

DEPARTMENT OF AGRONOMY
Hemvati Nandan Bahuguna Garhwal University
(A Central University)
Srinagar Garhwal (U.K.) : 246174
Course Curriculum for M.Sc. (Ag.) Agronomy: 2016-17
AGRONOMY
Course Structure - at a Glance

CODE	COURSE TITLE	Total Marks	Theory Marks I + E	Practical Marks	Credits
Semester - I					
SOA/AGRON/C-501	Statistical Methods and Experimental Designs	100	80 (20 + 60)	20	3 + 1
SOA/AGRON/C-502	Advances in Soil fertility and Nutrient Management	100	80 (20 + 60)	20	2 + 1
SOA/AGRON/C-503	Advances in Weed Management	100	80 (20 + 60)	20	2 + 1
SOA/AGRON/C-504	Principles and Practices of Water Management	100	80 (20 + 60)	20	3 + 1
SOA/AGRON/C-505	Agronomy of Major Cereals and Pulses	100	80 (20 + 60)	20	3 + 1
	Total	500	400 (100+300)	100	18 (13 + 5)
Semester - II					
SOA/AGRON/C-506	Agro meteorology and crop Weather Forecast	100	80 (20 + 60)	20	2 + 1
SOA/AGRON/C-507	Principles and Practices of Organic Farming	100	80 (20 + 60)	20	2 + 1
SOA/AGRON/C-508	Agronomy of Oil Seed, Fibre & Sugar Crops	100	80 (20 + 60)	20	3 + 1
SOA/AGRON/C-509	Agronomy of Fordder and Forage crops	100	80 (20 + 60)	20	3 + 1
SOA/AGRON/C-510	Agronomy of Medicinal and Aromatic Crops	100	80 (20 + 60)	20	3 + 1
	Total	500	400 (100+300)	100	18 (13 + 5)
SOA/AGRON/S-511	Self Study courses to be decided by concern department/college and to be evaluated by themselves. It is only pass/qualifying course	100	100	---	3 + 0
Semester - III					
SOA/AGRON/C-512	Dryland Farming	100	80 (20 + 60)	20	2 + 1
SOA/AGRON/C-513	Management of Problem Soils	100	80 (20 + 60)	20	2 + 1
SOA/AGRON/C-514	Modern concept in Crop Production	100	80 (20 + 60)	20	2 + 1
	Students can choose three out of the following four electives.				
SOA/AGRON/E-515	Crop Ecology	100	80 (20 + 60)	20	2 + 1
SOA/AGRON/E-516	Cropping System and Sustainable Agriculture	100	80 (20 + 60)	20	2 + 1
SOA/AGRON/E-517	Soil Taxonomy, Survey and Remote sensing	100	80 (20 + 60)	20	2 + 1
SOA/AGRON/E-518	Storage insect pests and their Management	100	80 (20 + 60)	20	2 + 1
	Total	600	480 (120+360)	120	18 (12 + 6)

Semester - IV					
SOA/AGRON/C-519	Thesis Or	200	----	---	0 + 8
SOA/AGRON/C-520		i. Seed Production Technology	100	80 (20 + 60)	20
SOA/AGRON/C-521	ii. Soil Conservation and watershed Management	100	80 (20 + 60)	20	3 + 1
SOA/AGRON/C-522	Seminar	100	----	---	0 + 1
Students can choose three out of the following four electives.					
SOA/AGRON/E-523	Analytical Techniques and Instrumental Methods in Soil and Plant Analysis	100	80 (20 + 60)	20	2 + 1
SOA/AGRON/E-524	Agrostology and Agroforestry	100	80 (20 + 60)	20	2 + 1
SOA/AGRON/E-525	Stress Physiology	100	80 (20 + 60)	20	2 + 1
SOA/AGRON/E-526	Soil, Water and Air pollution	100	80 (20 + 60)	20	2 + 1
	Total	600	400 (100 + 300)	100	18 (12 + 6)

I-Internal assessment

E-External assessment

SUMMARY OF CREDITS

Semester	Core Credits	Elective Credits	Total Credits
1 st	18 (500)	-	18 (500)
2 nd	18 (500)	-	18 (500)
3 rd	09 (300)	09 (300)	18 (600)
4 th	09 (300)	09 (300)	18 (600)
	54 (1600)	18 (600)	72 (2200)

AGRONOMY

COURSE CONTENTS

SEMESTER - I

SOA/AGRON/C-501 STATISTICAL METHODS AND EXPERIMENTAL DESIGNS

3 + 1

Theory

UNIT I

Processing of data: Classification and tabulation of statistical data by categories and measurements, graphical and diagrammatic representation-histogram. Frequency polygon, frequency curve and cumulative frequency curves.

UNIT II

Measure of location and dispersion : Mean, median, mode, partition values (quartiles, deciles and percentiles). Range, quartile deviation, mean deviation about mean and mean, standard deviation coefficient of variation, moment kurtosis.

UNIT III

Probability & distribution : Random experiment, sample space (discrete case only), events mathematical and statistical definition of probability, random variable (discrete and continuous), bernoulli trials, binomial distn. poisson distn. Poisson distn as a limiting case of the binomial distn, normal distn, properties of the above distributions and fitting with available data, Test for their goodness of fit.

UNIT IV

Correlation and regression : Bivariate data, bivariate frequency distn, correlation coefficient, rank correlation, Regression lines, regression coefficients and their relation with correlation coefficient, Multiple regression, multiple and partial correlation coefficients.

UNIT V

Estimation : Concept of population and sample; parameters and statistics: criteria for a good estimator unbiasedness, consistency of population mean and its confidence interval in the normal case.

UNIT VI

Testing of hypothesis : Null and alternative hypotheses, two type of errors, level of significance, power of the test, one tailed and two tailed tests.

UNIT VII

Tests of significance : (a) large sample tests for mean & equality of means of two populations (2-tests). Student's t-statistic and its use of testing the mean equality of means of two populations (with independent and paired observations) correlation coefficient and regression coefficients. (b) Chi-Square statistics and its use as a test of goodness of fit, independence of attributes (contingency table) with Yates correction, and testing for the variance of a population. (c) Fisher's F-statistic and its use in testing the equality of two variances and homogeneity of means (analysis of variance).

UNIT VIII

Analysis of variance and covariance (ANOVA and ANCOVA) : Analysis of variance and covariance with one way and two-way classifications (one observation per cell). Bartlett's test for testing the homogeneity of variances.

UNIT IX

Design of experiments : Need : uniformity trials, Principles of experimental design-replication, randomization and local control,

- (a) Completely randomized, randomized block and Latin square designs and their analysis, missing plot technique in RBD.

- (b) Simple factorial experiments of the type 2^2 , 3^3 , 2^4 , 3^2 , confounding in factorial experiments.
- (c) Split-plot experiments.

Practicals

- Presentation of data-tabulation, histograms and frequency polygons.
- Calculation of mean, mode, standard deviation, skewness and kurtosis.
- Calculation of expected frequencies in binomial, poisson and normal distributions testing the observed results against expected frequencies.
- Tests of significance as prescribed in theory.
- Regression and correlation coefficients and their significance.
- Analysis of variance for different designs prescribed.
- Analysis of covariance.

Suggested Readings

- Agricultural statistics ó Dr. S.R.S. Chandel.
- Agricultural statistics ó Singh, S.P. and Verma, R.P.S.
- An introduction to experimental design ó Williams S. Ray.
- Statistical methods in agriculture ó Dr. F.S.Chaudhary.
- Agril. Stat. & Coept. Designs ó Panse and Sukhatme P.K.

SOA/AGRON/C-502 **ADVANCES IN SOIL FERTILITY AND NUTRIENT MANAGEMENT** 2 + 1

Theory

UNIT I

Soil fertility and productivity - factors affecting; features of good soil management; problems of supply and availability of nutrients; relation between nutrient supply and crop growth; organic farming - basic concepts and definitions.

UNIT II

Criteria of essentiality of nutrients; Essential plant nutrients - their functions, nutrient deficiency symptoms; transformation and dynamics of major plant nutrients.

UNIT III

Preparation and use of farmyard manure, compost, green manures, vermicompost, biofertilizers and other organic concentrates their composition, availability and crop responses; recycling of organic wastes and residue management.

UNIT IV

Commercial fertilizers; composition, relative fertilizer value and cost; crop response to different nutrients, residual effects and fertilizer use efficiency, fertilizer mixtures and grades; agronomic, chemical and physiological methods of increasing fertilizer use efficiency; nutrient interactions.

UNIT V

Time and methods of manures and fertilizers application; foliar application and its concept; relative performance of organic and inorganic manures; economics of fertilizer use; integrated nutrient management; use of vermi-compost and residue wastes in crops.

Practicals

- Determination of soil pH, E_{Ce}, organic C, total N, available N, P, K and S in soils
- Determination of total N, P, K and S in plants
- Interpretation of interaction effects and computation of economic and yield optima

Suggested Readings

- Brady NC & Weil R.R 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.
- Fageria NK, Baligar VC & Jones CA. 1991. *Growth and Mineral Nutrition of Field Crops*. Marcel Dekker.
- Havlin JL, Beaton JD, Tisdale SL & Nelson WL. 2006. *Soil Fertility and Fertilizers*. 7th Ed. Prentice Hall.
- Prasad R & Power JF. 1997. *Soil Fertility Management for Sustainable Agriculture*. CRC Press.
- Yawalkar KS, Agrawal JP & Bokde S. 2000. *Manures and Fertilizers*. Agri-Horti Publ.

SOA/AGRON/C-503

ADVANCES IN WEED MANAGEMENT

2+1

Theory

UNIT I

Weed biology and ecology, crop-weed competition including allelopathy; principles and methods of weed control and classification; weed indices.

UNIT II

Herbicides introduction and history of their development; classification based on chemical, physiological application and selectivity; mode and mechanism of action of herbicides.

UNIT III

Herbicide structure - activity relationship; factors affecting the efficiency of herbicides; herbicide formulations, herbicide mixtures; herbicide resistance and management; weed control through bio-herbicides, myco-herbicides and allelochemicals; Degradation of herbicides in soil and plants; herbicide resistance in weeds and crops; herbicide rotation.

UNIT IV

Weed management in major crops and cropping systems; parasitic weeds; weed shifts in cropping systems; aquatic and perennial weed control.

UNIT V

Integrated weed management; cost : benefit analysis of weed management.

Practicals

- Identification of important weeds of different crops
- Preparation of a weed herbarium
- Weed survey in crops and cropping systems
- Crop-weed competition studies
- Preparation of spray solutions of herbicides for high and low-volume sprayers
- Use of various types of spray pumps and nozzles and calculation of swath width
- Economics of weed control
- Herbicide resistance analysis in plant and soil
- Bioassay of herbicide resistance
- Calculation of herbicidal requirement

Suggested Readings

- Aldrich RJ & Kramer RJ. 1997. *Principles in Weed Management*. Panima Publ.
- Ashton FM & Crafts AS. 1981. *Mode of Action of Herbicides*. 2nd Ed. Wiley Inter-Science.
- Gupta OP. 2007. *Weed Management - Principles and Practices*. Agrobios. Mandal RC. 1990. *Weed, Weedicides and Weed Control - Principles and Practices*. Agro-Botanical Publ.
- Rao VS. 2000. *Principles of Weed Science*. Oxford & IBH.
- Subramanian S, Ali AM & Kumar RJ. 1997. *All About Weed Control*. Kalyani.
- Zimdahl RL. 1999. *Fundamentals of Weed Science*. 2nd Ed. Academic Press.

Theory

UNIT I

Water and its role in plants; water resources of India, major irrigation projects, extent of area and crops irrigated in India and different states.

UNIT II

Soil water movement in soil and plants; transpiration; soil-water-plant relationships; water absorption by plants; plant response to water stress, crop plant adaptation to moisture stress condition.

UNIT III

Soil, plant and meteorological factors determining water needs of crops; scheduling, depth and methods of irrigation; micro irrigation system; fertigation; management of water in controlled environments and poly houses.

UNIT IV

Water management of the crops and cropping systems; quality of irrigation water and management of saline water for irrigation; water use efficiency. UNIT V

Excess of soil water and plant growth; water management in problem soils; drainage requirement of crops and methods of field drainage, their layout and spacing.

Practicals

- Measurement of soil water potential by using tensiometer, and pressure plate and membrane apparatus
- Soil-moisture characteristics curves
- Water flow measurements using different devices
- Determination of irrigation requirements
- Calculation of irrigation efficiency
- Determination of infiltration rate
- Determination of saturated/unsaturated hydraulic conductivity

Suggested Readings

- Lenka D. 1999. Irrigation and Drainage. Kalyani
Michael AM. 1978. Irrigation: Theory and Practice. Vikas Publ.
Paliwal KV. 1972. *Irrigation with Saline Water*. IARI Monograph, New Delhi.
Panda SC. 2003. Principles and Practices of Water Management. Agrobios.
Prihar SS & Sandhu BS. 1987. Irrigation of Food Crops - Principles and Practices. ICAR.
Reddy SR. 2000. Principles of Crop Production. Kalyani.
Singh Pratap & Maliwal PL. 2005. Technologies for Food Security and Sustainable Agriculture. Agrotech Publ.

Theory

Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality components, handling and processing of the produce for maximum production of

UNIT I

Rabi cereals. : Wheat and Barley.

UNIT II

Kharif cereals. : Paddy, Maize, Sorghum, Bajra & Smaller Millets

UNIT III

Rabi pulses.: Gram, Lentil and Pea.

UNIT IV

Kharif pulses.: Arhar, Mung and Urd.

Practicals

- Phenological studies at different growth stages of crop
- Estimation of crop yield on the basis of yield attributes
- Formulation of cropping schemes for various farm sizes and calculation of cropping and rotational intensities
- Working out growth indices (LAI, CGR, RGR, NAR, LAD), aggressiveness, relative crowding coefficient, monetary yield advantage and LER of prominent intercropping systems of different crops
- Estimation of protein content in pulses
- Planning and layout of field experiments
- Judging of physiological maturity in different crops
- Intercultural operations in different crops
- Determination of cost of cultivation of different crops
- Working out harvest index of various crops
- Study of seed production techniques in various crops
- Visit of field experiments on cultural, fertilizer, weed control and water management aspects
- Visit to nearby villages for identification of constraints in crop production

Suggested Readings

- Das NR. 2007. *Introduction to Crops of India*. Scientific Publ.
- Hunsgi G & Krishna KR. 1998. *Science of Field Crop Production*. Oxford & IBH.
- Jeswani LM & Baldev B. 1997. *Advances in Pulse Production Technology*. ICAR.
- Khare D & Bhale MS. 2000. *Seed Technology*. Scientific Publ.
- Kumar Ranjeet & Singh NP. 2003. *Maize Production in India: Golden Grain in Transition*. IARI, New Delhi.
- Pal M, Deha J & Rai RK. 1996. *Fundamentals of Cereal Crop Production*. Tata McGraw Hill.
- Prasad, Rajendra. 2002. *Text Book of Field Crop Production*. ICAR.
- Singh C, Singh P & Singh R. 2003. *Modern Techniques of Raising Field Crops*. Oxford & IBH.
- Singh, SS. 1998. *Crop Management*. Kalyani.
- Yadav DS. 1992. *Pulse Crops*. Kalyani.

SEMESTER - II

SOA/AGRON/C-506 **AGRO METEOROLOGY AND CROP WEATHER FORECASTING** 2+1
Theory

UNIT I

Agro meteorology - aim, scope and development in relation to crop environment; composition of atmosphere, distribution of atmospheric pressure and wind.

UNIT II

Characteristics of solar radiation; energy balance of atmosphere system; radiation distribution in plant canopies, radiation utilization by field crops; photosynthesis and efficiency of radiation utilization by field crops; energy budget of plant canopies; environmental temperature: soil, air and canopy temperature.

UNIT III

Temperature profile in air, soil, crop canopies; soil and air temperature effects on plant processes; environmental moisture and evaporation: measures of atmospheric temperature and relative humidity vapor pressure and their relationships; evapo-transpiration and meteorological factors determining evapo-transpiration.

UNIT IV

Modification of plant environment: artificial rain making, heat transfer, controlling heat load, heat trapping and shading; protection from cold, sensible and latent heat flux, controlling soil moisture; monsoon and their origin, characteristics of monsoon; onset, progress and withdrawal of monsoon; weather hazards, drought monitoring and planning for mitigation.

UNIT V

Weather forecasting in India - short, medium and long range; aerospace science and weather forecasting; benefits of weather services to agriculture, remote sensing; application in agriculture and its present status in India; atmospheric pollution and its effect on climate and crop production; climate change and its impact on agriculture.

Practicals

- Visit to agro-meteorological observatory and to record sun-shine hours, wind velocity, wind direction, relative humidity, soil and air temperature, evaporation, precipitation and atmospheric pressure.
- Measurement of solar radiation outside and within plant canopy.
- Measurement/estimation of evapo-transpiration by various methods.
- Measurement/estimation of soil water balance.
- Rainfall variability analysis.
- Determination of heat-unit requirement for different crops.
- Measurement of crop canopy temperature.
- Measurement of soil temperatures at different depths.
- Remote sensing and familiarization with agro-advisory service bulletins.
- Study of synoptic charts and weather reports, working principle of automatic weather station.
- Visit to solar observatory.

Suggested Readings

- Chang Jan Hu 1968. *Climate and Agriculture on Ecological Survey*. Aldine Publ.
- Critchfield HJ.1995. *General Climatology*. Prentice Hall of India.
- Das PK.1968. *The Monsoons*. National Book Trust Publ.
- Lal DS.1998. *Climatology*. Sharda Pustak Bhawan.
- Lenka D.1998. *Climate, Weather and Crops in India*. Kalyani.
- Mavi H.S.1994. *Introduction to Agro-meteorology*. Oxford & IBH.
- Mavi HS & Tupper GJ. 2004. *Agrometeorology: Principles and Application of Climate Studies in Agriculture*. Haworth Press.
- Menon PA.1991. *Our Weather*. National Book Trust Publ.
- Sahu DD. *Agrometeorology and Remote Sensing: Principles and Practices*. Agrobios.
- Variraju R & Krishnamurthy 1995. *Practical Manual on Agricultural Meteorology*. Kalyani.
- Varshneya MC & Balakrishana Pillai P. 2003. *Textbook of Agricultural Meteorology*. ICAR.

Theory

UNIT I

Organic farming - concept and definition, its relevance to India and global agriculture and future prospects; land and water management - land use, minimum tillage; shelter zones, hedges, pasture management, agro-forestry.

UNIT II

Organic farming and water use efficiency; soil fertility, nutrient recycling, organic residues, organic manures, composting, soil biota and decomposition of organic residues, earthworms and vermin compost, green manures and bio-fertilizers.

UNIT III

Farming systems, crop rotations, multiple and relay cropping systems, intercropping in relation to maintenance of soil productivity.

UNIT IV

Control of weeds, diseases and insect pest management, biological agents and pheromones, bio-pesticides.

UNIT V

Socio-economic impacts; marketing and export potential: inspection, certification, labeling and accreditation procedures; organic farming and national economy.

Practicals

- Aerobic and anaerobic methods of making compost
- Making of vermin compost
- Identification and nursery rising of important agro-forestry trees and trees for shelter belts.
- Efficient use of bio-fertilizers, technique of treating legume seeds with *Rhizobium* cultures, use of *Azotobacter*, *Azospirillum*, and PSB cultures in field
- Visit to an organic farm
- Quality standards, inspection, certification and labeling and accreditation procedures for farm produce from organic farms

Suggested Readings

- Ananthakrishnan TN. (Ed.). 1992. Emerging Trends in Biological Control of Phytophagous Insects. Oxford & IBH.
- Gaur AC. 1982. *A Manual of Rural Composting*, FAO/UNDP Regional Project Document, FAO.
- Lampin N. 1990. *Organic Farming*. Press Books, Ipswich, UK. Palaniappan SP & Anandurai K. 1999. *Organic Farming - Theory and Practice*. Scientific Publ.
- Rao BV Venkata. 1995. Small Farmer Focused Integrated Rural Development: Socio-economic Environment and Legal Perspective: Publ.3, Parisaraprajna Parishtana, Bangalore.
- Reddy MV. (Ed.). 1995. *Soil Organisms and Litter Decomposition in the Tropics*. Oxford & IBH.
- Sharma A. 2002. *Hand Book of Organic Farming*. Agrobios.
- Singh SP. (Ed.) 1994. *Technology for Production of Natural Enemies. PDBC, Bangalore*.
- Subba Rao NS. 2002. *Soil Microbiology*. Oxford & IBH.
- Trivedi RN. 1993. *A Text Book of Environmental Sciences*, Anmol Publ. Veeresh GK, Shivashankar K & Suiglachar MA. 1997. *Organic Farming and Sustainable Agriculture*. Association for Promotion of Organic Farming, Bangalore.
- WHO. 1990. *Public Health Impact of Pesticides Used in Agriculture*. WHO.
- Woolmer PL & Swift MJ. 1994. *The Biological Management of Tropical Soil Fertility*. TSBF & Wiley.

Theory

Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition quality component, handling and processing of the produce for maximum production of :

UNIT I

Rabi oilseeds - Rapeseed and mustard, linseed, etc.

UNIT II

Kharif oilseeds - Groundnut, sesame, castor, sunflower, soybean etc.

UNIT III

Fiber crops - Cotton, jute, sun hemp etc.

UNIT IV

Sugar crops - Sugar-beet and sugarcane.

Practicals

- Planning and layout of field experiments
- Cutting of sugarcane setts, its treatment and methods of sowing, tying and propping of sugarcane
- Determination of cane maturity and calculation on purity percentage, recovery percentage and sucrose content in cane juice phenological studies at different growth stages of crop
- Intercultural operations in different crops
- Cotton seed treatment
- Working out growth indices (LAI, CGR, RGR, NAR, LAD) aggressively, relative crowding coefficient, monetary yield advantage and LER of prominent intercropping systems
- Judging of physiological maturity in different crops and working out harvest index
- Working out cost of cultivation of different crops
- Estimation of crop yield on the basis of yield attributes
- Formulation of cropping schemes for various farm sizes and calculation of cropping and rotational intensities
- Determination of oil content in oilseeds and computation of oil yield
- Estimation of quality of fibre of different fibre crops
- Study of seed production techniques in various crops
- Visit of field experiments on cultural, fertilizer, weed control and water management aspects
- Visit to nearby villages for identification of constraints in crop production

Suggested Readings

Das NR. 2007. *Introduction to Crops of India*. Scientific Publ.

Das PC. 1997. *Oilseed Crops of India*. Kalyani.

Lakshmikantam N. 1983. *Technology in Sugarcane Growing*. 2nd Ed. Oxford & IBH.

Prasad, Rajendra. 2002. *Text Book of Field Crop Production*. ICAR.

Singh C, Singh P & Singh R. 2003. *Modern Techniques of Raising Field Crops*. Oxford & IBH.

Singh SS. 1998. *Crop Management*. Kalyani.

Theory

UNIT I

Adaptation, distribution, varietal improvement, agro-techniques and quality aspects including anti-quality factors of important fodder crops like maize, *bajra*, *guar*, cowpea, oats, barley, berseem, *senji*, lucerne etc.

UNIT II

Adaptation, distribution, varietal improvement, agro-techniques and quality aspects including anti-quality factors of important forage crops/grasses- lime, Napier grass, *Panicum*, *Lasiurus*, *Cenchrus* etc.

UNIT III

Year-round fodder production and management, preservation and utilization of forage and pasture crops.

UNIT IV

Principles and methods of hay and silage making; chemical and biochemical changes, nutrient losses and factors affecting quality of hay and silage; use of physical and chemical enrichments and biological methods for improving nutrition; value addition of poor quality fodder.

UNIT V

Economics of forage cultivation, uses and seed production techniques.

Practicals

- Practical Training of farm operations in raising fodder crops;
- Canopy measurement, yield and quality estimation, viz. crude protein, NDF, ADF, lignin, silica, cellulose etc. of various fodder and forage crops
- Anti-quality components like HCN in sorghum and such factors in other crops
- Hay and silage making and economics of their preparation

Suggested Readings

Chatterjee BN. 1989. Forage Crop Production - Principles and Practices. Oxford & IBH.
Das NR. 2007. *Introduction to Crops of India*. Scientific Publ.
Narayanan TR & Dabadghao PM. 1972. *Forage Crops of India*. ICAR. Singh P & Srivastava AK. 1990. *Forage Production Technology*. IGFRI, Jhansi.
Singh C, Singh P & Singh R. 2003. *Modern Techniques of Raising Field Crops*. Oxford & IBH.
Tejwani KG. 1994. *Agroforestry in India*. Oxford & IBH.

SOA/AGRON/C-510

AGRONOMY OF MEDICINAL AND AROMATIC CROPS

3+1

Theory

UNIT I

Importance of medicinal and aromatic plants in human health, national economy and related industries, classification of medicinal and aromatic plants according to botanical characteristics and uses.

UNIT II

Climate and soil requirements; cultural practices; yield and important constituents of medicinal plants (Isabgol, Rauwolfia, Poppy, *Aloe vera*, Satavar, Stevia, Safed Musli, Kalmegh, Asaphoetida, *Nux vomica*, Rosadle etc).

UNIT III

Climate and soil requirements; cultural practices; yield and important constituents of aromatic plants (Citronella, Palmarosa, Mentha, Basil, Lemon grass, Rose, Patchouli, Geranium, Levender & Jasmine etc.).

Practicals

- Identification of crops based on morphological and seed characteristics
- Raising of herbarium of medicinal and aromatic plants
- Quality characters in medicinal and aromatic plants
- Methods of analysis of essential oil and other chemicals of importance in medicinal and aromatic plants

Suggested Readings

- Chadha KL & Gupta R. 1995. *Advances in Horticulture*. Vol. II. Medicinal and Aromatic Plants. Malhotra Publ.
- Das NR. 2007. *Introduction to Crops of India*. Scientific Publ.
- Handa SS. 1984. *Cultivation and Utilization of Medicinal Plants*. RRL, CSIR, Jammu.
- Hussain A. 1984. *Essential Oil Plants and their Cultivation*. CIMAP, Lucknow.
- Hussain A. 1993. *Medicinal Plants and their Cultivation*. CIMAP, Lucknow.
- ICAR 2006. *Hand Book of Agriculture*. ICAR, New Delhi.
- Kumar N, Khader Md. Abdul, Rangaswami JBM & Irulappan 1997. *Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants*. Oxford & IBH.
- Prajapati ND, Purohit SS, Sharma AK & Kumar T. 2003. *A Hand Book of Medicinal Plants: A Complete Source Book*. Agrobios.
- Sharma R. 2004. *Agro-Techniques of Medicinal Plants*. Daya Publ. House.

SOA/AGRON/C-511

SELF STUDY COURSES

3+0

SEMESTER – III

SOA/AGRON/C-512

DRYLAND FARMING

2+1

Theory

UNIT I

Definition, concept and characteristics of dry land farming; dry land versus rainfed farming; significance and dimensions of dry land farming in Indian agriculture.

UNIT II

Soil and climatic parameters with special emphasis on rainfall characteristics; constraints limiting crop production in dry land areas; types of drought, characterization of environment for water availability; crop planning for erratic and aberrant weather conditions.

UNIT III

Stress physiology and resistance to drought, adaptation of crop plants to drought, drought management strategies; preparation of appropriate crop plans for dry land areas; mid contingent plan for aberrant weather conditions.

UNIT IV

Tillage, tith, frequency and depth of cultivation, compaction in soil tillage; concept of conservation tillage; tillage in relation to weed control and moisture conservation; techniques and practices of soil moisture conservation (use of mulches, kinds, effectiveness and economics); anti-transparents; soil and crop management techniques, seeding and efficient fertilizer use.

UNIT V

Concept of watershed resource management, problems, approach and components.

Practicals

- Seed treatment, seed germination and crop establishment in relation to soil moisture contents
- Moisture stress effects and recovery behavior of important crops
- Estimation of moisture index and aridity index
- Spray of anti-transpirants and their effect on crops
- Collection and interpretation of data for water balance equations
- Water use efficiency
- Preparation of crop plans for different drought conditions
- Study of field experiments relevant to dryland farming
- Visit to dryland research stations and watershed projects

Suggested Readings

- Das NR. 2007. *Tillage and Crop Production*. Scientific Publishers.
- Dhopte AM. 2002. *Agrotechnology for Dryland Farming*. Scientific Publ.
- Dhruv Narayan VV. 2002. *Soil and Water Conservation Research in India*. ICAR.
- Gupta US. (Ed.). 1995. *Production and Improvements of Crops for Drylands*. Oxford & IBH.
- Katyal JC & Farrington J. 1995. *Research for Rainfed Farming*. CRIDA. Rao SC & Ryan J. 2007. *Challenges and Strategies of Dryland Agriculture*. *Scientific Publishers*.
- Singh P & Maliwal PL. 2005. *Technologies for Food Security and Sustainable Agriculture*. Agrotech Publishing Company.
- Singh RP. 1988. *Improved Agronomic Practices for Dryland Crops*. CRIDA.
- Singh RP. 2005. *Sustainable Development of Dryland Agriculture in India*. Scientific Publ.
- Singh SD. 1998. *Arid Land Irrigation and Ecological Management*. *Scientific Publishers*.
- Venkateshwarlu J. 2004. *Rainfed Agriculture in India. Research and Development Scenario*. ICAR.

SOA/AGRON/C-513

MANAGEMENT OF PROBLEM SOILS

2+1

UNIT I

Problem soils classification and distribution. Nature and properties of saline, alkali and acidic soils.

UNIT II

Plant responses to soil reaction, extent of damage to crops, salt tolerance of the crops. Management and improvement of saline, alkali and acidic soils.

UNIT III

Excess soil water conditions ó sources and occurrences. Rainfall analysis and water balance. Effect of excess soil water on crop growth.

UNIT IV

Management of excess soil water, water fluctuation and side movements, lowering of water table for successful crop production. Degraded soils and their rehabilitation.

Practicals :-

- Determination of pH, E.C., gypsum requirement for sodic soils and lime requirement for acidic soils.
- Determination of specific gravity, bulk density, porosity and soil texture.
- Analysis of irrigation water.
- Visit to areas of problem soils.

Suggested Readings

- Bear FE. 1964. Chemistry of the Soil. Oxford & IBH.
- Jurinak JJ. 1978. Salt-affected Soils. Department of Soil Science & Biometeorology. Utah State Univ.
- USDA Handbook No. 60. 1954. Diagnosis and improvement of Saline and Alkali Soil. Oxford & IBH.
- Abro, I.P., and M. Fiseman, 1977. Alkali and Saline soils- identification and Improvement for crop production. Bull No.4, CSSRI (ICAR), Karnal, India.
- Agarwal, R.R., J.S.P. Yadav and R.N. Gupta, 1982. Saline and Alkali soils of India, ICAR, New Delhi.
- Anonymous (1976). Acid of India. Their genesis, Characteristics and management, Bull. 9, ICAR, New Delhi.
- Bhargava, G.P., 1989. Salt Affected Soils of India. A source book. Oxford & IBH Publication co., New Delhi.
- Mandal, S.C. M.K. Sinha and H. Sinha, 1975. Acid Soils of India and Liming, Tech. Bull. (Agric.), 51, ICAR, New Delhi.
- Mehta, K.K. 1983, Reclamation of Alkali Soils in India, Oxford & IBH publishing co., New Delhi.

SOA/AGRON/C-514

MODERN CONCEPT IN CROP PRODUCTION

2+1

Theory

UNIT I

Crop growth analysis in relation to environment; Agro-ecological zones of India.

UNIT II

Quantitative agro-biological principles and inverse yield nitrogen law; Mitscherlich yield equation, its interpretation and applicability; Baule unit.

UNIT III

Effect of lodging in cereals; physiology of grain yield in cereals; optimization of plant population and planting geometry in relation to different resources, concept of ideal plant type and crop modeling for desired crop yield.

UNIT IV

Scientific principles of crop production; crop response production functions; concept of soil plant relations; yield and environmental stress.

UNIT V

Integrated farming systems, organic farming, and resource conservation technology including modern concept of tillage; dry farming; determining the nutrient needs for yield potentiality of crop plants, concept of balance nutrition and integrated nutrient management; precision agriculture.

Practicals :-

- Technique of rapid soil and plant tissue test.
- Technique of rapid field test for conductances.
- Determination of soil moisture.
- Finding out leaf area and calculation of LAI, NAR, CGR.

Suggested Readings

Balasubramaniyan P & Palaniappan SP. 2001. *Principles and Practices of Agronomy*. Agrobios.
Fageria NK. 1992. *Maximizing Crop Yields*. Marcel Dekker.

- Havlin JL, Beaton JD, Tisdale SL & Nelson WL. 2006. *Soil Fertility and Fertilizers*. 7th Ed. Prentice Hall.
- Paroda R.S. 2003. *Sustaining our Food Security*. Konark Publ.
- Reddy SR. 2000. *Principles of Crop Production*. Kalyani Publ.
- Sankaran S & Mudaliar TVS. 1997. *Principles of Agronomy*. The Bangalore Printing & Publ.
- Singh SS. 2006. *Principles and Practices of Agronomy*. Kalyani.

ELECTIVE COURSES :

Students can choose three out of the following four electives.

SOA/AGRON/E-515

CROP ECOLOGY

2+1

Theory

UNIT I

Concept of crop ecology, agricultural systems, ecology of cropping systems, principles of plant distribution and adaptation, crop and world food supply.

UNIT II

Ecosystem characteristics, types and functions, terrestrial ecology, flow of energy in ecosystem, ecosystem productivity, biomass, succession and climax concept.

UNIT III

Physiological response of crop plants to light, temperature, CO₂, moisture and solar radiation; influence of climate on photosynthesis and productivity of crops; effect of global climate change on crop production.

UNIT IV

Exploitation of solar energy in crops; vertical distribution of temperature; efficiency in crop production.

UNIT V

Competition in crop plants; environmental pollution, ecological basis of environmental management and environment manipulation through agronomic practices; improvement of unproductive lands through crop selection and management.

Practicals :-

- Study of the climatic logical data of the state and their relationship with the growth and yield of the crops.
- Effect of solar light on photosynthesis rate of plants.
- Nitrogen cycle and Nitrogen fixation.
- Food Chain.
- Determination of areas in India with the help of data of crop yield.
- Study the micro- climate in crops.

Suggested Readings

- Ambasht RS. 1986. *A Text Book of Plant Ecology*. 9th Ed. Students & Friends & Co.
- Chadha KL & Swaminathan MS. 2006. *Environment and Agriculture*. Malhotra Publ. House.
- Dwivedi P, Dwivedi SK & Kalita MC. 2007. *Biodiversity and Environmental Biotechnology*. Scientific Publ.
- Hemantarajan A. 2007. *Environmental Physiology*. Scientific Publ.
- Kumar HD. 1992. *Modern Concepts of Ecology*. 7th Ed. Vikas.Publ.
- Lenka D. 1998. *Climate, Weather and Crops in India*. Kalyani.
- Misra KC. 1989. *Manual of Plant Ecology*. 3rd Ed. Oxford & IBH.
- Pandey SN & Sinha BK. 1995. *Plant Physiology*. Vikas Publ.

- Sharma PD. 1998. *Ecology and Environment*. Rastogi Publ.
 Singh J & Dhillon SS. 1984. *Agricultural Geography*. Tata McGraw Hill. Taiz L & Zeiger E.
 1992. *Plant Physiology*. Benjamin/Cummings Publ.

SOA/AGRON/E-516 CROPPING SYSTEMS AND SUSTAINABLE AGRICULTURE 2+1

Theory

UNIT I

Cropping systems: definition, indices and its importance; physical resources, soil and water management in cropping systems; assessment of land use.

UNIT II

Concept of sustainability in cropping systems and farming systems, scope and objectives; production potential under monoculture cropping, multiple cropping, alley cropping, sequential cropping and intercropping, mechanism of yield advantage in intercropping systems.

UNIT III

Above and below ground interactions and allelopathic effects; competition relations; multi-storied cropping and yield stability in intercropping, role of non-monetary inputs and low cost technologies; research need on sustainable agriculture.

UNIT IV

Crop diversification for sustainability; role of organic matter in maintenance of soil fertility; crop residue management; fertilizer use efficiency and concept of fertilizer use in intensive cropping system.

UNIT V

Plant ideotypes for drylands; plant growth regulators and their role in sustainability.

Practicals :-

- Preparation of cropping schemes for dry and irrigated areas.
- Evaluation of Cropping system : Simple values indices, crop equivalent yield (CEY), Land equivalent ratio (LER), Relative crowding co-efficient.
- Evaluation of constraints and optimization of farming system.
- Intercropping trap and decoy crops, constructed traps, repellents, biological control and strategic use of pesticides in crops and natural medicines in animals, contour farming, integrated crop-livestock ó fish farming.
- Integrated forage production and forms ó centered techniques and practices thereof.

Suggested Readings

- Palaniappan SP & Sivaraman K. 1996. *Cropping Systems in the Tropics; Principles and Management*. New Age.
 Panda SC. 2003. *Cropping and Farming Systems*. Agrobios.
 Reddy SR. 2000. *Principles of Crop Production*. Kalyani.
 Sankaran S & Mudaliar TVS. 1997. *Principles of Agronomy*. The Bangalore Printing & Publ.Co.
 Singh SS. 2006. *Principles and Practices of Agronomy*. Kalyani.
 Tisdale SL, Nelson WL, Beaton JD & Havlin JL. 1997. *Soil Fertility and Fertilizers*. Prentice Hall.

SOA/AGRON/E-517 SOIL TAXONOMY, SURVEY AND REMOTE SENSING 2+1

Theory

UNIT I

Soil survey ó definition, objectives, methods, soil mapping units, types and advantages; land capability classification.

UNIT II

Morphological, physical and chemical properties used in distinguishing and classifying soils, principles of soil taxonomy, classification systems.

UNIT III

Soils of India and their taxonomic classification, Important characteristics, potential and constraints.

UNIT IV

Remote sensing- introduction, definition, concept, principles, importance, scope, types, advantages and disadvantages and its application in agriculture and soil classification.

Practicals

ÉField visit and practice of judging soil texture by feel method.

ÉExamination of soil profile.

ÉStudy of base map used for soil survey, village or cadastral maps, topographic maps, aerial photographs.

ÉExamination of soil properties of some important soils of India.

ÉAerial photographs, adjustment of stereoscope.

ÉArea estimation of eroded land from F.C.C. (false colour composite).

ÉVisit of remote sensing application centre/soil survey organization.

Suggested Readings

Campbell, P.i. and Wynne, R.H., 2011. Introduction to Remote Sensing, 5th edition, The Guilford Press Publi.,

Gibson, P,i., 2000. Introductory Remote Sensing: Principles and concepts, Google book.

Seghal, i.L., 2006. Introductory Pedology, 2nd edition, Kalyani Publi., Ludhiana.

Seghal, J.L., 1996. Pedology, First edition, Kalyani Publi., Ludhiana.

Soil Survey Staff, 1981. Soil Survey Manual. Soil Conservation Service, U.S. Dept. Agric., Publi., Washing, D.C.

Soil Survey Staff, 1999. Soil Taxonomy, 2 edition, USDA-SCS Publi., Washing, D.C.

SOA/AGRON/E-518

STORAGE INSECT PESTS AND THEIR MANAGEMENT

2+1

Theory

UNIT I

Introduction, history concepts and significance of management of storage insect pests. Post-harvest losses *in toto visà-vis* total production of food grains in India. Scientific and socio-economic factors responsible for grain losses.

UNIT II

Important pests namely insects, mites, rodents, birds and microorganisms associated with stored grain and field conditions including agricultural products; traditional storage structures; association of stored grain insects with fungi and mites, their systematic position, identification, distribution, host range, biology, nature and extent of damage, role of field and cross infestations and natural enemies, type of losses in stored grains and their effect on quality including biochemical changes.

UNIT III

Ecology of insect pests of stored commodities/grains with special emphasis on role of moisture, temperature and humidity in safe storage of food grains and commodities. Stored grain deterioration process, physical and biochemical changes and consequences. Grain storage- types of storage structures i.e., traditional, improved and modern storage structures in current usage. Ideal seeds and commodities storage conditions.

UNIT IV

Important rodent pests associated with stored grains and their non-chemical and chemical control including fumigation of rat burrows. Role of bird pests and their management. Control of infestation by insect pests, mites and microorganisms. Preventive measures- Hygiene/sanitation, disinfestations of stores/receptacles, legal methods. Curative measures-Non-chemical control measures- ecological, mechanical, physical, cultural, biological and engineering. Chemical control- prophylactic and curative-Characteristics of pesticides, their use and precautions in their handling with special emphasis on fumigants. Integrated approaches to stored grain pest management.

Practicals

Collection, identification and familiarization with the stored grains/seed insect pests and nature of damage caused by them; detection of insect infestation in stored food grains; estimation of losses in stored food grains; determination of moisture content in stored food grains; familiarization of storage structures, demonstration of preventive and curative measures including fumigation techniques; treatment of packing materials and their effect on seed quality. Field visits to save grain campaign, central warehouse and FCI warehouses and institutions engaged in research or practice of grain storage like CFTRI, IGSMRI, Hapur etc. (only where logistically feasible).

Suggesting Readings

Hall DW. 1970. *Handling and Storage of Food Grains in Tropical and Subtropical Areas*. FAO. Agricultural Development Paper No. 90 and FAO, Plant Production and Protection Series No. 19, FAO, Rome.

Jayas DV, White NDG & Muir WE. 1995. *Stored Grain Ecosystem*. Marcel Dekker, New York.

Khader V. 2004. *Textbook on Food Storage and Preservation*. Kalyani Publ., New Delhi.

Khare BP. 1994. *Stored Grain Pests and Their Management*. Kalyani Publ., New Delhi.

Subramanyam B & Hagstrum DW. 1995. *Interrelated Management of Insects in Stored Products*. Marcel Dekker, New York.

SEMESTER - IV

SOA/AGRON/C-519

THESIS
Or

0 + 8

SOA/AGRON/C-520

SEED PRODUCTION TECHNOLOGY

3 + 1

UNIT I

Objectives of seed production technology: Role in increasing agriculture production seed its importance, in green revolution difference between grain and seed. Concept of seed quality, steps involve in seed production. Principles of seed production, concept and factors that affect the seed quality in the growing; processing and distribution of seed, seed replacement rate, multiplication rate, seed industry in India and role of various agencies, important terminology used in seed industry, breeders, foundation, and certified seed, maintenance of genetic purity.

UNIT II

Seed certification : Its concept, role & goal, necessity of seed certification, minimum seed certification standard for self and cross pollinated crops, Field and seed inspections, objectives, general principles and methods. Preparation of field reports, seed certification terms; seed certification agencies, certified and truthfully labeled seeds.

UNIT III

Nucleus and breeders seed production of self pollinated crops: Viz. Rice, Wheat, Arhar, Gram, Soyabean, Rapeseed and Mustard.

UNIT IV

Maintenance of nucleus and breeders seed in cross pollinated crop varieties: in bred and no-inbreds, maintenance of seed of established varieties, foundation, and certified seed production of Maize inbreds, single and double cross hybrids.

UNIT V

Hybrid seed production : of Rice, Maize, Sorghum, and Bajra, and Sunflower using male sterility systems..

UNIT VI

Latest released hybrids L of Rice, Maize, Sorghum, and Bajra, their characteristic features.

UNIT VII.

Seed testing : Importance of seed testing in production of high quality seed. Techniques of seed testing; Sampling, Sample preparation for seed testing, purity testing, germination test, physiology of seed in relation to viability, vigour & dormancy of seeds, Varietal identification, through electrophoresis. Growth out test for cultivar, purity. Seed legislation and seed law enforcement including IPR, PBR in India. Recent development in seed industry. Genetic aspect of varietal deterioration.

UNIT VIII

Seed processing storage and marketing principle & practices of seed drying and seed separation selecting of sources air and screen seed cleanness physical characteristics utilized in seed cleaning & grading; seed treatment, type of seed treatment, materials & methods of seed packing, factors affecting seed in storage, problems of stored grains pest & methods to avoid the loss. Distribution & marketing of seed.

Practicals

- Testing of seeds for their purity, viability & germination.
- Seed treatment for diseases & pests.
- Handling of crop protection equipment.
- Seed sampling & preparation of samples for seed testing.
- Evaluation of seed tests & writing of seed testing report.
- Visit to a seed processing plant.
- To see equipment & machinery used in seed processing.
- To see cleaning grading, treating & packing of seed.
- Field trip to see production in field of maize.
- Visit to seed production plots of vegetable crop.
- Acquaintance of insecticide, fungicide & pesticide.
- Identification of important varieties of Maize, Jowar, Bajara, Paddy & Wheat.

Suggested Readings

- U.S.D.A. Year Book Seeds, 1961.
- International rules for seed testing I.S.T.A. proceedings 959. Vol. 2 & 3.
- Seed certification, processing & storage, I.C.A.R. Miscellaneous Bulletin No. 84.
- Seed certification Manual, produced by N.S.C. & the Rockefeller Foundation.
- Seed processing storage & distribution Manual, produced by N.S.C. and the Rockefeller Foundation.
- Seed Production Manual, Produced by N.S.C. and the Rockefeller Foundation.
- Seed Technology-Agrawal, R.L.
- Technique seed Science & Technology-Agrawal, P.K.
- Seed Technology-Dahia, B.S. and Rai, K.N.
- Seed Science and Technology-Sen, S. and Ghosh, N.

Theory

UNIT I

Soil erosion: definition, nature and extent of erosion; types of erosion, factors affecting erosion.

UNIT II

Soil conservation: definition, methods of soil conservation; agronomic measures - contour cultivation, strip cropping, cover crops; vegetative barriers; improved dry farming practices; mechanical measures - bunding, gully control, bench terracing; role of grasses and pastures in soil conservation; wind breaks and shelter belts.

UNIT III

Watershed management: definition, objectives, concepts, approach, components, steps in implementation of watershed; development of cropping systems for watershed areas.

UNIT IV

Land use capability classification, alternate land use systems; agro-forestry; ley farming; *jhum* management - basic concepts, socio-ethnic aspects, its layout.

UNIT V

Drainage considerations and agronomic management; rehabilitation of abandoned *jhum* lands and measures to prevent soil erosion.

Practicals

- Study of different types of erosion.
- Field studies of different soil conservation measures.
- Run-off and soil loss measurements.
- Laying out run-off plot and deciding treatments.
- Identification of different grasses and trees for soil conservation.
- Visit to a soil conservation research centre, demonstration and training centre.

Suggested Readings

Arakeri HR & Roy D. 1984. Principles of Soil Conservation and Water Management. Oxford & IBH.

Dhruvanarayana VV. 1993. Soil and Water Conservation Research in India. ICAR.

FAO. 2004. Soil and Water Conservation in Semi-Arid Areas. Soils Bull., Paper 57.

Frederick RT, Hobbs J, Arthur D & Roy L. 1999. *Soil and Water Conservation: Productivity and Environment Protection*. 3rd Ed. Prentice Hall.

Gurmel Singh, Venkataraman CG, Sastry B & Joshi P. 1990. *Manual of Soil and Water Conservation Practices*. Oxford & IBH.

Murthy VVN. 1995. *Land and Water Management Engineering*. Kalyani. Tripathi RP & Singh HP. 1993. *Soil Erosion and Conservation*. Wiley Eastern.

Yellamanda Reddy T & Sankara Reddy GH. 1992. *Principles of Agronomy*. Kalyani.

ELECTIVE COURSES :

Students can choose three out of the following four electives.

SOA/AGRON/E-523 ANALYTICAL TECHNIQUES AND INSTRUMENTAL METHODS IN SOIL AND PLANT ANALYSIS 2+1**Theory****UNIT I**

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

UNIT II

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

UNIT III

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

UNIT IV

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

Practicals

- Analysis of soil and plant samples for N, P, K, Ca, Mg, S, Zn, Cu, Fe, Mn, B and Mo; analysis of plant materials by digesting plant materials by wet and dry ashing and soil by wet digestion methods.
- Determination of lime and gypsum requirement of soil; drawing normalized exchange isotherms; measurement of redox potential.
- Analysis of soil extracts and irrigation waters for their soluble cations and anions and interpretation of results.

Suggested Readings

Hesse P. 1971. Textbook of Soil Chemical Analysis. William Clowes & Sons. Jackson ML. 1967. Soil Chemical Analysis. Prentice Hall of India.
Keith A Smith 1991. Soil Analysis; Modern Instrumental Techniques. Marcel Dekker.
Kenneth Helrich 1990. Official Methods of Analysis. Association of Official Analytical Chemists.
Page AL, Miller RH & Keeney DR. 1982. Methods of Soil Analysis. Part II. SSSA, Madison.
Piper CE. Soil and Plant Analysis. Hans Publ.
Singh D, Chhonkar PK & Pandey RN. 1999. Soil Plant Water Analysis - A Methods Manual. IARI, New Delhi.
Tan KH. 2003. Soil Sampling, Preparation and Analysis. CRC Press/Taylor & Francis.
Tandon HLS. 1993. Methods of Analysis of Soils, Fertilizers and Waters. FDCO, New Delhi.
Vogel AL. 1979. A Textbook of Quantitative Inorganic Analysis. ELBS Longman.

SOA/AGRON/E-524 AGROSTOLOGY AND AGRO-FORESTRY 2+1**Theory****UNIT I**

Agrostology: definition and importance; principles of grassland ecology: grassland ecology - community, climax, dominant species, succession, biotype, ecological status of grasslands in India, grass cover of India; problems and management of grasslands.

UNIT II

Importance, classification (various criteria), scope, status and research needs of pastures; pasture establishment, their improvement and renovation-natural pastures, cultivated pastures; common pasture grasses.

UNIT III

Agro forestry: definition and importance; agro forestry systems, agrisilviculture, silvipasture, agrisilvipasture, agrihorticulture, aqua- silviculture, alley cropping and energy plantation.

UNIT IV

Crop production technology in agro-forestry and agrostology system; silvipastoral system: meaning and importance for wasteland development; selection of species, planting methods and problems of seed germination in agro-forestry systems; irrigation and manuring in agro-forestry systems, associative influence in relation to above ground and underground interferences; lopping and coppicing in agro-forestry systems; social acceptability and economic viability, nutritive value of trees; tender operation; desirable tree characteristics.

Practicals

- Preparation of charts and maps of India showing different types of pastures and agro-forestry systems.
- Identification of seeds and plants of common grasses, legumes and trees of economic importance with reference to agro-forestry.
- Seed treatment for better germination of farm vegetation.
- Methods of propagation/planting of grasses and trees in silvipastoral system.
- Fertilizer application in strip and silvipastoral systems.
- After-care of plantation.
- Estimation of protein content in loppings of important fodder trees.
- Estimation of calorie value of wood of important fuel trees.
- Estimation of total biomass and fuel wood.
- Economics of agro-forestry.
- Visit to important agro-forestry research stations.

Suggested Readings

- Chatterjee BN & Das PK. 1989. Forage Crop Production. Principles and Practices. Oxford & IBH.
- Dabadghao PM & Shankaranarayan KA. 1973. *The Grass Cover in India*. ICAR.
- Dwivedi AP. 1992. Agroforestry- Principles and Practices. Oxford & IBH. Indian Society of Agronomy. 1989. Agroforestry System in India. Research and Development, New Delhi.
- Narayan TR & Dabadghao PM. 1972. *Forage Crop of India*. ICAR, New Delhi.
- Pathak PS & Roy MM. 1994. Agroforestry System for Degraded Lands. Oxford & IBH.
- Sen NL, Dadheech RC, Dashora LK & Rawat TS. 2004. *Manual of Agroforestry and Social Forestry*. Agrotech Publ.
- Shah SA. 1988. *Forestry for People*. ICAR.
- Singh Panjab, Pathak PS & Roy MM. 1994. *Agroforestry System for Sustainable Use*. Oxford & IBH.
- Singh SP. 1994. *Handbook of Agroforestry*. Agrotech Publ.
- Solanki KR. 2000. Multipurpose Tree Species: Research, Retrospect and Prospects. Agrobios.
- Tejwani KG. 1994. *Agroforestry in India*. Oxford & IBH.

Theory

UNIT I

Response of plants to abiotic stresses: Abiotic stresses affecting plant productivity. Basic principles of a crop improvement programme under stress. Interactions between biotic and abiotic stresses.

UNIT II

Drought stress: Physiological, biochemical and molecular mechanism, strategies to alleviate drought stress, signal transduction mechanism, Drought in relation to MAS and QTL, Role of ROS/ antioxidants, ABA, Cytokinin and other hormones.

UNIT III

Temperature stress (high and low): Tolerance mechanisms-role of membrane lipids in temperature tolerance. Functions of regulatory proteins.

UNIT IV

Salinity stress: Species variation in salt tolerance. Salinity effects at Cellular and whole plant level, tolerance mechanisms. Salt tolerance in Glycophytes and halophytes, breeding for salt resistance.

UNIT V

Heavy metal stress: Aluminium and cadmium toxicity in acid soils. Role of phytochelatin (heavy metal binding proteins).

Practicals

Determination of water status of plants: RWC, pressure chamber and psychrometry, determination of osmotic potential by osmometer, stomatal conductance, canopy temperature by infra-red thermometer, creation of nutrient deficiency and assessment of root characteristics, chlorophyll content index by chlorophyll meter, root biomass by root capacitance meter, heat tolerance and membrane integrity.

Suggested Readings

- Andrew, M.A. and Wood, J. Eds Jenks 2010. *Genes for plant abiotic stress*. Wiley-Blackwell Publication.
- Buchanan, B.B., Gruissem, W. and Jones, R.L. 2000. *Biochemistry and Molecular Biology of Plants*. Am. Soc. Plant Physiologists, Rockville, Maryland.
- Hirt, H., Shinozaki, K. Hirt, Heribert 2004. *Plant responses to abiotic stress*. Springer Berlin Heidelberg Publication.
- Hopkins, W.G. and Huner, N.P.A. 2004. *Introduction to Plant Physiology*. John Wiley & Sons.
- Khan, N.A. and Singh, Sarvajeet 2008. *Abiotic stress and plant responses*. I.K. Publication.
- Parikh, A., Sopory, S.K. and Bohnert, H.J. 2010. *Abiotic stress adaptation in plants: Physiological, molecular and genomic foundation*. Springer Publication.
- Taize, L. and Zeiger, E. 2006. *Plant Physiology*. Sinauer Associates, Inc, Publishers, Sunderland, Massachusetts, USA.

Theory

UNIT I

Soil, water and air pollution problems associated with agriculture, nature and extent.

UNIT II

Nature and sources of pollutants ô agricultural, industrial, urban wastes, fertilizers and pesticides,

acid rains, oil spills etc.; air, water and soil pollutants - their CPC standards and effect on plants, animals and human beings.

UNIT III

Sewage and industrial effluents - their composition and effect on soil properties/health, and plant growth and human beings; soil as sink for waste disposal.

UNIT IV

Pesticides - their classification, behavior in soil and effect on soil microorganisms.

UNIT V

Toxic elements their sources, behavior in soils, effect on nutrients availability, effect on plant and human health.

UNIT VI

Pollution of water resources due to leaching of nutrients and pesticides from soil; emission of greenhouse gases - carbon dioxide, methane and nitrous oxide.

UNIT VIII

Remediation/amelioration of contaminated soil and water; remote sensing applications in monitoring and management of soil and water pollution.

Practicals

- Sampling of sewage waters, sewage sludge, solid/liquid industrial wastes, polluted soils and plants.
- Estimation of dissolved and suspended solids, chemical oxygen demand (COD), biological demand (BOD), nitrate and ammoniacal nitrogen and phosphorus, heavy metal content in effluents.
- Heavy metals in contaminated soils and plants
- Management of contaminants in soil and plants to safeguard food safety.
- Air sampling and determination of particulate matter and oxides of sulphur.
- Visit to various industrial sites to study the impact of pollutants on soil and plants.

Suggested Readings

Lal R, Kimble J, Levine E & Stewart BA. 1995. Soil Management and Greenhouse Effect. CRC Press.

Middlebrooks EJ. 1979. Industrial Pollution Control. Vol. 1. Agro industries. John Wiley Interscience.

Ross SM. Toxic Metals in Soil Plant Systems. John Wiley & Sons.

Vesilund PA & Pierce 1983. Environmental Pollution and Control. Ann Arbor Science Publi.