

**Theory:**

Agro meteorology: aim, scope and development in relation to crop environment, composition of atmosphere, distribution of atmospheric pressure, Solar radiation : characteristics, energy balance of atmosphere system, radiation distribution in plant canopies, radiation utilization by field crops, photosynthesis and efficiency of radiation utilization by crops, energy budget of plant canopies, Environmental temperature: soil, air, canopy temperature, temperature profile in air, soil and crop canopies, soil and air temperature effects on plant processes, regulation of air, soil temperature for protection against frost and hot winds, Environmental moisture and evaporation, measures of atmospheric moisture, temperature, relative humidity, vapour pressure and their relationship, evapotranspiration and meteorological factors determining evapotranspiration, Modification of plant environment: artificial rain making, controlling heat load, heat trapping and shedding, protection from cold, reduction in sensible and latent heat flux, Monsoon: monsoon and their origin, characteristics of monsoon, onset and progress of monsoon, withdrawal of monsoon, Weather forecasting in India: short, medium and long range forecasting, benefits of weather service to agriculture, forecasting of destructive frost, soil moisture forecast, phenological forecast, crop yield forecast, Aero-space science and remote sensing : application in agriculture, present status of remote sensing in India, Atmospheric pollution and its effect on climate and crop production.

**Practical**

Agrometeorological observatory- classes, site selection, layout and installation of meteorological instruments; handling of meteorological instruments; measurement of weather parameters; working out agroclimatic indices; maintenances of record; calculation of daily, weekly and monthly means; visit to state remote sensing centre, Jodhpur/Jaipur; measurement of soil temperature in different soil conditions/depths; interpretation and use of weather data; rainfall analysis for variability; moisture availability indices for an arid and a humid district, length of growing season, fitting cropping systems; preparation of weather maps, synoptic charts and weather reports; preparation of crop weather calendars, to become familiar with agro advisory service bulletins visit to ARS, Durgapura/Bikaner.

**Lecture schedule- Theory**

S. No.	Topic	No. of lectures
1	Agro meteorology - aim, scope and development in relation to crop	2
2	Composition of atmosphere, distribution of atm. pressure	1
3	Solar radiation – characteristics	1
4	Energy balance of atmosphere system	1
5	Radiation distribution in plant canopies, radiation utilization by field crops	2
6	Photosynthesis and efficiency of radiation utilization by crops	2
7	Energy budget of plant canopies	1
8	Environmental temperature- soil, air, canopy temperature, temperature	2

	crop canopies	
9	soil and air temperature effects on plant processes	2
10	Regulation of air, soil temperature for protection against frost and hot winds	2
11	Environmental moisture and evaporation - measures of atmospheric moisture, temperature, relative humidity, vapour pressure	2
12	Evapotranspiration and meteorological factors determining	2
13	Modification of plant environment, artificial rain making, controlling heat load, heat	2
14	Protection from cold, reduction in sensible and latent heat flux	1
15	Monsoon and their origin, characteristics of monsoon	1
16	Onset and progress of monsoon withdrawal of monsoon	1
17	Weather forecasting in India: short, medium and long range forecasting	2
	Benefits of weather service to agriculture, forecasting of destructive frost, soil moisture	2
19	Aero-space science and remote sensing - application in agriculture, present status of	2
20	Atmospheric pollution and its effect on climate and crop production	1

### Lecture schedule- Practical

S. No.	Topic	No. of lectures
1	Agro meteorological observatory – classes, site selection, layout and installation	1
2	Handling of meteorological instruments	1
3	Measurement of weather parameters	1
4	Working out agro climatic indices	1
5	Maintenance of records	1
6	Calculation of daily, weekly and monthly means	2
7	Visit to state Remote Sensing Centre, Jodhpur/Jaipur	1
8	Measurement of soil temperature in different soil conditions/depths	1
9	Interpretation and use of weather data	1
10	Rainfall analysis for variability	2
11	Moisture availability indices for an arid district	1
12	Moisture availability indices for a humid district	1
13	Length for growing season, fitting cropping systems	1
14	Preparation of weather maps, synoptic charts & weather reports	1
15	Preparation of crop weather calendar	1
16	To become familiar with Agro-advisory-service bulletins/	1

### Suggested Readings:

- S. Mavi (1994). Introduction to Agrometeorology. Oxford & IBH Publishing Co. New Delhi.
- P.A. Menon (1989). Our weather. National Book Trust, New Delhi.
- A.A. Rama Sastu (1984). Weather and Weather forecasting Publication Division, GOI.
- P.K. Das (1992). The Monsoon. National Book Trust, New Delhi.
- S. Venkateraman and A. Krishnan. Crops and Weather. Indian Council of Agricultural Research, New Delhi. Critchfield, H.J. 1995. General Climatology, Prentice Hall of India Pvt. Ltd., New Delhi
- R.S. Gena and S.P. Seetharaman (1991). Natural Resource Management: The

Role of Remote sensing in decision making. Oxford & IBH Publishing Co. New Delhi.

- K.L. Joshi, Sinha and D.P. Gupta (1985). Physical Geography, National Council of Educational Research and Training, New Delhi.
- Vasiraju Radha Krishna Murthy (1995). Practical Manual on Agricultural Meteorology, Kalyani Publishers, Ludhiana.
- D.S. Lal, 1998. Climatology. Sharda Pustak Bhawan.
- S.R. Ghadekar, 1991. Meteorology, Agromet Publishers, Nagpur.

**AGRON 512**

**Principles and Practices of Water Management**

**3(2+1)**

**Theory:**

Water, its properties and role in plants; Water resources of India, Major irrigation projects and extent of area and crops irrigated in India; Water potential – concept, components and relationship between different components; Water movement in plant and soils; Absorption and transpiration of water in plants; Scheduling and methods of irrigation including micro irrigation system; Fertigation, Water use efficiency: Water management of crops and cropping systems; Soil, plant and meteorological factors determining water needs of crops; Water deficit stress in plants and its effect on growth. Quality of irrigation water – effect of saline water and soil salinity on plants and its management, Excess soil water and plant growth; Water management in problem soils; Drainage requirement of crops and methods of drainage, their layout and spacing.

**Practical:**

Determination of soluble salts,  $\text{Ca}^{+2}$  and  $\text{Mg}^{+2}$  and  $\text{Na}$  in irrigation water; Determination of  $\text{CO}_3^{2-}$  and  $\text{HCO}_3^-$  of FC and PWP; Soil moisture measurement by tensiometer and pressure plate apparatus; Water flow measurement using different devices. Determining soil profile moisture deficit and irrigation requirement. Calculations on irrigation efficiencies; Computation of water requirement of crops using modified Penman formula. Determination of infiltration rates and hydraulic conductivity.

### Lecture schedule- Theory

S. No.	Topic	No. of lectures
1	Water, its properties and role in plants	2
2	Water resources of India, major irrigation projects, and extent of area and crops irrigated	3
3	Water potential-concept, components and relationship between different	2
4	Water movement in plants and soils	2
5	Absorption-types and relative importance	2
6	Transpiration – types and methods to reduce transpiration	2
7	Scheduling of irrigation and methods of irrigation including micro irrigation system,	2
8	Water use efficiency and factors affecting it	2
9	Water management of crops and cropping systems	2
10	Soil, plant and meteorological factors determining water needs of crops	2
11	Water deficit stress in plants and its effect on growth	2
12	Quality of irrigation water-criteria used, effect of poor quality water on plant growth and	3
13	Excess soil water and plant growth	2
14	Water management in problem soils	2
15	Drainage requirement of crops and methods of drainage, their layout and	2

### Lecture schedule- Practical

S. No.	Topic	No. of lectures
1	Determination of soluble salts and Ca + Mg in irrigation water	1
2	Determination of CO <sub>3</sub> <sup>=</sup> and HCO <sub>3</sub> <sup>-</sup> and Na in irrigation water	1
3	Determination of FC and PWP	2
4	Determination of soil moisture by tensiometer and pressure plate apparatus	2
5	Water flow measurement using different devices	2
6	Determining soil profile moisture deficit	1
7	Determination of irrigation requirement of crops	2
8	Calculations on irrigation efficiencies	2

9	Computation of water requirement of crops using modified Penman formula	1
10	Determination of infiltration rate of soil	1
11	Determination of hydraulic conductivity of soil	1

**Suggested Readings:**

A.M. Michael, 1987. Irrigation – Theory and Practice, Vikas Publishing House Pvt. Ltd., New Delhi

S.S. Parihar and B.S. Sandhu, 1978. Irrigation of field crops – Principles and Practices, ICAR, New Delhi

D. Lenka, 1999. Irrigation and Drainage. Kalyani Publishers, New Delhi.

**AGRON 513 Principles and Practices of Soil Fertility and Nutrient Management  
3(2+1)**

**Theory:**

Problems and management relating to mechanical impedance and soil submergence; Salt affected soils - problems and remedial measures; Soil acidity and remedial measures; Soil fertility and productivity concept and differences: Criteria of essentiality and forms in which nutrients are absorbed by plants; Physiological methods of increasing FUE. **Nitrogen:** Functions, deficiency and toxicity symptoms, forms of nitrogen, nitrogen transformation in soil, organic and mineral N balance in soil, mineralization of N compounds, losses of N from soil, nitrogenous fertilizer materials. Methods to increase N use efficiency and slow release fertilizers; Biological N fixation, symbiotic and free living N fixers; **Phosphorus:** Functions and deficiency symptoms, forms of P in soil, their availability and P fixation, various phosphatic fertilizers; Practices of increasing the effectiveness of applied and native phosphorus (PSB). **Potassium:** Functions and deficiency symptoms, forms of K in soil, fixation and release of potassium in soil; Potassic fertilizers and their application. Sulphur and micronutrients (Fe, Zn) functions, deficiency symptoms and application; Inter relationship of nutrient availability and soil pH; Important nutrient interactions and their effect on nutrient availability, cation exchange capacity and availability of plant nutrients; Integrated nutrient management. **Practical:** Procedure of plant and soil sampling; Determination of soil pH, EC and organic carbon; Determination of total N and available N, P and K in soils; Determination of N, P, K and S in plant samples; Determination of Ca, Mg and Na in soil; Determination of gypsum requirement of alkali soils.

**Lecture schedule- Theory**

S.No.	Topic	No. of lectures
1.	Soil problems relating to mechanical impedance and their management / remedial	1
2.	Soil submergence - meaning, causes and electro chemical changes occurring (oxidized-	2
3.	Salt affected soils – characteristics, classification and their remedial	2
4.	Soil acidity-characteristics, reasons of soils acidity and remedial measures/	2
5.	Soil fertility and productivity concept and differences	1
6.	Criteria of essentiality and forms in which nutrients are absorbed by plant.	2
7.	Physiological methods of increasing FUE	1
8.	<b>Nitrogen:</b>	
9.	Functions, deficiency and toxicity symptoms, forms of nitrogen, N – transformation in soil, organic and mineral nitrogen balance in soil, mineralization of N	4
10.	N-fertilizers, slow release fertilizers and methods to increase nitrogen use	1
11.	Biological nitrogen fixation, symbiotic and free living N fixers	2
12.	<b>Phosphors</b>	
13.	Functions and deficiency symptoms, forms of P in soil and their	2

	availability in relation to pH, P-fixation.	
14	Various P fertilizers and practices of increasing the effectiveness of applied and native phosphorus (PSB)	2
15	<b>Potassium:</b>	
16	Functions and deficiency symptoms, forms of K in soil, fixation and release of K in	3
17	Potassic fertilizer and their application	1
18	<b>Sulphur and micronutrients (Fe &amp; Zn) – functions, deficiency symptoms</b>	2
19	<b>Interrelationship of nutrient availability and soil pH</b>	1
20	Important nutrient interactions and their effect on nutrient availability, cation exchange	2
21	Integrated nutrient management concepts	1

### Lecture schedule- Practical

S. No.	Topic	No. of lectures
1	Procedure of plant and soil sampling	1
2	Determination of soil pH, ECe and organic carbon	3
3	Determination of total N and available N, P and K in soil	4
4	Determination of total N, P, K and S in plant samples	4
5	Determination of Ca, Mg and Na in soil	2
6	Determination of gypsum requirement of alkali soils	2

### Suggested Readings:

1. S.L. Tisdale, W.L. Nelson, J.D. Beaton and J.L. Havlin. 1997. Soil Fertility and Fertilizers. Prentice Hall of India, Pvt. Ltd., New Delhi
2. T.R. Reddy and G.H.S. Reddi 1992. Principles of Agronomy, Kalyani Publishers, New Delhi
3. L.A. Richards, 1968. Diagnosis and Improvement of Saline and Alkali Soils, Oxford and IBH Publishing Company, New Delhi
4. Tamhaney, Motiramani, Bali and Donahu, 1970. Soils Their Chemistry and Fertility in Tropical Asia, Prentice Hall of India, New Delhi
5. R.R. Agarwal, J.S. P. Yadav and S.N. Gupta, 1982. Saline and Alkalai soils of India. ICAR Publication, New Delhi
6. G.Singh, J.S. Kolar and H.S. Sekhon, 2002. Recent Advances in Agronomy, Indian Society of Agornomy, IARI, New Delhi
7. J.S. Kanwar, 1978. Soil Fertility: Theory and Practices, ICAR Publication, New Delhi
8. J.L. Havlin, J.D. Beaton, S.L. Tisdale and WL. Nelson, 2006. Soil Fertility and Fertilizers- An Introduction to Nutrient Management, Prentice Hall of India, Pvt. Ltd., New Delhi
9. N.C. Brady and R.R. Weil, 2003. Elements of the Nature and Properties of Soils. Prentice Hall, New Jersey.
10. R.S. Yawalkar, J.P. Agarwal and J. Bokde 1992. Manures and Fertilizers. Agri-Horticultural House, Nagpur
11. N.K. Fageria, V.C. Baligar and C.A. Jones 1991. Growth and Mineral Nutrition of Field Crops. Marcel Dekker, New York.

**Theory:**

Agronomic aspects in food security; Crop growth and production in relation to climate change; Agro ecological and agroclimatic zones of India; Concept of potential yield; Modern concepts in tillage - zero, minimum and conservation tillage; Optimization of plant population and planting geometry in relation to soil fertility, solar radiation and available moisture regimes; Mitscherlich, Baule and Inverse yield : nitrogen laws; Biotic and abiotic stresses; Concept of ideal plant type; Organic farming, Physiology of grain yield in cereals; Crop growth analysis; Crop modelling in agronomic systems; Precision agriculture; Growth regulators and their role in agriculture; Designer crops; Vermitechnology; Agro biodiversity; Seed priming; Indigenous technological knowledge; Herbicide resistance in weeds; Allelopathy in agriculture; Plant nutrition and disease tolerance in field crops.

**Lecture schedule- Theory**

S. No.	Topic	No. of lectures
1	Population and food requirement	1
2	Agronomic techniques for food security, crop nutrition, value addition	2
3	Effect of climate change on crop production	1
4	Direct and interactive effect of different climatic parameters on crop	2
5	Agroecological and agroclimatic zones of India and their introduction	2
6	Concept of potential yield	1
7	Introduction to modern concepts of tillage - zero tillage minimum tillage	3
8	Conservation tillage - its advantages, disadvantages, types and	1
9	Relationship between plant population and yield and response curves	1
10	Optimum plant population in relation to soil fertility and solar radiation	1
11	Mitscherlich equation, Baule unit and inverse yield: nitrogen laws	2
12	Abiotic and biotic stresses	2
13	Definition and concept of ideal plant type	1
14	Characteristics of an ideotype plant for dryland agriculture	1
15	Ideotype plant for wheat	1
16	Organic farming – definition, differences between conventional and organic	2
17	Physiology of grain yield in cereals	2
18	Growth curves and analysis of crop growth : LAI, CGR, RGR, NAR,	2
19	Crop model-definition, concept and types (empirical & mechanistic)	1
20	Scientific basis of modelling	1
21.	Model applications	1
22	Precision agriculture-definition, basic concept, scope and approach	1
23.	Technologies for precision agriculture: computers, geographical information	2
24.	Plant growth regulators-definition,types and their role in crop	2
25	Designer crops - concept and importance	2
26	Vermi- technology, meaning, methods and scope	2
27	Agro- biodiversity- definition, effects, threats and conservation	2
28	Seed priming- concept, importance and use in crop production	1
29	Indigenous technological knowledge and its use in crop production	1
30	Herbicide resistance in weeds – meaning and management of resistant	2
31	Allelopathy in agriculture	1
32	Plant nutrition and disease tolerance in field crops	1

### Suggested Readings:

1. Gardner, F.P.; Pearce, G.R. and Michell, R.I. Physiology of Crop Plants, Scientific Pub., Jodhpur.
2. S.P. Palaniappan and Shivarama, K. 1996. Cropping Systems in the Tropics - Principles and Management. New Age International Pub.
3. Fageria, N.K. 1992. Maximising crop yields. Marcel Dekker, New York.
4. Reddy, S.R. 2000. Principles of Agronomy. Kalyani Pub. New Delhi.
5. Sankaran, S. and Mudaliar, T.V.S. 1997. Principles of Agronomy. The Bangalore Printing and Pub. Bangalore.
6. Redford, J. 1967. Growth Analysis formulae: Their use and abuse. Crop Science. 76:171 - 175.
7. Singh, G.; Kolar, J.S. and Sekhon, H.S. 2002 Recent Advances in Agronomy (Ed). ISA, Publication, New-Delhi.
8. Paroda, R.S. 2003. Sustaining Our Food Security. Konark Publishers Pvt. Ltd., Delhi

### **AGRON 522 Principles and Practices of Weed Management 3(2+1)**

#### **Objective**

To familiarize the students about the weeds, herbicides and methods of weed control.

#### **Theory**

Weed-biology, ecology and classification; history, development and classification of herbicides, their properties, mode of action and uses, basis of selectivity of herbicides; herbicide mixtures, adjuvants and safeners; weed control principles and management practices in important grain crops, oilseeds, pulses, sugar, fibre crops, tuber crops and forage crops; vegetables and orchards; weed control under specific situations viz. intercropping systems, non cropped areas and drylands; noxious farm weeds and parasitic weeds and their control; fate of herbicides in soil; herbicide - pesticides and fertilizer interactions; allelopathic effect; integrated weed management; problem of aquatic weeds particularly water hyacinth, hydrilla and typha grass in Rajasthan and their possible control measures; weed control through bio herbicides and myco- herbicides; herbicide resistance in weeds and crops.

#### **Practical :**

Identification of common *kharif*, *rabi* and perennial weeds of crop fields, road sides, waste lands and irrigation channels; familiarization with trade names, common names, uses, cost and source of availability of herbicides; calibration of sprayer and maintenance (before and after use); study of different herbicidal formulations; calculation on herbicidal requirement for field crops and aquatic situation; application of herbicides in field crops; control of some noxious weeds by cultural and chemical means; study on weed control efficiency and calculation on weed infestation and weed index; preparation of weed herbarium, methodology for weed control research and precautions in handling or storage of herbicides.

#### **Lecture schedule – Theory**

S. No.	Topic	No.
22.	Weeds- biology, ecology and classification	2
23.	Herbicides -	2
24.	a) History, development and classification of herbicides	2
25.	b) Properties of herbicides	2
26.	c) Mode of action and uses of herbicides	2
27.	d) Basis of selectivity of herbicides	2

28.	Herbicide mixtures, adjuvants and safeners	2
29.	Weed control principles and management practices in important crops	1
30.	a) Grain crops	2
31.	b) Oilseeds and pulses	2
32.	c) Sugar and fibre crops	1
33.	d) Tuber and forage crops	2
34.	e) Vegetable crops	2
35.	f) Orchards	1
36.	Weed control under specific situations – intercropping system, drylands and non	1
37.	Noxious farm weeds, parasitic weeds and their control	1
38.	Fate of herbicides in soil	2
39.	Herbicide- pesticides and fertiliser interactions	1
40.	Allelopathic effects	1
41.	Integrated weed management	1
42.	Problem of aquatic weeds particularly water hyacinth, hydrilla and typha grass in	1
43.	Weed control through bio-herbicides and mvco- herbicides	1
44.	Herbicide resistance in weeds and crops	1

### Lectureschedule-Practical

S. No.	Topic	No. o
1	Identification of common <i>Kharif</i> and <i>Rabi</i> weeds	1
2	Identification of perennial weeds of crop fields, road sides, wastelands and irrigation	1
3	Familiarization with trade names, common names, uses, cost and sources of availability of	1
4	Calibration of sprayers and maintenance (before and after use)	1
5	Study of different herbicidal formulations	1
6	Calculation on herbicidal requirement for field crops under aquatic situations	2
7	Application of herbicides in field crops	2
8	Control of some noxious weeds by cultural and chemical means	1
9	Study on weed control efficiency and calculation on weed infestation and	2
10	Preparation of weed herbarium	2
11	Methodology for weed control research	1
12	Precautions in handling or storage of herbicides	1

#### 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

**AGRON 523 Dryland Farming and Watershed Management****3(3+0)****Theory:**

Definition, concept, significance and dimensions of dryland farming in Indian agriculture, characteristics of dryland farming and dryland versus rainfed farming: constraints limiting crop production in dry land areas;

characterisation of environment for water availability; delineation of dry farming areas on the basis of moisture deficit index and their characteristics, use of mulches, kinds, effectiveness and economics; antitranspirants- their types, mechanism and role in dry farming; water harvesting- its concepts, techniques and practices; soil and crop management techniques- tillage, seeding, fertilizer use, crop and varietal choice, cropping system, weed control and other management practices; plant ideotypes for drylands, drought management strategies; preparation of appropriate crop plans for dryland areas; mid season corrections for aberrant weather conditions. Watershed management- definition, objectives, concepts, problems, approach components, development of cropping systems for watershed areas; alternate land use systems; planning and operation of project for watershed management.

**Lecture Schedule- Theory**

<b>S. No.</b>	<b>Topic</b>	<b>No. of Lectures</b>
1	Dryland farming- definition, concept, significance and dimensions of dryland farming in	3
2	Characteristics of dryland farming and dryland versus rainfed farming	3
3	Constraints limiting crop production in dry land areas	3
4	Characterisation of environment for water availability	3
5	Delineation of dry farming areas on the basis of moisture deficit index and their	3
6	Use of mulches, kinds, effectiveness and economics	3
7	Antitranspirants- their types, mechanism and role in dry farming	3
8	Water harvesting, its concepts, techniques and practices	3
9	Soil and crop management techniques- tillage, seeding, fertilizer use, crop and varietal	5
10	Plant ideotypes for drylands	2
11	Drought management strategies	3
12	Preparation of appropriate crop plans for dryland areas	2
13	Mid season corrections for aberrant weather condition	2
14	Watershed management- Definition, objectives, problems, approach and	3
15	Development of cropping system for watershed areas	3
16	Alternate land use systems	3
17	Planning and operation of project for watershed management	3

**Suggested Readings:**

1. R.P. Singh, Srinivas Sharma, M.V. Padmanabhan, S.K. Das and P.K. Mishra, 1990. A

- Field Manual on Watershed Management, ICAR (CRIDA) Publication, Hyderabad.
2. S.C. Verma and M.P. Singh. 1984. Agronomy of New Plant Types. Tara Book Agency, Varanasi.
  3. S. Palaniappan. 1985. Cropping Systems in Tropics: Principles and Management, Wiley Eastern Ltd., New Delhi & TNAU, Coimbatore.
  4. Mahendra Pal, K.A. Singh and I.P.S. Ahlawat. 1985. Cropping System Research I & II. In processing of the National Symposium on Cropping Systems Published by ISA, New Delhi.

**Theory:**

Cropping systems- intercropping and multiple cropping, concepts, needs, indices and assessment; existing cropping systems under irrigated and rainfed situations. Cropping system indices viz., relative spread index and relative yield index. Farming system: integrated farming system, alternate farming system - meaning and scope including specific examples. Recycling and crop residue management. Natural farming - concept and components. Organic farming. Crop diversification – principles, types and needs, Sustainable agriculture - definition, scope and objectives, Natural resources, their characterization and management; Sustainable cropping and farming systems in agriculture in relation to environmental degradation; Research needs on sustainable agriculture.

**Lecture schedule – Theory**

S. No.	Topic	No. of lectures
1	Cropping systems – definition and types	2
2	Intercropping – concept, needs, types, indices and assessments	3
3	Multiple cropping - concept and needs, Types, selection of crops and computation of	6
4	Cropping systems under irrigated conditions	5
5	Cropping systems for rainfed situation	2
6	Cropping system indices - relative spread index and relative yield index	2
7	Farming systems - integrated farming systems; definition, its components and IFS	3
8	Alternate farming systems – meaning, scope and specific examples	3
9	Recycling and crop residue management	2
10	Natural farming – concept and components	2
11	Organic farming - definition, concept and components	2
12	Relevance of organic farming in present context its certification and	3
13	Crop diversification – principles, types and needs	3
14	Sustainable agriculture – definition, scope and objectives	2
15	Natural resources – their characterization and management	3
16	Sustainable cropping and farming systems in relation to environmental	3
17	Research needs on sustainable agriculture	2

**Suggested Readings:**

1. K.N. Singh and R.P. Singh (Eds), 1990. Agronomic Research Towards Sustainable Agriculture, Indian Society of Agronomy, New Delhi
2. R.P. Singh, 1990. Sustainable Agriculture: Issues, Perspectives and Prospects in Semi Arid Tropics. Vol I & II Indian Society of Agronomy, New Delhi

3. Proceedings of the National Symposium on Cropping Systems 1985. Indian Society of Agronomy, New Delhi
4. R.M. Devlin and E.H. Watham. 1986. Plant Physiology. CBS Publishers and Distributors, New Delhi. L.L.Somani, K.L. Totawat and B.L. Baser. 1992 (Ed.) Proceedings of National
5. Seminar on Natural Farming, NSMP Publication, Rajasthan College of Agriculture, Udaipur
6. K. Balakrishnan Nair, U.N. Goswami and K. Kunhkrishnan 1972 (Ed.) Proceedings of the Symposium on Cropping Patterns in India. ICAR Publication, New Delhi.
7. R.W. Willey 1979. Intercropping: Its Importance and Research Needs, Field Crop Abstracts 332:1-10 & 73- 81
8. S.C. Panda. 2004. Cropping Systems and Farming Systems. Agrobios (India) Jodhpur
9. Guriqbal Singh, J.S. Kolar and H.S. Sekhon 2002. Recent Advances in Agronomy, Indian Society of Agronomy, IARI, New Delhi
10. Singh, S.S. 2006. *Principles and Practices of Agronomy*. Kalyani Publishers, Ludhiana.

**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 rice, wheat, maize, barley, sorghum, pearl millet, chickpea and pigeon pea.

**Practical**

Phenological studies at different growth stages of crops, different methods of raising nursery including dapog in rice; estimation of crop yields on the basis of yield attributes; calculation of fertilizer requirements and their application at different stages of growth on the basis of soil test values; computation of cost of cultivation of various crops, planning and layout of field experiments, formulation of cropping scheme for various farm sizes, calculation of cropping and rotation intensities, visit of field experiments for cultural, fertilizer, weed control and water management aspects; working out indices of intercropping systems – L.E.R. aggressivity, relative crowding coefficient and monetary yield advantage, ATER; determination of physiological maturity in different crops; working out of harvest index in various crops; computation of growth analysis indices. Study of root nodules and seed treatment with bio-fertilizers in pulses, Estimation of protein in pulses.

**Lecture schedule – Theory**

S. No	Topic	No. of lectures
1	<b>Rice:</b> Importance, production, distribution and classification, Cropping systems, agronomy of hybrid rice and climate, Climate, soil and cultural requirements and improved varieties, Nutrient, water and weed management in relation to	5
2	<b>Wheat:</b> Importance, production, distribution and classification, Cropping systems,	5
3	<b>Maize:</b> Importance, production, distribution, cropping systems and classification, Adaptability in different agro climatic zones, climate, soil and cultural requirements and improved varieties, Nutrient, water and weed	5

	<u>in India and its package.</u>	
4	<b>Barley:</b> Importance, production, distribution, classification and cropping systems, Adaptability in different agro-climatic zones, climate, improved varieties, soil and cultural requirements Nutrient, water and weed management, Crop protection,	3
5	<b>Sorghum</b> : Importance, production, distribution and cropping systems, Adaptability in different agro-climatic zones, climate, improved varieties, soil and cultural requirements, nutrient, weed and water management in relation to latest	4

6	<b>Pearl millet</b> : Importance, production, distribution and adaptability in different agroclimatic zones, Cropping systems, climate, improved varieties, soil and cultural requirements for maximization of production, Nutrient, weed and water	4
7	<b>Chickpea</b> :Importance, origin, production and distribution, classification, morphology and phenology, cropping systems, adaptability, Climate, soil and cultural	3
8	<b>Pigeon pea</b> :Importance, origin, protection and distribution, classification, morphology and phenology, cropping systems, Adaptability, climate, soil and improved varieties, Nutrient, water and weed management, crop	3

### Lecture Schedule – Practical

S.No	Topic	No. of lectures
1	Phenological studies at different growth stages of crops	1
2	Methods of raising nursery including dapog in paddy	1
3	Calculation of fertilizer requirements on the basis of soil test values	1
4	Computation of cost of cultivation in crops	1
5	Formulation of cropping schemes for various farm sizes and calculation of cropping and	2
6	Planning and layout of field experiments	1
7	Working out of indices of intercropping systems – LER aggressivity, relative crowding	1
8	Determination of physiological maturity in different crops	1
9	Working out of harvest index in various crops	1
10	Computation of growth analysis indices	1
11	Visit of field experiments on cultural, fertilizer, weed control and water management	1
12	Study of yield attributing characters of cereals and pulses, computation of yield on the	1
13	Study of pattern and morphology of root nodules in pulses and seed treatment of pulses	1
14	Estimation of protein in pulses	1
15	Interculture operations in various crops	1

### Suggested Readings :

Das NR. 2007. *Introduction to Crops of India*. Scientific Publ. Hunsigi  
G & Krishna KR. 1998. *Science of Field Crop Production*. Oxford &  
IBH. Khare D & Bhale MS. 2000. *Seed Technology*. Scientific Publ.  
Pal M, Deka J & Rai RK. 1996. *Fundamentals of Cereal Crop  
Production*.Tata McGrawHill. Prasad, Rajendra. 2002. *Text Book of Field  
Crop Production*. ICAR.

## AGRON 532 Agronomy of Oilseeds, Fibre and Commercial Crops 3(2+1)

### 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 oilseeds - groundnut, rapeseed and mustard and soybean; fibre crops - cotton and jute and commercial crops-sugarcane and potato.

### Practical

Phenological studies at different growth stages of crops, study of yield attributing characters of oilseeds and cotton; computation of yield on the basis of yield attributing characters; determination of protein and oil content

in oilseeds, Seed treatment of cotton seed with sulphuric acid and cow dung; computation of cost of cultivation of various crops; determination of quality of cotton including ginning per cent and lint index; calculation of fertilizer requirements and their application at different growth stages in various crops on the basis of soil test values.

cutting of cane setts, its treatment and method of sowing, tying and propping of sugarcane; determination of

cane maturity and calculation on purity percentage, recovery percentage and sucrose content in juice; preparation of blue print for sugarcane, calculation of seed rate and fertilizer requirement for sugarcane; to work out the cost of cultivation of sugarcane; selection of potato seed, its treatment and method of sowing; calculation of seed rate and fertilizer requirement for potato; preparation of blue print for potato.

### Lecture schedule – Theory

S.No.	Topic	No. of lectures
1	<b>Groundnut:</b> Importance, origin, history, production and distribution, classification, morphology, branching, cropping systems, Adaptability, climate, soil and cultural requirement for maximization of production and improved	4
2	<b>Rapeseed and mustard :</b> Importance , origin, history, production and distribution, classification, morphology, cropping systems, Adaptability, climate, soil and cultural requirements and improved varieties, Nutrient, water and	3
3	<b>Soybean :</b> Importance, origin, history, production and distribution, cropping systems, adaptability, climate, soil and cultural requirement for maximization of	3
4	<b>Cotton :</b> Importance, origin, history, production and distribution, classification , morphology, branching, cropping systems, Adaptability, climate, soil and cultural requirements for maximization of production and improved varieties. Nutrient, water and weed management in relation to latest	4

5	<b>Jute</b> :Importance, origin, history, production and distribution, classification, morphology, Adaptability, climate, soil and cultural requirement and improved varieties, Nutrient, water and weed management	3
6	<b>Sugarcane:</b> Origin, history, importance, distribution and adaptation, Classification, morphology and phenology , General production constraints and varietal improvement, climate, soil, sowing methods and Seed treatment	9
	ripening and harvesting, Ratoon management ,Sugarcane quality and factors affecting, Disease, insect and pest management , Post harvest handling for marketing industrial	
7	<b>Potato</b> :Origin, history, importance, distribution and adaptation, classification, morphology and phenology , Climate, soil, sowing methods ,varieties, Selection of seed and its treatment and fertilizer management , Intercultivation, irrigation,	6

### Lecture schedule - Practical

S.No.	Topic	No. of lectures
1	Study of yield attributing characters of oilseeds, cotton and jute, computation of yield	1
2	Determination of oil content in oilseeds and computation of oil yield	1
3	Seed treatment of cotton seed with sulphuric acid and cow dung	1
4.	Estimation of protein in oilseed crops	1
5.	Determination of quality of cotton including ginning % and lint index	1
6	Calculation of fertilizer requirements and their application at different growth stages	1
7	Phenological studies in sugarcane	1
8	Cutting of cane setts, its treatment and method of sowing	1
9	Tying and propping of sugarcane	1
10	Determination of cane maturity and calculation on purity, recovery and sucrose	1
11	Calculation of seed rate and fertilizer requirement of sugarcane	1
12	Working out cost of cultivation of sugarcane crop	1
13.	Preparation of blue print of sugarcane and potato	1
14.	Phenological studies in potato	1
15.	Selection of potato seed, its treatment and method of sowing	1
16.	Calculation of seed rate and fertilizer requirement for potato	1

### Suggested Readings:

1. Das, N.R. 2007. Introduction to crops of India. Scientific Publisher, Jodhpur.
2. H.C. Srivastava, S. Bhaskaran, B. Vatsyas and K.K.G. MENon, 1985. Oilseed Production: Constraints and Opportunities, Oxford & IBH Company, New Delhi. Research and Development Strategies for Oilseed Production in India, 1979.
3. Proceedings of National Symposium, 7-9 Nov. 1979, ICAR Publication, New Delhi.
4. J.S.Grewal & V.P.Jaiswal. 1990. Agronomical studies in potato under all India

**SOILS 513 Analytical techniques and instrumental methods in soil and plant analysis**

**3(1+2)**

**Theory**

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.

**Practical**

Preparation of solutions for standard curves, analytical reagents, qualitative reagents, indicators

and standard solutions for acid-base, oxidation reduction and complexometric titration; soil, water and plant sampling techniques, their processing and handling.

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

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

**Lecture schedule— Theory**

S. No	Topic	No. of lecture
1.	Principles of visible, ultraviolet and infrared spectrophotometry	2
2.	Principle and instrumentation of atomic absorption spectrophotometer	2
3.	Principles of flame-photometry	1
4.	Principles and instrumentation of inductively coupled plasma spectrometry	2
5.	Principles and instrumentation of chromatographic techniques	4
6.	Principles of mass spectrometry and X-ray diffractometry	2
7.	Principles of identification of minerals by X-ray by different methods.	3

### Lecture schedule - Practical

S.	Topic	No. of
1.	Analytical chemistry – Basic concepts, techniques and calculations	3
2.	Principle of analytical instruments and their calibration for soil and plant analysis	2
3.	Determination of available nitrogen in soil	1
4.	Determination of available phosphorus in soil	1
5.	Determination of available potassium in soil	1
6.	Determination of available sulphur in soil	1
7.	Determination of available Boron in soil	1
8.	Determination of available molybdenum in soil	1
9.	Determination of iron, copper, manganese and zinc in soil	1
10.	Determination of potential buffering capacity of phosphorus	1
11.	Determination of potential buffering capacity of potassium	1
12.	Determination of ammonium fixation capacity of soil	1
13.	Determination of potassium fixation capacity of soil	1
14.	Determination the cation exchange capacity of soil	1
15.	Determination the anion exchange capacity of soil	1
16.	Determination of calcium and magnesium in soil	1
17.	Determination of Sodium in soil	1
18.	Estimation of root cation exchange capacity	1
19.	Determination of nitrogen in plant	1
20.	Determination of phosphorus in plant	1
21.	Determination of potassium in plant	1
22.	Determination of sulphur in plant	1
23.	Determination of calcium and magnesium in plant	1
24.	Determination of boron in plant	1
25.	Determination of molybdenum in plant	1
26.	Determination of iron, copper, manganese and zinc in plant	1
27.	Estimation of root cation exchange capacity	1
28.	Drawing normalized exchange isotherms; measurement of redox potential	2

#### Suggested Readings

Hesse P. 971. *Textbook of Soil Chemical Analysis*. William Clowes & Sons. Jackson ML. 1967. *Soil Chemical Analysis*. Prentice Hall of India.

Keith A Smith 1991. *Soil Analysis; Modern Instrumental Techniques*. Marcel Dekker.  
Kenneth Helrich 1990. *Official Methods of Analysis* Association of Official  
Analytical Chemists. Page AL, Miller RH & Keeney DR. 1982. *Methods of Soil  
Analysis*. Part II. SSSA, Madison.  
Piper CE. *Soil and Plant Analysis*. Hans Publ.  
Singh D, Chhonkar PK & Pandey RN. 1999. *Soil Plant Water Analysis – A Methods Manual*.  
IARI, New Delhi. Tan KH. 2003. *Soil Sampling, Preparation and Analysis*. CRC Press/Taylor  
& Francis.

**Theory**

Classification, tabulation and graphical representation of data. Box-plot, Descriptive statistics. Exploratory data analysis; Theory of probability. Random variable and mathematical expectation, 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. Large sample theory, Introduction to theory of estimation and confidence-intervals. Correlation and regression. Simple and multiple linear regression model, estimation of parameters, predicted values and residuals, correlation, partial correlation coefficient, multiple correlation coefficient, rank correlation, test of significance of correlation coefficient and regression coefficients. Coefficient of determination, Non-parametric tests - sign, Wilcoxon, Mann-Whitney U-test, Wald Wolfowitz run test, Run test for the randomness of a sequence. Median test, Kruskal- Wallis test, Friedman two-way ANOVA by ranks. Kendall's coefficient of concordance.

**Practical**

Exploratory data analysis, Box-Cox plots; 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 point estimation of parameters of binomial, Poisson and Normal distribution; Correlation and regression analysis, Nonparametric tests.

**Lecture schedule: Theory**

S. No	Topics	No. of Lectures
1.	Classification, tabulation	2
2.	Exploratory data analysis	1
3.	Theory of probability	2
4.	Random variable and mathematical expectation	1
5.	Binomial, Poisson, Negative Binomial, Normal distribution	4
6.	Beta and Gamma distributions and their applications	2
7.	Tests of significance for large samples	2

8.	Tests of significance for small samples	3
9.	theory of estimation and confidence-intervals	2
10	Simple partial and multiple correlation	3
11	Simple and partial regression	3
12	Non parametric tests	1
13	One sample non parametric tests	2
14	Two sample non parametric tests	2
15	k sample non parametric tests	2

**Lecture schedule: Practical**

S. N.	Topics	No. of Lectures
1.	Box-Cox plots	1
2.	Fitting of Binomial distribution	1
3.	Fitting of Poisson distribution	1
4.	Fitting of Negative binomial distribution	1
5.	Fitting of Normal distribution	1
6.	Large Sample tests	1
7.	Chi Square test	1
8.	One sample, two sample and paired t test	1
9.	F- test	1
10	Computation of Simple correlation	1
11	Computation of partial and multiple correlation	1
12	Computation of Simple and partial regression	1
13	Computation of Run test	1
14	Sign and sign wilcoxon test	1
15	Mann-whitney U test	1
16	Kruskal- Wallis test	1

**References:**

1. Anderson TW. 1958. *An Introduction to Multivariate Statistical Analysis*. John Wiley.
2. Dillon WR & Goldstein M. 1984. *Multivariate Analysis - Methods and Applications*. John Wiley.
3. Goon AM, Gupta MK & Dasgupta B. 1977. *An Outline of Statistical Theory*. Vol. I. The World Press.
4. Goon AM, Gupta MK & Dasgupta B. 1983. *Fundamentals of Statistics*. Vol. I. The World Press.
5. Hoel PG. 1971. *Introduction to Mathematical Statistics*. John Wiley.
6. Hogg RV & Craig TT. 1978. *Introduction to Mathematical Statistics*. Macmillan.
7. Morrison DF. 1976. *Multivariate Statistical Methods*. McGraw Hill.
8. Siegel S, Johan N & Casellan Jr. 1956. *Non-parametric Tests for Behavior Sciences*. John Wiley.
9. Learning Statistics: <http://freestatistics.altervista.org/en/learning.php>.

**Theory**

Need for designing of experiments, characteristics of a good design. Basic principles of designs- randomization, replication and local control, Uniformity trials, size and shape of plots and blocks; Analysis of variance; Completely randomized design, randomized block design and Latin square design, Factorial experiments, (symmetrical as well as asymmetrical), orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment, Split plot and strip plot designs; Analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, crossover designs, balanced incomplete block design, resolvable designs and their applications ~ concepts, randomisation procedure, analysis and interpretation of results. Response surfaces. Experiments with mixtures. **Practical**

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

S. No.	Topics	No. of Lectures
1.	Basic concepts of design of experiment	2
2.	Basic principles of designs	3
3.	Uniformity trials	1
4.	Size and shape of plots and blocks	1
5.	Analysis of variance and transformations	2
6.	CRD, RBD and LSD	3
7.	Factorial experiments	4
8.	Confounding in symmetrical factorial experiments	2
9.	Factorial experiments with control treatment	2
10.	Split plot design	2
11.	Strip plot design	2
12.	Analysis of covariance and missing plot techniques	2
13.	crossover designs	1
14.	resolvable designs	1
15.	Response surfaces	2
16.	Experiments with mixtures	2

## Lecture schedule: Practical

S. N.	Topics	No. of Lectures
1.	Formation of plots	1
2.	Formation of blocks	1
3.	Analysis of CRD	1
4.	Analysis of RBD	1
5.	Analysis of LSD	1
6.	Analysis of factorial experiment	1
7.	Analysis of asymmetric factorial experiments	1
8.	Analysis of confounded factorial experiments	1
9.	Analysis with missing data in RBD	1
10.	Analysis with missing data in LSD	1
11.	Transformation of data	1
12.	Analysis of SPD	1
13.	Analysis of strip plot design	1
14.	Analysis of resolvable designs	1
15.	Fitting of response surfaces	2

## References:

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

**Theory**

Definition and classification of plant growth regulators- Hormones, endogenous growth substances and synthetic chemicals, Endogenous growth regulating substances other than hormones. triconanol, Phenols – polyamines, jasmonates, concept of death hormone. Site of synthesis, biosynthetic pathways and metabolism and the influence on plant growth development of individual group of hormones- Auxins, Gibberellins, cytokinins, Abscisic acid and Ethylene Brassinosteroids. Signal perception, transduction, and effect at functional gene level of different hormones- Auxins- cell elongation, Gibberellins -, germination of dormant seeds, cytokinins- cell division. Retardation of senescence of plant parts, Abscisic acid- Stomatal closure and induction of drought resistance, Ethylene- fruit ripening. Interaction of hormones in regulation of plant growth and development processes. Rooting of cuttings - Flowering. Apical dominance, molecular aspects of control of reproductive growth and development. Synthetic growth regulators- Classification, their effect on plant growth and development. Practical utility in agriculture and horticulture.

**Practical**

Extraction of hormones from plant tissue. Auxins- bioassays- auxins effect on rooting of cuttings, abscission, apical dominance, Gibberellins- bioassays-GA effect on germination of dormant seeds, cytokinin- bioassays- cytokinin effect on apical dominance and senescence, ABA bioassay estimation. ABA effect on stomatal movement, Ethylene bioassays, estimation using physico chemical techniques (with the condition that GLC/ HPLC is provided) - effect of hormones on breaking dormancy.

**Lecture schedule--Theory**

<b>S.No.</b>	<b>Topic</b>	<b>No.</b>
1.	Definition and classification of plant growth regulators- Hormones,	2
2.	Endogenous growth substances and synthetic chemicals	2
3.	Endogenous growth regulating substances other than hormones.	3
4.	Site of synthesis, biosynthetic pathways and metabolism and the influence on	1
5.	Site of synthesis, biosynthetic pathways and metabolism and the influence on	1
6.	Site of synthesis, biosynthetic pathways and metabolism and the influence on	1
7.	Site of synthesis, biosynthetic pathways and metabolism and the influence on	1
8.	Site of synthesis, biosynthetic pathways and metabolism and the influence on plant growth and development of individual group of hormones- Ethylene	1
9.	Site of synthesis, biosynthetic pathways and metabolism and the influence on and development of individual group of hormones- brassinosteroids	2
10.	Signal perception. Transduction and effect at functional gene level of different hormones-	3
11.	Signal perception. Transduction and effect at functional gene level of different hormones- cytokinins- cell division. Retardation of senescence of plant parts, Abscisic acid- Stomatal	3
12.	Interaction of hormones in regulation of plant growth and development processes. Rooting	3
13.	Molecular aspects of control of reproductive growth and development.	3
14.	Synthetic growth regulators- Classification, their effect on plant growth and	3
15.	Practical utility of Synthetic growth regulators agriculture and horticulture.	3

### Lecture schedule—Practical

S.No.	Topic	No. of lectures
1	Extraction of hormones from plant tissue.	5
2	Auxins- bioassays- auxins effect on rooting of cuttings, abscission, apical dominance	2
3	Gibberellins- bioassays-GA effect on germination of dormant seeds,	2
4	Cytokines- bioassays- cytokinin effect on apical dominance and senescence,	2
5	ABA bioassays estimation. ABA effect on stomatal movement,	2
6	Ethylene bioassays, effect of hormones on breaking dormancy	2
7	Estimation of PGRs using physico chemical techniques (with the condition that GLC/ HPLC	3

### Suggested Readings

Hopkins WG & Huner NPA. 2004. *Introduction to Plant Physiology*. John Wiley & Sons. Salisbury FB & Ross C. 1992. *Plant Physiology*. 4th Ed. Wadsworth Publ.

**Theory**

Area and distribution of problem soils – acidic, saline, sodic and physically degraded soils; origin and basic concept of problematic soils, and factors responsible, morphological features of saline, sodic and saline-sodic soils;

characterization of salt-affected soils - soluble salts, ESP, pH; physical, chemical and microbiological properties, management of salt-affected soils; salt tolerance of crops - mechanism and ratings; monitoring of soil salinity in the field; management principles for sandy, clayey, red lateritic and dry land soils, acid soils - nature of soil acidity, sources of soil acidity; effect on plant growth, lime requirement of acid soils; management of acid soils; biological sickness of soils and its management, quality of irrigation water; management of brackish water for irrigation; salt balance under irrigation; characterization of brackish waters, area and extent; relationship in water use and quality, agronomic practices in relation to problematic soils; cropping pattern for utilizing poor quality ground waters. **Practical**

Characterization of acid, acid sulfate, salt-affected and calcareous soils, determination of cations ( $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Ca}^{++}$  and  $\text{Mg}^{++}$ ) in ground water and soil, samples, determination of anions ( $\text{Cl}^-$ ,  $\text{SO}_4^{--}$ ,  $\text{CO}_3^{--}$  and  $\text{HCO}_3^-$ ) in ground waters and soil samples, lime requirements of acid soil and gypsum requirements of sodic soil.

**Lectureschedule—Theory**

S. No	Topic	No. of lecture
1.	Area and distribution of problem soils – acidic, saline, sodic and physically	2
2.	Origin and basic concept of problematic soils, and factors responsible	3
3.	Morphological features of saline, sodic and saline-sodic soils	2
4.	Characterization of salt-affected soils - soluble salts, ESP, pH; physical, chemical and	2
5.	Management of salt-affected soils	2
6.	Salt tolerance of crops - mechanism and ratings	2
7.	Monitoring of soil salinity in the field	1
8.	Management principles for sandy, clayey, red lateritic and dry land soils	3

9.	Acid soils - nature of soil acidity, sources of soil acidity	1
10	Soil acidity effect on plant growth and lime requirement of acid soils	2
11	Management of acid and acid sulphate soils	2
12	Biological sickness of soils and its management	2
13	Quality of irrigation water and their crop response	2
14	Management of brackish water for irrigation	2
15	Salt balance under irrigation	1
16	Characterization of brackish waters, area and extent, relationship in water use	3

#### Lecture schedule—Practical

S. No.	Topic	No.
1.	Characterization of acid and acid sulfate soils salt-affected and calcareous	1
2.	Characterization of salt-affected soils	1
3.	Characterization of calcareous soils	1
4.	Determination of $\text{Ca}^{++}$ and $\text{Mg}^{++}$ in soil	1
5.	Determination of $\text{Ca}^{++}$ and $\text{Mg}^{++}$ in ground water	1
6.	Determination of Potassium in ground water	1
7.	Determination of Potassium in soil	1
8.	Determination of sodium in ground water	1
9.	Determination of sodium in soil	1

<b>10.</b>	Determination of $\text{CO}_3^{--}$ and $\text{HCO}_3^-$ in ground waters	<b>1</b>
<b>11.</b>	Determination of $\text{CO}_3^{--}$ and $\text{HCO}_3^-$ in soil	<b>1</b>
<b>12.</b>	Determination of chloride in ground waters	<b>1</b>
<b>13.</b>	Determination of chloride soil	<b>1</b>
<b>14.</b>	Determination of sulphate ( $\text{SO}_4^{--}$ ) in ground waters	<b>1</b>
<b>15.</b>	Determination of sulphate ( $\text{SO}_4^{--}$ ) in soil	<b>1</b>
<b>16.</b>	Determination of gypsum requirement of sodic soil	<b>1</b>
<b>17.</b>	Determination of lime requirement of acid soil	<b>1</b>

### **Suggested Readings**

1. Bear FE. 1964. *Chemistry of the Soil*. Oxford & IBH.
2. Jurinak JJ. 1978. *Salt-affected Soils*. Department of Soil Science & Biometeorology. Utah State Univ.
3. USDA Handbook No. 60. 1954. *Diagnosis and improvement of Saline and Alkali Soils*. Oxford & IBH.