Objectives: micro nutrients in isolation or in

Objectives: i. To maintain soil fertility.

ii. Sustainable agriculture production. iii. Improve farmer's profit. iv.

Increase availability of nutrient from all resources. v. Match demand and supply. vi. Minimising loss of nutrients. vii.

Key principle: Balanced fertilizer. viii. Aim of balanced fertilizer. ix. Increase crop yield. x.

Increase farm income. Components: 1. Chemicals: Urea, DAP to supply nitrogen, superphosphate and rock phosphate supply phosphorus, murate of potash and sulphate of potash supply potash. There are various complex fertilizers to supply combination of nutrients. Similarly there are many chemical compounds which supply various macro and micro nutrients in isolation or in combination. 2. Organic matter: Farmyard manure, vermicompost, oil cakes of different oilseeds like castor, neem etc.

Incorporation of organic residues of proceeding crop in the fields, if time and soil conditions permit also serves as a source of organic nutrients for the succeeding crop. 3. Biological: (a) Green manures: cowpea, sunhemp, sesbania, etc. and green leaf manures like subabul, etc.

(b) Biofertilizers Advantages: i. Nutrients are easily and quickly available for the plants. ii. Good for maintaining soil health iii. Good for supplying micronutrient iv. All sources can be generated on farm itself. v. It have advantage of being diversified into small units to meet the demands of the specific problems of location.

vi. Quality and shelf life of food products are increased. Disadvantages: i. Excessive use of fertilizers leads to imbalance in the soil pH. ii. Most of the chemical fertilizers are high energy consuming. iii. Chemical fertilizers pollute the environment.

iv. Organic sources are bulk in nature, low in nutrient content. v.

Organic manures are having high C: N ratio and not properly composed can lead to temporary deficiency.

Nitrogen Losses:

Nitrogen is a important macro nutrient for crop plants, which will be taken by the plants form soils. This nutrient released in soils either by weathering or by decomposition of organic matter or by addition of fertilizers, induce N2 losses from soils.

N2 Losses: 1. Leaching of loss/drainage loss of NO3 Depends on: Mobility: N2 Mobile for leaching loss Region: Humid region N2 loss is high than arid region. Soil Type: High loss in sandy soil than loam/clay. Land Nature: More loss in barren soil than crop covered land.

2. Run of loss like of NO–3. 3. Gaseous losses: Takes place three ways: (a) Volatilization/Non-biological loss of NH3: Volatilization: Volatilization is a gaseous loss of N in which inorganic N ions can be converted to gas and lost to the atmosphere. Causes for Volatilization — i. Poor drainage: Volatilization occur in poorly drained soil, (e.

g.) rice. ii. Alkaline pH: Volatilization occurs in soil pH > 7. 5. iii.

Soil pH coupled with form of fertilizer applied: Acidic soil + NH^{+}_4 Fertilizer (Amm. Fertilizer) > No Volatilization (because soil pH don't increase) Acid soil + Urea (NH_4 Forming Fertilizer) > Volatilization (because soil pH increase) [Acid soil + $2H_2O^{+}$ + CO $(NH_2)_2$ > 2 NH^{+}_4 + HCO^{-}_3 NH_4 > NH_3^ (Volatilization)] (b) Chemical Decomposition of NO^{-}_2 under acid condition. (i) Decomposition of NH_4 NO_2 NH_4 NO_2 > 2 H_2O + N_2 ^ (ii) Van slyke reaction R – NH_2 + HNO_2 > R-OH + H_2O + N_2^ (iii) Spontaneous decomposition of Nitrous acid. 3 HNO_2 > H_2O + 2 NO ^ NO + Î > NO_2 ^ 2 $2HNO_2$ > NO + NO_2 ^ + H_2O (c) Microbial Denitrification: Liberation of N_2 and N_2O. i. Denitrification: Nitrates are subjected to reduction in soils especially in those that are poorly drained or water logged and low in aeration with the help of micro organisms (or) Biological reduction of NO_3 to NO_2. ii.

Micro organism involved a. Pseudomonas denitrijicans b. Thiobacillus denitrificans iii. Process of denitrification in Soil: $2NO^{-}_3$ Nitrate > -2 (0) 2N02 (Nitrate) > 2NO (Nitric oxide) > N_2O (Nitrous oxide) > N_2 ^ (Eliminated) Microganism removes O_2 act on e acceptor. i. Example: Rice ecosystem.

Causes of Denitrification — i. Water logged condition/anaerobic condition. Significance of N_2 Losses: 1. It maintains the N balances of N cycle. 2. N released during denitrification fixed by biological N fixation, makes available to plants. 3. In ecological point of view, leaching of NO_3 causes eutrophication, but denitrification prevents this eutrophication.

Way to Compensation: 1. In case of leaching in alkali soil, add 25%, more N_2. 2. Denitrification can be reduced by addition of P04 residues.

3. Adequate drainage Problems by N2 Losses: i. Eutrophication ii. Atmospheric pollution

Fertilizers Use Efficiency (FUE):

What percentage of an applied fertilizer nutrient is utilized by the crops cropping system. This is termed as FUE. Measures of FUE: It can be measured by the percentage of added fertilizer nutrient recovered by the harvested portion of a crop (or) kgms of economic produce per kg of nutrient applied. Problems of ‘ N’ fertilizer – Leaching and volatilization. Problems of ‘ P’ fertilizer – Fixation, immobility and transformation.

Nitrogen Use Efficiency:

i. Mainly determined by various kinds of losses in the field, viz. volatilization in the form of ammonia, leaching and runoff, denitrification.

ii. N fertilizers are amide and ammoniacal forms. iii.

Converted into nitrate form, it becomes very much susceptible to loss by leaching with irrigation rain water iv. Application of nitrogen fertilizer in split doses or as top dressing increases the efficiency of nitrogen use v. The NH4+ ions in ammonical fertilizers are adsorbed the soil clay. They may be utilised directly by certain crops e.

g. rice, else they are transformed into nitrates by microbes and taken in this form. vi.

Higher the clay content of the soil and its exchange capacity the better is nitrogen use efficiency. Urea Transformation in soil: Factors Determine

Nutrient Uptake: i. Crops, nature of root system ii. Water iii. Texture and pH soil iv. Management practices (land preparation, choice of variety, timely sowing, optimum plant population, timely weed control, weed management, plant protection and balanced supply of essential plant nutrients) v. Agro climatic conditions Practices to increase Nitrogen Use Efficiency: i.

Split application > apply ' N' in 2 or 3 installments to coincide with the peak period of nitrogen requirement of the crop. ii. Sub surface application iii.

Pelleting with soil iv. Incubation of urea with moist soil (1: 6) for 2 or 3 days, resulting in the adsorption by soil clays of ammonia formed by the hydrolysis of urea. Increase Efficiency through Slow Release Nitrogenous Fertilizers: 1.

Urea aldehyde condensation products e. g. urea form, oxamide, isobutytidene diurea 2. Urea coated with sulphur, lac and neem.

The coating is form a temporary barrier between urea granules and soil or soil water, thus reducing the rate of urea hydrolysis. 3. Blend Nitrogen fertilizer with a nitrification inhibitors: i. Non toxic to plants, soil micro-organisms, animal and fish. ii. Block the conversion of NH4 > NO3 by inhibiting Nitrosomonas activity. iii. Not interfere with the transformation NO2 (nitrite) by nitrobactors.

iv. Be able to move with the fertilizer so that it will be distributed uniformly throughout the soil zone contacted by nitrogen fertilizer. v. Stable and long time inhibitory action vi. Relatively inexpensive, so that it can be used as commercial basis. e.

g. Nitrapyrin. 4. Judicious mix of manures and fertilizers. 5. Placement of urea super granules, made up of ordinary granules below the soil surface has been found to increase, to varying extent the NUE with regard to rice crop.

Phosphorous use Efficiency:

i. Fixation of phosphate is main problem.

ii. Water soluble phosphatic fertilizer after application to the soil react preferably with Fe and Al to form initial phosphate reaction products. iii. Ca, mg carbonates, pH and water status of the soil control the nature of the reaction products. iv. Efficiency of phosphatic fertilizers depends primarily upon the release of ‘ P’ from the products rather than the fertilizer. v.

Reaction products vary in their ability to release ‘ P’. Measure to Increase Efficiency: i. Minimum contact of the fertilizer with the soil to restrict phosphate fixation. ii. Rise pH of acid soil by liming. iii. Liming, deep placement and combined use of super phosphate and organic manures to increase the PUE.

iv. Rice to increase PUE > surface broadcast, followed by mixing during puddling. v. Wheat – Phosphate placement applied in seed furrow or drilling by just below the seeds. vi. Crop rotation – to utilise ‘ P’ direct as well as residual effect.

Gram + rice rotation. vii. In India application of ‘ P’ Fertilizer with organic matter is beneficial. This increase the crop response and decrease fixation. viii.

Better utilisation of ‘ P’ in acid soil mixed with Farm Yard manure. ix. Sun hemp – Application of phosphate before ploughing best method to improve soil fertility. x. Crop may not use > 10% of ‘ P’ if applied broad cast upto 30% efficiency when applied as concentrated band along the plant row. xi. Clay soil have greater phosphate fixing capacity than sandy soil.

Potassium Use Efficiency:

All potassium fertilizer are water soluble.

Different ‘ k’ fertilizer consist of ‘ k’ in combination with chloride, sulphate, nitrate. Both chloride and sulphate of ê are soluble in water and on application to the soil then ionizes into k+, Cl– and SO42- ions. The released k+ ion from the fertilizer gets adsorbed on the soil colloids and also available to the plant through cation exchange reactions.

Nutrient Fixation:

The process where by readily soluble plant nutrients are changed into less soluble form by reaction with inorganic or organic compounds of the soil restricting their mobility in the soil and thereby suffer a decrease in their availability to the plants. Two kinds of fixation.

Cation fixation: N, K, Fe, Mn, Cu, Zn Anion fixation: P, B, Mo Phosphorous Fixation in the Soil: Phosphorous was fixed in the soil by the 3 general types of reactions. 1. Adsorption 2. Isomorphous replacement 3. Double Decomposition (i) Adsorption: (a) Physical Adsorption (b) Chemical Adsorption In Physical Adsorption phosphate is held in the soil solid surface and Chemical Adsorption phosphate penetrate more or less uniformly into the soil surface.

Adsorption of ‘ P’ takes place on – i. On the surface of constant charge – crystalline clay minerals through cations. ii.

On the surface of variable charges like Fe3+, Al oxides, organic matter. iii. On the surface of kaolinite and Allophanes which have pH dependent charges on their crystal edges and surfaces. iv. On the surface of organic matter which have pH dependent cations on their surface. (ii) Isomorphous Replacement Reaction: Phosphate is fixed by the Hydroxyl (OH–) and silicate ions through attached to silicon and Al and are liable to either dissociate to give (Si, Al)+ + OH– (or), accept a proton (H+ ion) and give rise to positively. Charged clay, which then take part in the anion exchange with P04 (Si, Al) – OH > – (Si, Al) + + OH– (Si, Al) – OH + H+ > (Si, Al) – OH+2 Another important mechanism for the phosphate fixation is a certain amount of silicate released from the tetrahedron.

But reaction of Fe, Al Hydroxides with the phosphate ions are the most significant for phosphate fixation in soils. (iii) Double Decomposition Reaction: This fixation (precipitation) is largely depend upon the pH of the system. This phosphate fixation can be divided into two categories: i. Reaction involving Fe and Al – here P fixation can be reduced with increase in pH. ii. Reaction involving Ca (ÎÍ) 2 /Ñà CO3 – here P fixation can be increased by increasing pH. Factors Affecting Phosphate Fixation: 1. Nature and amount of Soil components a.

Hydrous oxides of Fe, Al b. Type of clay c. Amount of clay d. Calcium carbonates 2. pH 3. Other ions 4. Organic matter 5.

Temperature 6. Over liming.

Nitrogen Mineralisation Immobilization:

Nitrogen Mineralisation: It is a process of conversion of organic nitrogen to ammonia, which involves two reactions viz. aminization and ammonification. Aminization: It is nothing but the process which converts the proteins into amimoacids and amines by the action of heterotrophic bacteria and fungi.

Bacteria in alkaline and neutral soils. While fungi dominates in acid soils. Proteins > Amino acids + Amines + urea + Energy Ammonification: Here amines and amino acids are decomposed by other heterotrophs, there by releasing ammonia. Fate of Ammonia: i. It may be converted to NO–2 and NO-3 nitrification. ii.

Absorbed directly by higher plants. iii. May be fixed in a biologically unavailable form. iv. May be slowly released back to the atmosphere as N2. ‘ N’ Immobilization: It is the conversion of inorganic nitrogen to organic nitrogen and it is basically the reverse of nitrogen mineralisation.

If decomposing organic matter contains low ‘ N’ relative to ‘ c’ microorganisms will immobilize inorganic nitrogen in the soil. Soil micro organism compete very effectively with plants for inorganic nitrogen during immobilization and plants may become readily deficient in nitrogen. For this nitrogen fertilizers are applied to compensate for immobilization and crop requirements.