

# Shri Vishwanath P. G. College Kalan, Sultanpur

(Affiliated to)

DR. RAM MANOHAR LOHIA AVADH UNIVERSITY, AYODHYA

Structure of Syllabus for the Program: M.Sc.

**Subject: Agronomy**



## SEMESTER-WISE TITLES OF THE PAPERS IN PG AGRONOMY COURSES

Year	Semester	Course code	Paper Title	Theory/Practical	Credit	
<b>First Year</b>	<b>I</b>	AGR. - 501	Modern Concept in Crop Production	Theory & Practical	<b>3(2+1)</b>	
		AGR. - 503	Principles and Practices of Weed Management	Theory & Practical	<b>3(2+1)</b>	
		AGR. - 506	Scientific Cultivation of Major Cereals and Pulses	Theory & Practical	<b>3(2+1)</b>	
		AS. - 501	Agricultural Statistics	Theory & Practical	<b>3(2+1)</b>	
	<b>II</b>	AGR. - 502	Principles and Practices of Soil Fertilizers and Nutrient Management	Theory & Practical	<b>3(2+1)</b>	
		AGR. - 504	Principles and Practices of Water Management	Theory & Practical	<b>3(2+1)</b>	
		AGR. - 507	Scientific Cultivation of Oil Seeds, Fiber and Sugar Crops	Theory & Practical	<b>3(2+1)</b>	
		AGR. - 511	Cropping system and sustainable Agriculture	Theory & Practical	<b>3(2+1)</b>	
<b>Second Year</b>	<b>III</b>	AGR. - 509	Agronomy of Fodder and Forage Crops	Theory & Practical	<b>3(2+1)</b>	
		AGR. - 510	Agrostology & Agroforestry	Theory & Practical	<b>3(2+1)</b>	
		AGR. - 512	Dry Land Farming and Watershed Management	Theory & Practical	<b>3(2+1)</b>	
		CA - 502	Computer Application in Agriculture	Theory & Practical	<b>2(1+1)</b>	
		PGS - 501	Library and Information Services	Practical	<b>1(0+1)</b>	
	<b>IV</b>	AGR. - 591	Master Seminar	Presentation	<b>1(0+1)</b>	
		AGR. - 599	Master Research (Thesis)	Research	<b>20</b>	
		<b>OR</b>				
		<b>Special Papers – (20-Credits) Satisfactory /Unsatisfactory</b>				
		AGR. - 513	Principles and Practices of Organic Farming	Theory & Practical	<b>4(3+1)</b>	
		AGR. - 505	Agro meteorology and crop weather forecasting	Theory & Practical	<b>4(3+1)</b>	
		AGR. - 508	Agronomy of Medicinal, Aromatic and under Utilized Crops	Theory & Practical	<b>4(3+1)</b>	
		AGR. - 514	Crop Production in Problematic Soils	Theory & Practical	<b>4(3+1)</b>	
AGR. - 515	Diagnosis of Nutritional Deficiency in Field Crops and their Remedial Measure	Theory & Practical	<b>4(3+1)</b>			

## Semester I

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### **AGR – 501 (Paper -I)**

#### **MODERN CONCEPTS IN CROP PRODUCTION**

**3 (2+1)**

##### **Theory**

##### UNIT - 1

Crop growth analysis in relation to environment, agro-ecological zones of India.

##### UNIT-2

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

##### UNIT-3

Effect of lodging in cereals; physiology of grains yield in cereals; optimization of plant population and planting geometry in relation to different resources.

##### UNIT - 4

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

##### UNIT - 5

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 plant; concept of balance nutrition and integrated nutrient management.

##### **Practical:**

- Study of growth analysis. Phases of growth yield analysis
- Study of agro-ecological zones.
- Study of tillage, modern concept and related with course.

### **AGR – 503 (Paper -II)**

#### **PRINCIPLES AND PRACTICES OF WEED MANAGEMENT 3 (2+1)**

##### **Theory**

##### UNIT - 1

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

##### UNIT-2

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

##### UNIT - 3

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.

##### UNIT-4

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

##### UNIT-5

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

##### **Practical**

- Identification of important weeds of different crop
- Preparation of a weed herbarium
- Weed survey in crop and cropping systems
- Crop-weed competition studies
- Preparation of spray solution of herbicides for high and low-volume sprayers
- Economics of weed control
- Herbicides resistance analysis in plant and soil
- Calculation of herbicidal requirement

### **AGR – 506 (Paper -III)**

## **SCIENTIFIC CULTIVATION OF MAJOR CEREALS AND PULSES**

**3 (2+1)**

### **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 - 1

Rabi cereals; wheat, barley, oat

#### UNIT - 2

Kharif cereals: Paddy, Maize, sorghum, bajra.

#### UNIT-3

Rabi pulses; chickpea, field pea, lentil, rajmash

#### UNIT - 4

Kharif pulses: Arhar, Urd, Moong, Cowpea, Soyabean

### **Practical**

- Phenological studies at different growth stages of crop.
- Estimation of crop yield on basis of yield attributes.
- Formulation of cropping schemes for various farm size and calculation of cropping and rotational intensities.
- Planning and layout of field experiments.
- Judging of physiological maturity in different crop.
- Intercultural operations in different crops.
- Determination of cost of cultivation of different crop.
- Work out harvest index of various crops.
- Study of seed production techniques in various crop
- Visit of field experiments on cultural, fertilizer weed control and water management aspects.

## **AS – 501 (Paper -IV)**

### **AGRICULTURAL STATISTICS**

**3(2 +1)**

#### **Theory:**

##### **UNIT- 1**

Classification tabulation and graphical representation of data. Box-plot. Descriptive statistics. Exploratory data analysis; Theory of probability. Random variable and mathematical expectation.

##### **UNIT - 2**

Discrete and continuous probability distribution: Binomial, Poisson, Normal distribution, Concept of sampling distribution chi-square, t and F distributions. Tests of significance based on Normal, chi-square, t and F distribution. Large sample theory.

##### **UNIT - 3**

Introduction to theory of estimation and confidence-intervals, correlation and regression, Simple and multiple linear regression model, estimation of parameters, predicted value and residuals, correlation coefficient, partial correlation coefficient, multiple correlation coefficient, rank correlation coefficient, test of significance of correlation coefficient and regression coefficient, coefficient of determination.

##### **UNIT - 4**

Need for designing of experiments, characteristics of a good design, Basic principles of designs, randomization, replication and local control.

##### **UNIT-5**

Uniformity trails, size and shape of plots and blocks, analysis of variance, completely randomized design, randomized block design and Latin square design, missing plot techniques, split plot design.

##### **UNIT-6**

Sampling Techniques - Planning of survey, method of data collection, questionnaire v/s schedule, Problems of sampling frame choice of sample of design, probability sampling, sample space, sampling design, simple random sampling, Estimation of proportion, confidence interval, Determination of sample size, stratified sampling, cluster sampling, multi state sampling, systematic sampling, ratio and regression method of estimation, Non sampling error-source and classification.

#### **Practical**

- **Related with the course**

## Semester II

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### **AGR- 502 (Paper -I)**

#### **PRINCIPLES AND PRACTICES OF SOIL FERTILITY AND NUTRIENT MANAGEMENT**

**3 (2 +1)**

##### **Theory**

###### UNIT-1

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.

###### UNIT - 2

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

###### UNIT - 3

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

###### UNIT - 4

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 interaction.

###### UNIT-5

Time and method of manures and fertilizers applications; foliar application and its concept; relative performance of organic and inorganic manures; economics of fertilizer use; integrated nutrient management; use of vermicompost and residue wastes in crops.

##### **Practical**

- Determination of soil pH, ECe, organic C, total N available NPK and S in soil
- Determination of total N, P, K and S in plants.
- Numerical problems on fertilizers Requirement and fertilizer mixture.

### **AGR – 504 (Paper -II)**

#### **PRINCIPLES AND PRACTICES OF WATER MANAGEMENT**

**3 (2+1)**

##### **Theory**

###### UNIT - 1

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 - 2

Soil water movement in soil and plants; transpiration; soil-water-plant relationships; water absorption by plants; plant response to water stress.

###### UNIT-3

Soil, plant and meteorological factors determining water needs of crop; scheduling, depth and methods of irrigation; micro- irrigation system; fertigation; management of water in controlled environments and polyhouses.

#### UNIT-4

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

#### UNIT - 5

Excess of soil water and plant growth; water management in problem soils; drainage requirement of crop and methods of field drainage.

#### **Practical**

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

### **AGR – 507 (Paper -III)**

## **SCIENTIFIC CULTIVATION OF OILSEED, FIBRE AND SUGAR CROPS**

**3 (2+1)**

#### **Theory**

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

#### UNIT - 1

Rabi oilseeds - Rapeseed and mustard, linseed

#### UNIT - 2

Kharif oilseed - Groundnut, Til, Castor, Sunflower, Soyabean

#### UNIT - 3

Fiber crops - Cotton, Jute, Sun hemp.

#### UNIT-4

Sugar crop - Sugar-beet and Sugarcane

#### **Practical**

- Planning-and layout of field experiments.
- Cutting of sugarcane setts. It's treatment and methods of sowing tying and propping of sugarcane.
- Intercultural operations in different crops.
- Cotton seed treatment.
- Judging of physiological maturity in different crops and workout harvest index.
- Work out cost of cultivation of different crops.
- Estimation of crop yield on the basis of yield attributes.
- Study of seeds production techniques in various crops.
- Visit of field experiments on cultural fertilizer, weed control and water management aspects.

## **AGR – 511 (Paper -IV)**

### **CROPPING SYSTEM AND SUSTAINABLE AGRICULTURE 3 (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 - 2**

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-3**

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 -4**

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 - 5**

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

#### **Practical:**

- **Related with the Course**

### Semester III

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#### **AGR- 509 (Paper -1)**

#### **AGRONOMY OF FODDER AND FORAGE CROPS**

**3(2+1)**

##### **Theory:**

##### UNIT -1

Area and distribution varietal improvement, agro-techniques and quality aspects including anti-quality factors of important fodder crops like maize, sorghum, bajra, cowpea, oats, barley, berseem, lucerne. Guar, etc.

##### UNIT - II

Area and distribution, varietal improvement, agro-technique and quality aspects including anti-quality factors of important forage crops/grasses, napier grass, sudan grass, Rohdes grass, Deenanath grass, 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.

##### **Practical:**

- Practical raining of farm operation 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.
- Field visit and identification of fodder and forage crops.

#### **AGR- 510 (Paper - II)**

#### **AGROSTOLOGY AND AGRO-FORESTRY**

**3(2+1)**

##### **Theory:**

##### UNIT -1

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 need of pastures; pasture establishment, their improvement and renovation - natural pastures, cultivated pastures; common pasture grasses.



### UNIT-III

Agroforestry: definition and importance; agroforestry systems, agri-silviculture, silvipasture, agri-silvipasture, agri-horticulture, 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 operations; desirable tree characteristics.

#### **Practical:**

- 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 total biomass and fuel wood.
- Economics of agro-forestry.
- Visit to important agro-forestry research stations.

### **AGR- 512 (Paper-III)**

#### **DRY LAND FARMING AND WATERSHED MANAGEMENT 3(2+1)**

#### **Theory:**

##### UNIT -1

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, tillage, 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); antitranspirants; soil and crop management techniques, seeding and efficient

fertilizer use.

#### UNIT-V

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

##### **Practical:**

- Seed treatment, seed germination and crop establishment in relation to soil moisture contents.
- Moisture stress effects and recovery behaviour 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 plants for different drought conditions.
- Study of field experiments relevant to dryland farming.
- Visit to dryland research stations and watershed projects.

### **CA - 502 (Paper-IV)**

#### **COMPUTER APPLICATION IN AGRICULTURE**

**2(1+1)**

##### **Theory:**

Introduction to computer, operating system, definition and types, application of Ms-Office for document creation & Editing, Data presentation, interpretation and graph creation, statistical analysis, mathematical expressions, database concepts and types, uses of DBMS in Agriculture, World Wide Web (WWW); Memory, Basic Anatomy of Computer System. e-Agriculture concepts and applications, Use of ICT in Agriculture. IT Application for computation of water and nutrient requirement of crops, computer-controlled devices (automated system) for agri-input management, Smart phone Apps in Agriculture. Decision support systems, concepts, components and applications in agriculture.

##### **Practical:**

Study of computer components, accessories, practice of important DOS Commands. Introduction of different operating system such as window, Files & Folders, File Management. Use of MS-Word and MS Power-point for creating, editing and presenting a scientific document. MS-Excel - Creating a spread-sheet, use for statistical tools, writing expressions, creating graphs, analysis of scientific data, MS-Access- Creating database.

### **PGS-501 (Paper-V)**

#### **LIBRARY AND INFORMATION SERVICES**

**1(0+1)**

##### **Practical:**

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information - Primary Sources Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services ( Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online

Public Access Catalogue and other computerized library services; Use of Internal including search engines and its resources; e-resources access methods.

## Semester IV

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### **AGR- 513 (Paper-I)**

#### **PRINCIPLES AND PRACTICES OF ORGANIC FARMING**

**4(3+1)**

#### **Theory:**

##### UNIT -1

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 vermicompost, green manures and biofertilizers.

##### UNIT - III

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

##### UNIT - IV

Control of weeds, diseases and insect pest management, biological agents and pheromones, biopesticides.

##### UNIT - V

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

#### **Practical:**

- Aerobic and anaerobic methods of making compost.
- Making of vermicompost.
- Identification and nursery raising of important agro-forestry trees and trees for shelter belts.
- Efficient use of biofertilizers, techniques of treating legume seeds with Rhizobium cultures, use of Azotobacter, Azospirillum and PSB cultures in field.
- Quality standards, inspection, certification, labelling and accreditation procedures for farm produce from organic farms.
- Visit to an organic farm.

### **AGR- 505 (Paper - II)**

#### **AGROMETEOROLOGY AND CROP WEATHER FORECASTING**

**4(3+1)**

#### **Theory:**

##### UNIT-1

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; 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, vapour pressure and their relationships; evapo-transpiration and meteorological factors determining evapotranspiration.

#### UNIT-IV

Monsoon: monsoon and their origin, characteristics of monsoon; onset, progress and withdrawal of monsoon.

#### UNIT-V

Weather forecasting in India- short, medium and long range 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.

#### **Practical:**

- 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/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.

### **AGR- 508 (Paper-III)**

## **AGRONOMY OF MEDICINAL, AROMATIC AND UNDER-UTILIZED CROPS**

**4(3+1)**

#### **Theory:**

#### UNIT -1

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 (Rauwolfia, Aloe Vera, Satavar, Safed Musli, Ashwagandha, etc).

#### UNIT-III

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

#### UNIT - IV

Climate and soil requirements; cultural practices; yield of under-utilized crops (Lathyrus, Sesbania, Clusterbean, French bean. Fenugreek, Tea and Tobacco).

#### **Practical:**

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

### **AGR- 514 (Paper-IV)**

## **CROP PRODUCTION IN PROBLEMATIC SOILS                      4(3+1)**

#### **Theory:**

#### UNIT-I

Problem soils and their distribution in India; acid, saline and waterlogged soils, origin of problematic soils and factors responsible.

#### UNIT-II

Response of crop to acidity, salinity, sodicity, excess water and nutrient imbalance.

#### UNIT - III

Reclamation of problem soils, role of amendments and drainage. Lime requirement for acid soils and gypsum requirement for sodic soils.

#### UNIT-IV

Crop production techniques in problem soils-crops, varieties, cropping system and agronomic practices.

#### UNIT - V

Effects of water table fluctuation on crop growth. Degraded lands and their rehabilitation.

#### **Practical:**

- Characterization of acid, salt affected and calcareous soils.
- Lime requirement of acid soils.
- Gypsum requirement of Sodic Soils.
- Determination of cations (Na<sup>+</sup>, K<sup>+</sup>, Ca<sup>++</sup>, and Mg<sup>++</sup>,) in soil samples
- Determination of anions (Cl, So<sub>4</sub>, Co<sub>3</sub>) in soil samples.
- Reclamation of problem soils by agronomic practices.

**AGR- 515 (Paper-V)****Diagnosis of Nutritional Deficiency in Field Crops and their Remedial Measure****4(3+1)****Theory:**

Deficiency symptoms of individual elements - macro, micro exhibited by cereals, oilseeds, pulses, fibre crops, forage crops, sugar crops, tuber crops, causes of deficiency, physiological changes brought about in plants due to deficiency. Plants parts showing the symptoms critical level of nutrient elements of deficiency, indicator plants for different elements. Toxicity limits of different elements. Toxicity systems. Prevention alleviation of deficiency toxicity, similarity of deficiency symptoms with disease symptoms.

**Practical:**

- Principles of colorimetry
- Flame-photometry and atomic absorption spectroscopy
- Chemical analysis of soil for total and available nutrients
- Analysis of plants for essential elements.