cucurbits, tomato, eggplant, hot pepper, etc.



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- Breeding system and handling of filial generations of different vegetables.
- Exposure to biotechnological lab practices.
- Visit to breeding farms.

**Suggested Reading**

Allard RW. 1960. *Principle of plant breeding*. John Willey and Sons, USA. Kalloo G. 1988. *Vegetable breeding* (Vol. I, II, III). CRC Press, Fl, USA.

Kole CR. 2007. *Genome mapping and molecular breeding in plants-vegetables*. Springer, USA. Peter KV and Pradeep Kumar T. 1998. *Genetics and breeding of vegetables*. ICAR, New Delhi, p. 488.

Prohens J and Nuez F. 2007. *Handbook of plant breeding-vegetables* (Vol I and II). Springer, USA.

Singh BD. 2007. *Plant breeding- principles and methods* (8th edn.). Kalyani Publishers, New Delhi.

Singh Ram J. 2007. *Genetic resources, chromosome engineering, and crop improvement-vegetable crops* (Vol. 3). CRC Press, Fl, USA.

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**Syllabus**

**VSC 505: Breeding of Self Pollinated Vegetable Crops (2+1)**

Course code	Course Name	TEACHING & EVALUATION SCHEME							
		THEORY			PRACTICAL		L	P	CREDITS
		End Sem University Exam	Mid Term Exam	Teachers Assessment*	End Sem University Exam	Teacher's Assessment*			
VSC 505	Breeding of Self Pollinated Vegetable Crops	50	30	00	15	05	2	1	3

**Legends:** L - Lecture; P – Practical

\*Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class etc.

**Objective**

To impart comprehensive knowledge about principles and practices of breeding of self pollinated vegetable crops.

**Theory**

Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination and fertilization mechanism, sterility, breeding objectives, breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, resistance breeding for biotic and abiotic stresses, breeding for protected environment and quality improvement, molecular markers and marker's assisted breeding; QTLs, PPV and FR Act.

**Unit I**

*Tuber crops:* Potato.

**Unit II**

*Fruit vegetables-* Tomato, eggplant, hot pepper, sweet pepper and okra.

**Unit III**

*Leguminous vegetables-* Garden peas and cowpea.

**Unit IV**

*Leguminous vegetables:* French bean, Indian bean, cluster bean and broad bean.

**Unit V**

*Leafy vegetables-* Lettuce and fenugreek.

**Practical**

- Floral mechanisms favouring self and often cross pollination.
- Progeny testing and development of inbred lines.



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- Selection of desirable plants from breeding population, observations and analysis of various qualitative and quantitative traits in germplasm, hybrids and segregating generations.
- Palynological studies, selfing and crossing techniques.
- Hybrid seed production of vegetable crops in bulk.
- Screening techniques for biotic and abiotic stress resistance in above mentioned crops.
- Molecular marker techniques to identify useful traits in the vegetable crops and special breeding techniques.
- Visit to breeding farms.

### **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, 598 p.

Hazra P and Som MG. 2016. *Vegetable seed production and hybrid technology* (Second revised edition), Kalyani Publishers, Ludhiana, 459 p

Kaloo G. 1988. *Vegetable breeding*. Vols. I-III. CRC Press.

Kaloo 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 Kaloo 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, 509 p.

Peter KV and Hazra P. (Eds). 2015. *Hand book of vegetables Volume III*. Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 634 p.

Rai N and Rai M. 2006. *Heterosis breeding in vegetable crops*. New India Publ.



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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 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.

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**Syllabus**

**PSM 502: Production of Spice Crops (2+1)**

Course code	Course Name	TEACHING & EVALUATION SCHEME							
		THEORY			PRACTICAL		L	P	CREDITS
		End Sem University Exam	Mid Term Exam	Teachers Assessment*	End Sem University Exam	Teacher's Assessment*			
PSM 502	Production of Spice Crops	50	30	00	15	05	2	1	3

**Legends: L** - Lecture; **P** – Practical

\*Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class etc.

**Objective**

The course is designed to provide both basic and applied knowledge on various aspects of production technology of spice crops grown in India.

**Unit I**

Role of Spice crops: Introduction, importance of spice crops, pharmaceutical significance, historical accent, present status – national and international, prospects, role of Spices board and other development agencies. Classification of spice crops: Major spices, minor spices, seed spices, tree spices, herbal spices.

**Unit II**

Varietal wealth: Botany and taxonomy, species, cultivars, commercial varieties/ hybrids in spice crops. Propagation and nursery management: Seed, vegetative and micropropagation methods, nursery techniques and nursery management practices.

**Unit III**

Agro techniques: Climatic and soil requirements, site selection, layout, sowing/ planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercropping, mixed cropping, intercultural operations, weed control, mulching, plant protection, precision farming, physiological disorders, protected cultivation.

**Unit IV**

Maturity indices and harvest: Maturity indices, harvesting methods, harvesting seasons, mechanized harvesting.

**Unit V**

Post harvest management: Post harvest management including primary processing, grading, packaging and storage, GMP in major spice crops.

**Practical**

- GAP in spice crops;
- GMP in spice crops;
- Short term experiments on spice crops;



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- Exposure visits to spice farms, research institutes.

**Suggested Reading**

Agarwal S, Sastry EVD and Sharma RK. 2001. Seed Spices: Production, Quality, Export. Pointer Publ.

Arya PS. 2003. Spice Crops of India. Kalyani.

Bose TK, Mitra SK, Farooqi SK and Sadhu MK. Eds. 1999. Tropical Horticulture. Vol.I. Naya Prokash.

Chadha KL and Rethinam P. Eds. 1993. Advances in Horticulture. Vols. IX-X. Plantation Crops and Spices. Malhotra Publ. House.

Gupta S. Ed. Hand Book of Spices and Packaging with Formulae. Engineers India Research Institute, New Delhi.

Kumar NA, Khader P, Rangaswami and Irulappan I. 2000. Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants. Oxford and IBH.

Nybe EV, Miniraj N and Peter KV. 2007. Spices. New India Publ. Agency.

Parthasarthy VA, Kandiannan V and Srinivasan V. 2008. Organic Spices. New India Publ. Agency.

Peter KV. 2001. Handbook of Herbs and Spices. Vols. I-III. Woodhead Publ. Co. UK and CRC USA.

Ponnuswami V et al. 2018. Medicinal Herbs and Herbal Cure. Narendra Publishing House, New Delhi.

Pruthi JS. Ed. 1998. Spices and Condiments. National Book Trust.

Pruthi JS. 2001. Minor Spices and Condiments- Crop Management and Post Harvest Technology. ICAR.

Purseglove JW, Brown EG, Green CL and Robbins SRJ. Eds. 1981. Spices. Vols. I, II. Longman.

Ramachandra et al. 2018. Breeding of Spices and Plantation crops. Narendra Publishing House, New Delhi.

Ravindran PN. 2000. Black pepper, *Piper nigrum*. CRC press.

Ravindran PN. 2002. Cardamom, the genus *Elettaria*. CRC press

Ravindran PN. 2003. Cinnamon and cassia. CRC press

Ravindran PN. 2004. Ginger, the genus *Zingiber*. CRC press

Ravindran PN. 2007. Turmeric, the genus *curcuma*. CRC press

Ravindran PN. 2017. The Encyclopedia of Herbs and Spices. CABI

Shanmugavelu KG, Kumar N and Peter KV. 2002. Production Technology of Spices and Plantation Crops. Agrobios.

Sharangi AB, Datta S and Deb P. 2018. Spices “Agrotechniques for quality produce”. Apple Academic Press (Tylor and Francis Groups), New Jersey, USA.

Sharangi AB. 2018. Indian Spices “The legacy, production and processing of India’s treasured export.” Springer International publishing AG, Part of Springer Nature 2018, Cham,



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Switzerland.

Restructured and Revised Syllabi of Post-graduate Programmes Vol. 1 428

Sharangi AB and Datta S. 2015. Value Addition of Horticultural crops: Recent trends and

Future directions. SPRINGER; ISBN: 978-81-322-2261-3.

Sharangi AB and Acharya SK. 2008. Quality Management of Horticultural crops. Agrotech

Publishing House, Udaipur; ISBN: 81-8321-090-2.

Thamburaj S and Singh N. Eds. 2004. Vegetables, Tuber Crops and Spices, ICAR.

Tiwari RS and Agarwal A. 2004. Production Technology of Spices. International Book Distr.

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**Syllabus**

**FSC 503: Propagation and Nursery Management in Fruit Crops (2+1)**

Course code	Course Name	TEACHING & EVALUATION SCHEME							
		THEORY			PRACTICAL		L	P	CREDITS
		End Sem University Exam	Mid Term Exam	Teachers Assessment*	End Sem University Exam	Teacher's Assessment*			
FSC 503	Propagation and Nursery Management in Fruit Crops	50	30	00	15	05	2	1	3

**Legends: L - Lecture; P – Practical**

\*Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class etc.

**Objective**

To understand the principles and methods of propagation and nursery management in fruit crops.

**Unit I**

General Concepts and Phenomena: Introduction, understanding cellular basis for propagation, sexual and asexual propagation, apomixis, polyembryony, chimeras. Factors influencing seed germination of fruit crops, dormancy, hormonal regulation of seed germination and seedling growth. Seed quality, treatment, packing, storage, certification and testing.

**Unit II**

Conventional Asexual Propagation: Cutting– methods, rooting of soft and hardwood cuttings under mist and hotbeds. Use of PGR in propagation, Physiological, anatomical and biochemical aspects of root induction in cuttings. Layering – principle and methods.

**Unit III**

Budding and grafting – principles and methods, establishment and management of bud wood bank. Stock, scion and inter stock relationship – graft incompatibility, physiology of rootstock and top working.

**Unit IV**

Micropropagation: Micro-propagation – principles and concepts, commercial exploitation in horticultural crops. Techniques –in-vitro clonal propagation, direct organogenesis, embryogenesis, micrografting, meristem culture, genetic fidelity testing. Hardening, packaging and transport of micro-propagules.

**Unit V**

Management Practices and Regulation: Nursery – types, structures, components, planning and layout. Nursery management practices for healthy propagule production. Nursery Act, nursery accreditation, import and export of seeds and planting material and quarantine.

**Practical**



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- Hands on practices on rooting of dormant and summer cuttings.
- Anatomical studies in rooting of cutting and graft union.
- Hands on practices on various methods of budding and grafting.
- Propagation by layering and stooling.
- Micropropagation- explant preparation, media preparation, culturing – meristem tip culture, axillary bud culture, micro-grafting, hardening.
- Visit to commercial tissue culture laboratories and accredited nurseries.

**Suggested Reading**

- Bose TK, Mitra SK and Sadhu MK. 1991. Propagation of Tropical and Subtropical Horticultural Crops. Naya Prokash, Kolkatta.
- Davies FT, Geneve RL and Wilson SB. 2018. Hartmann and Kester's Plant Propagation- Principles and Practices. Pearson, USA/ PrenticeHall of India. New Delhi.
- Gill SS, Bal JS and Sandhu AS. 2016. Raising Fruit Nursery. Kalyani Publishers, New Delhi.
- Jain S and Ishil K. 2003. Micropropagation of Woody Trees and Fruits. Springer.
- Jain S and Hoggmann H. 2007. Protocols for Micropropagation of Woody Trees and Fruits. Springer.
- Joshi P. 2015. Nursery Management of Fruit Crops in India. NIPA, New Delhi.
- Love et al. 2017. Tropical Fruit Tree Propagation Guide. UH-CTAHR F\_N\_49. College of Tropical Agriculture and Human Resources University of Hawaii at Manwa, USA.
- Peter KV, eds. 2008. Basics of Horticulture. New India Publishing Agency, New Delhi.
- Rajan S and Baby LM. 2007. Propagation of Horticultural Crops. NIPA, New Delhi.
- Sharma RR. 2014. Propagation of Horticultural Crops. Kalyani Publishers, New Delhi.
- Sharma RR and Srivastav M. 2004. Propagation and Nursery Management. Intl. Book Publishing Co., Lucknow.
- Singh SP. 1989. Mist Propagation. Metropolitan Book Co.
- Singh RS. 2014. Propagation of Horticultural Plants: Arid and Semi-Arid Regions. NIPA, New Delhi.
- Tyagi S. 2019. Hi-Tech Horticulture. Vol I: Crop Improvement, Nursery and Rootstock Management. NIPA, New Delhi.

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**Syllabus**

**STAT 502: STATISTICAL METHODS FOR APPLIED SCIENCES (3+1)**

Course Code	Course Name	TEACHING & EVALUATION SCHEME							
		THEORY			PRACTICAL		L	P	CREDITS
		End Sem University Exam	Mid Term Exam	Teachers Assessment*	End Sem University Exam	Teachers Assessment*			
STAT 502	Statistical methods for Applied sciences	50	30	0	15	5	3	1	4

**Legends:** L - Lecture; P – Practical;

\*Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class etc.

**Objective**

This course is meant for students who do not have sufficient background of Statistical Methods. The students would be exposed to concepts of statistical methods and statistical inference that would help them in understanding the importance of statistics. It would also help them in understanding the concepts involved in data presentation, analysis and interpretation. The students would get an exposure to presentation of data, probability distributions, parameter estimation, tests of significance, regression and multivariate analytical techniques.

**Theory**

**UNIT I**

Box-plot, Descriptive statistics, Exploratory data analysis, Theory of probability, Random variable and mathematical expectation

**UNIT II**

Discrete and continuous probability distributions, Binomial, Poisson, Negative Binomial, Normal distribution, Beta and Gamma distributions and their applications. Concept of sampling distribution: chi-square, t and F distributions. Tests of significance based on Normal, chi-square, t and F distributions.

**UNIT III**

Introduction to theory of estimation and confidence-intervals, Simple and multiple correlation coefficient, partial correlation, rank correlation, Simple and multiple linear regression model, test of significance of correlation coefficient and regression coefficients, Coefficient of determination, Fitting of quadratic models.



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**UNIT IV**

Non-parametric tests – sign, Wilcoxon, Mann-Whitney U-test, Run test for the randomness of a sequence. Median test

**UNIT V**

Introduction to ANOVA: One way and Two Way, Introduction to Sampling Techniques, Introduction to Multivariate Analysis, Transformation of Data.

**Practical**

- Exploratory data analysis, fitting of distributions ~ Binomial, Poisson, Negative Binomial, Normal.
- Large sample tests, testing of hypothesis based on exact sampling distributions ~ chi square, t and F.
- Confidence interval estimation and Correlation and regression analysis, fitting of Linear and Quadratic Model.
- Non-parametric tests. ANOVA: One way, Two Way, SRS

**Suggested Readings**

- Goon A.M, Gupta M.K and Dasgupta B. 1977. An Outline of Statistical Theory. Vol. I. The World Press.
- Goon A.M, Gupta M.K. and Dasgupta B. 1983. Fundamentals of Statistics. Vol. I. The World Press.
- Hoel P.G. 1971. Introduction to Mathematical Statistics. John Wiley.
- Hogg R.V and Craig T.T. 1978. Introduction to Mathematical Statistics. Macmillan.
- Morrison D.F. 1976. Multivariate Statistical Methods. McGraw Hill.
- Hogg RV, McKean JW, Craig AT. 2012. Introduction to Mathematical Statistics 7<sup>th</sup> Edition.
- Siegel S, Johan N & Casellan Jr. 1956. Non-parametric Tests for Behavior Sciences. John Wiley.
- Anderson TW. 2009. An Introduction to Multivariate Statistical Analysis, 3rd Ed . John Wiley
- <http://freestatistics.altervista.org/en/learning.php>.
- <http://www.statsoft.com/textbook/stathome.html>

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**PGS 501: LIBRARY AND INFORMATION SERVICES (0+1)**

Course code	Course Name	TEACHING & EVALUATION SCHEME							
		THEORY			PRACTICAL		L	P	CREDITS
		End Sem University Exam	Mid Term Exam	Teachers Assessment*	End Sem University Exam	Teacher's Assessment*			
PGS 501	Library and Information Services	00	00	00	60	40	0	1	1

**Legends:** L - Lecture; P – Practical;

\*Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class etc.

### 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.

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**PGS 502: TECHNICAL WRITING AND COMMUNICATIONS SKILLS (0+1)**

Course Code	Course Name	TEACHING & EVALUATION SCHEME							
		THEORY			PRACTICAL		L	P	CREDITS
		End Sem University Exam	Mid Term Exam	Teachers Assessment*	End Sem University Exam	Teachers Assessment*			
PGS 502	Technical Writing & Communications Skills	0	0	0	60	40	0	1	1

**Legends:** L - Lecture; P – Practical;

\*Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class etc.

**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**

- 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.



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**Suggested Readings**

- Barnes and Noble. Robert C. (Ed.). 2005. Spoken English: Flourish Your Language.
- Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.
- Collins' Cobuild English Dictionary. 1995.
- Harper Collins. Gordon HM and Walter JA. 1970. Technical Writing. 3rd Ed.
- Holt, Rinehart and Winston. Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.
- James HS. 1994. Handbook for Technical Writing. NTC Business Books.
- Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.
- Mohan K. 2005. Speaking English Effectively. MacMillan India.
- Richard WS. 1969. Technical Writing.
- Sethi J and Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.
- Wren PC and Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.

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**PGS 503: INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE**  
**(1+0)**

Course Code	Course Name	TEACHING & EVALUATION SCHEME							
		THEORY			PRACTICAL		L	P	CREDITS
		End Sem University Exam	Mid Term Exam	Teachers Assessment*	End Sem University Exam	Teachers Assessment*			
PGS 503	Intellectual Property and Its Management in Agriculture	50	40	10	0	0	1	0	1

**Legends:** L - Lecture; P – Practical;

\*Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class etc.

### **Objectives**

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**

#### **UNIT I**

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPs Agreement.

#### **UNIT II**

Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties.

#### **UNIT III**

Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks etc.

#### **UNIT IV**

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;

#### **UNIT V**



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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 F H & Maredia K.1998. *Intellectual Property Rights in Agricultural Biotechnology*. CABI.
- Ganguli P. 2001. *Intellectual Property Rights: Unleashing Knowledge Economy*. McGraw-Hill.
- *Intellectual Property Rights: Key to New Wealth Generation*. 2001. NRDC & Aesthetic Technologies.
- Ministry of Agriculture, Government of India. 2004. *State of Indian Farmer. Vol. V. Technology Generation and IPR Issues*. Academic Foundation.
- Rothschild M & Scott N. (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 Publ. House.
- *The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.*

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