Fundamentals of Environmental Pollution and Control
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Lecture No. # 22
Parameters of soil for vegetative growth (continued)

Okay, so we will begin this class today with this you know the other parameters that are important for vegetative growth. So, what we started you know what we have talked so far about this soil organic matter.

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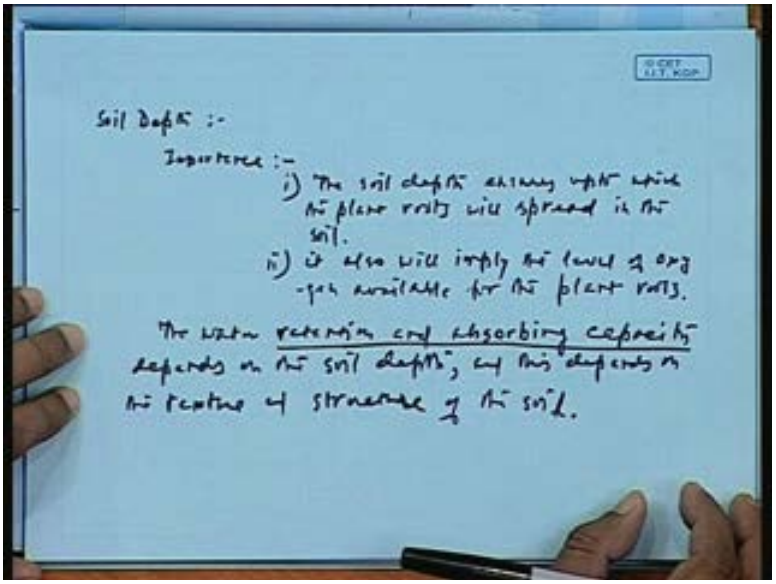

Now, we will come to soil depth. There is another important parameter the soil depth, the soil depth serves you know in two, two ways, the importance of soil depth importance, importance as we can see for this soil depth. The first of all that soil depth ensures up to which the plant roots will spread in the soil, will spread in the soil and also more importantly say this it also will imply, it will also imply up to, it will also imply the level of oxygen available, level of oxygen available for the plants roots, for the plant roots. The water retention, water retention and absorbing capacity, water retention, retention and absorption capacity depends on the soil depth, soil depth, the soil depth and also and this depends on, this depends on the texture and structure, texture and structure of the soil.

So, the water retention and absorbing capacity depends on the soil depth and these depend and these depends on the texture and this whole thing the retention and absorbing capacity this depends on the texture and structure of the soil, texture and structure of the soil. So, this is about soil depth, we will not discuss much about this. In fact you know in the next you know on the, when we are discussing soil air we will be able to understand more on this. So, this is about, this is the soil depth you know that is important for our, for the requirement of soil for vegetative growth.

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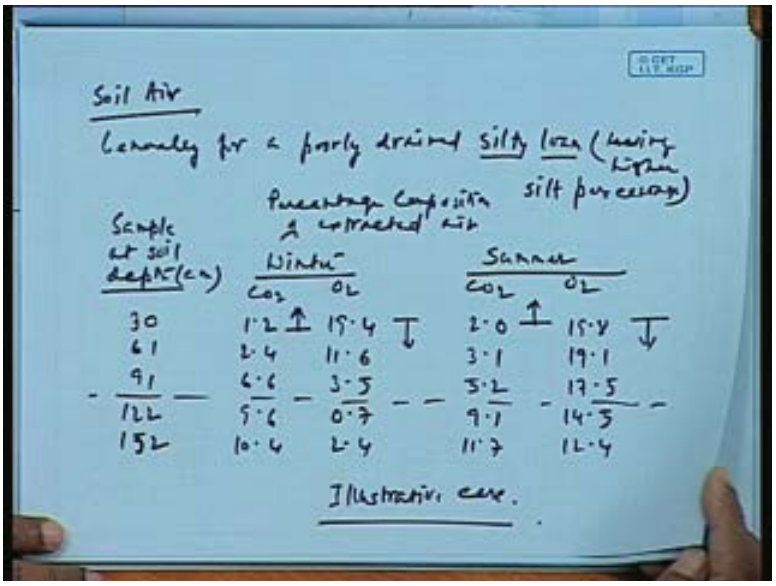

So, here you know the next is soil air, soil air. Interestingly you know generally for a poorly drained silty loam, poorly drained silty loam you know you remember the constituents of the loam 60%, 20%, 20% that we have done, so here if it is the silt, the percentage of silt is more say you know about 25% or 30% like that then we'll call this as silty loam. So, this silt loam is a poorly drained silty loam. Generally, for poorly drained silty loam having, having higher, higher silt percentage you just observe this the sample, sample at soil depth, percentage of composition, percentage composition of extracted air, percentage composition of extracted air.

Generally in winter, generally in winter and winter if you see carbon dioxide and oxygen and say in summer, summer we just see CO 2 and oxygen. You see this, the concentration at different levels you know you just see this soil depth in centimeter. This is just an example case, this is just an example case to illustrate you know how at different depths of soil, the typical concentration of air, gaseous concentration in the air how it actually varies, this one is 152.

See this, this one is 1.2, 19.4, 19.4 you can see this 11.6, 3.5, 3.5, 0.7, 2.4. So, you can see this, this one is going down, this one is going down on the other hand 2.4, 6.6, 9.6 and 10.4, so this one is going up. So, this is with depth, with depth it was going up, with depth this one is going down. So, similarly the only the condition would be somewhat better in the, only the condition would be somewhat better in summer but not to say that this one is the trend remains the same, the trend remains the same 19.8, 19.1, 17.5, 14.5 and 12.4.

Sir, in the first case the percentage of oxygen increase with after 120 centimeters. Yeah, yeah, yeah, yeah, yeah, yeah, okay, okay I mean this is an experimental case, this is an experimental case. Here at least you know 0.7, this one is an experimental case may be you know somewhere it has got say the mostly the trend is towards decreasing. Here also you can see the mostly the trend is towards decreasing but decreasing at a lower rate, this is decreasing at a higher rate. So, this is just to, just to suggest, just to suggest how the soil parameters actually behave soil, this the

concentration of oxygen and carbon dioxide in the soil at different depths are available. This is just an illustrative case you know it is an illustration, illustrative case, illustrative case.

So, here this one is extremely important for, extremely important as you can see soil air is very important for say for the retention of this, for retention of you know the particularly for the plant root respiration. You can see this, if this oxygen continuously go down, so the as a result of this you know generally if you can think of, if you generally think of here it is about most of the plants reach their plant roots at about this depth, except for, except for very large plants, their plants roots should be almost here, almost at this level. So they don't go below further down than this, okay.

Now, this is about the soil air you know mostly the concentrate composition of the soil air and other things are also of great importance but will not find time to discuss them. You know this is just to illustrate you know what we expect, what we can expect in the soil in terms of the gaseous percentages.

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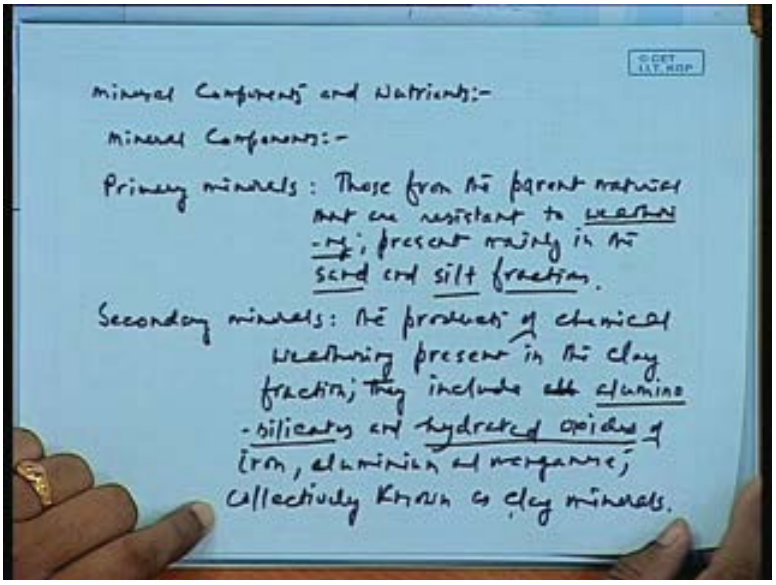

See, the next important thing is you know this mineral components, mineral components, mineral components and nutrients. See, this mineral components in this first of all to tie with this mineral components, mineral components these are the primary minerals, primary minerals. This is how to identify them in the soil is those from the parent, parent material that are resistant to, resistant to weathering present mainly in the sand and sand and silt fractions, sand and silt fractions. You see what this is you know to identify this, parent material that are resistant to weathering, resistant to weathering, so you know resistant to oxidation mostly primarily oxidation present mainly in the sand and silt fractions. They are, they generally do not get weathered they remain in the soil but there are secondary minerals which are essentially weathered products. These secondary minerals as I have said the plants cannot, plants cannot take anything in the form of solid, it has to be in the dissolved state.

So and this the, this is what the products, the products of chemical weathering, products of chemical weathering present in the clay, present in the clay fraction. They include iron, aluminium, iron, aluminium and manganese collectively known as, collectively known as clay minerals. So, you know you can see this primary mineral that we generally discussed as we have said those from the parent mineral, those from the parent mineral, material that are resistance to weathering, that are resistant to weathering. This is what is now that would remain after the weathering, after the weathering in the soil. This is the fraction which would not, which would not be soluble, which should not dissolve into water, this would remain as it is in the sand and silt fractions.

Secondary mineral, secondary minerals the products of chemical weathering present in the clay fraction they include aluminium, aluminium silicates and hydrated oxides. This is, this is very important, this hydrated oxides are basically the food or the nutrients for the plants. They are, they are basically the nutrients which are used by the plants for growth. Iron, aluminium, manganese collectively known as clay minerals, collectively known as clay minerals. So, if you just observe this clay minerals of this say the most common fraction, most common, most common mineral in sand and silt fractions, mineral in sand and silt fraction is quartz, quartz which we generally known as Sio 2.

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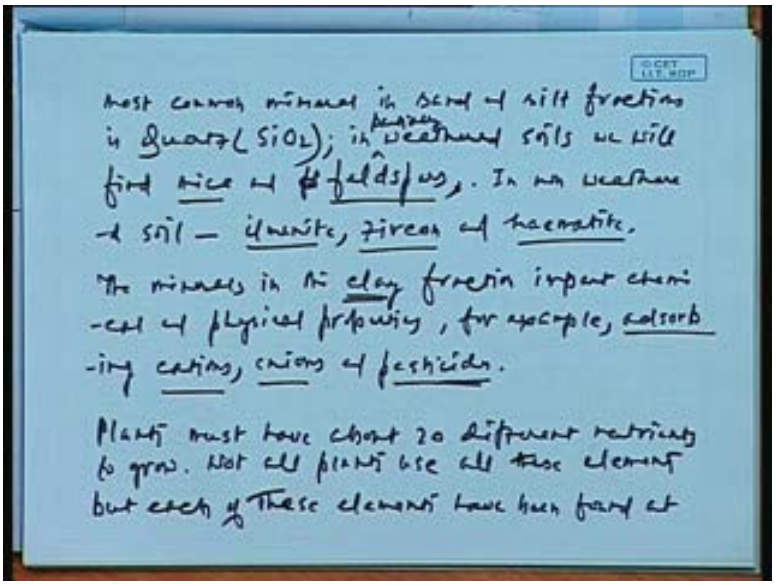

In weathered soil, weathered soils we will find, will find in the weathered soil we will find mica and feldspars, mica and feldspars, mica and feldspars this is also strongly weathered micas in strongly, in partially, in partially weathered soils we will find mica and feldspar. In non-weathered, in non-weathered soil, in non-weathered soil we will find ilmenite, ilmenite, zircon and hematite okay, in non-weathered soil we will find ilmenite, zircon, hematite. So, you know this is, this gives you an idea about the composition of the soils. So, what we are finding mostly is say you know silica, this is as most common is as the quartz fractions that we are getting, we would also get mica, we would also get feldspar.

In non-weathered soil mostly the soil which is not weathered, we will find mostly the substances like say minerals like ilmenite, zircon and hematite. So, this is, this forms the basically the most of the minerals that we can expect, that we can expect in the soil, this, the minerals another very important thing that is, that is of great use. So, here you know this forms this is the minerals in the clay fractions, the minerals, minerals in the clay fraction, impart, impart chemical and physical properties, chemical and physical properties. For example, for example adsorbing, adsorbing cations, anions and pesticides and pesticides right.

So, you can see this you know the clay fraction impart chemical and physical properties for example. So, here this one is all important most of the kind, the sand and silt generally provide a physical property for the soil, sand and silt provide the physical property of the soil. Say you know the soil strength, soil physical other physical density all these things are physical properties are generally governed by the sand and silt but the clay is actually the particle, clay is actually the particle which helps in the adsorbing of cations, anions and pesticides. This is what is the most important part of the soil, most important part of the soil where the soil would be able to use this, this anions, cations for its growth okay.

Now having to say all this you know there are, there are different kinds of characteristics I will not go into the detail of that. So, this is apart from that the nutrients, the plants, plants must have about 20 nutrients, different nutrients, different nutrients to grow, nutrients to grow. See this, all this not all plants, not all plants use all these elements, all these elements but each of, but each of these elements have been found, have been found at least, see what it means is that all 20 elements, there are 20 different nutrients plant need to go but plants, all plants should not need all this 20. Say, there are may be some plants which would require 15 of them, some other plants would requires another 15 of them out of which you know say 10 or 12 would be common and 8 would be uncommon.

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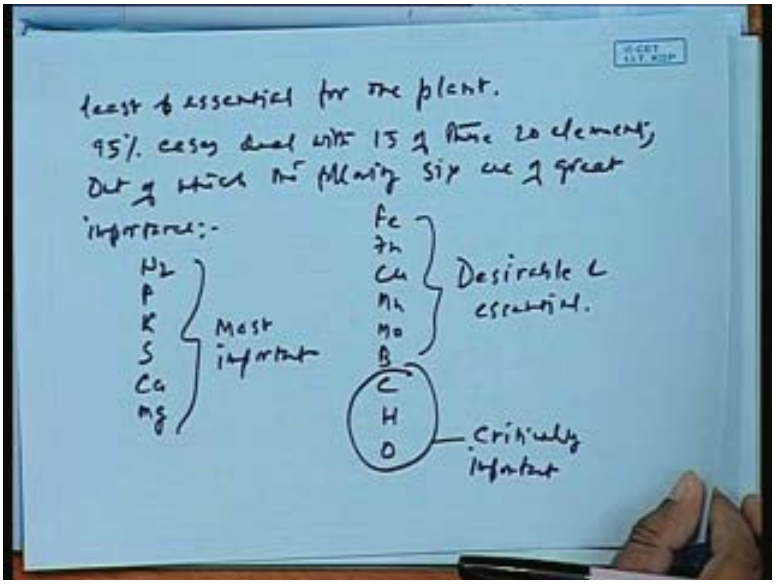

So, you know together it would be 20, so is like this but each of this elements have been found, have been found at least, at least found, at least for, at least, at least essential for one plant okay at least essentially found all this. 95%, 95% time, 95% cases, 95% cases deal with 15 of these 20 elements, 15 of these 20 elements, 15 of these 20 elements out of which, out of which, out of which, out of which the following 6, 6 are of, following 6 are of great importance. This is you know the most important one are the nitrogen then phosphorus, potassium, N P K that we know sulphur, calcium, this is most important, these are the most important things, these are most important apart from that you know we would require say zinc, copper, manganese, molybdenum, boron and other things like carbon and hydrogen that you know carbon, hydrogen it is a separate league all altogether. We would not, this is altogether, these are to say that you know is important is you know superfluous because these are mostly the plants are made of the carbon and hydrogen. So, you know apart from that so the mostly the, apart form that that you know we have carbon, oxygen and hydrogen that we deal with separately. So, this is what you can finally the mostly, the important elements that we can see this 6 here, 6 here and 5 and 14, there may be one or one may be okay we have missed one, that is iron. So, here you can see this is, this makes the so these are most important this is a critically important, critically important these are desirable and essential, okay.

Most important, critically important desirable and essential, so you know this is or this all these are supposed to be provided, all these are to be supposed to be provided in the plant. So, you know here you can see this, say this you know you know mostly for these fertilizers that we use we say that you know it's given a number NPK okay. This is NPK is nitrogen, phosphorous and potassium, this three, this three forms the most important, most important element in any fertilizer, in mostly inorganic fertilizer. So, here these things these are, these are the important aspects you know which we should find out about a soil, about the soil how much of the soil, what is the concentration of this substances in the soil so that the plant can take them easily and they should be available in a form of, in the form of, in the dissolved fractions. They should be in the form of dissolved material. So here, so this, this form, this would form the most of this, this essential elements if you are provided to the plant, the plant would be in a position to survive. So, here apart from this, apart from this there are few other things that I would like to discuss here. This is, one is this organic compound I mean you know these organic compounds in soil, soil organic matter we have discussed but the part is that we have discussed the importance.

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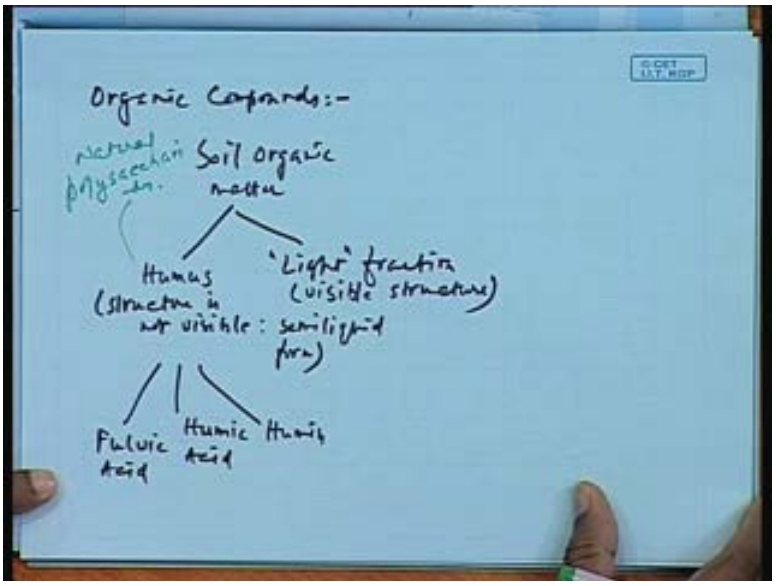

Here, I would just briefly deal about what are all these organic compounds that we see that we found in the, in the soil, organic compounds that we find in the soil. The soil organic matter, soil organic matter is composed of you know generally we have two fraction, we generally called this is a say humus, humus and is called light fraction, light fraction, visible structure, visible structure, soil organic matter, humus and light fraction, visible structure.

What is, let me give you an example, small example here. If you just see you know you have all seen that you know a particularly say cow dung, okay. If you observe the cow dung you know after rain or things like that you would observe that there is a, there are some fractions which are visible, the structures are visible you know we can find out the cellulose in them okay. They are you know these are solid fractions, these are solid fractions you know these are solid fractions for which the structure is available. Other than that there is a liquid fraction which is generally in the liquid form, you cannot see much of the structure there because you know these are already in the, in the form of a semi mixture or in the dissolved state they remain. So, this particularly is this, the whenever you can see the visible structures the mostly, the light fraction, the visible structure that we can see this is and this together forms the humus, a large part of that is humus.

So, a one light fraction where the structure is visible and another case the structure is not visible, visible. So, you know in the semi liquid, semi liquid form, semi liquid form, this humus and this humus is essentially composed of if we can make this a fulvic acid, fulvic acid then you find humic acid and you find humin and you find humin. So, effect you know particularly, particularly have been this humus, this all humus is basically this humus you know is known as, this humus are essentially natural, natural, natural polysaccharides, natural polysaccharides, these are mostly natural polysaccharides.

Natural polysaccharides means this is saccharin's you know you have heard of this saccharine's you know which are basically higher highly bonded carbon, hydrogen, oxygen compound mostly this is a basically an organic compound. This natural polysaccharides is the polysaccharides can

be synthetic also you know that today we manufacture a number of polysaccharides like you know the polysaccharides which is used for say as substitute for sugar, for most of the people you know for diabetic people they use polysaccharides. So, these are polysaccharides means you know number of bonding of different polysaccharides, it's not a single, single molecular structure of an saccharide there are number of, number of molecular structure together these are called poly, poly, yeah poly saccharin's, the saccharin's are mostly carbon hydrogen and oxygen compounds you know in a highly bonded organic compounds, there may be some other substances also, some other elements also connected with that. So, these are the natural polysaccharides. Mostly if you just identify what humus is you have to identify them as say you know something like you know generally the food we identify as you know in the form of carbohydrate or in the form of fat or things like that, so is humus is essentially a polysaccharide is a structurally is a polysaccharide.

This is and is composed of this three, these three acids you know fulvic acid, humic acid and humin acid. So, this is remember one thing this is, this is not a single acid okay. This is the family of acids is all these are basically family of acids, this is these are all family of acids you know there are fulvic acid, there may be different number of species available in fulvic acid, number of species may be available in humic acid. This is just a family of a certain class of acids, these are families of certain kind of acids. So, you know here if you just observe so this is what you know if you are just for our purpose for engineering purpose what is the concentration, I mean general a constituent of an organic.

Suppose, if we are going to use an organic fertilizer in the soil, so you must know a little bit about you know what it contains, what it, what purpose it would serve. So, here in this case you know these are, this is the soil organic matter serves in that matter itself. So, here if you can just see that average chemical composition, average chemical composition you see here this average chemical composition I'll just make this you know somewhat detail because of a component, component humic acid, humic acid, fulvic acid percentage okay carbon, oxygen, hydrogen, nitrogen, sulphur, COOH a radical phenolic, phenolic OH.
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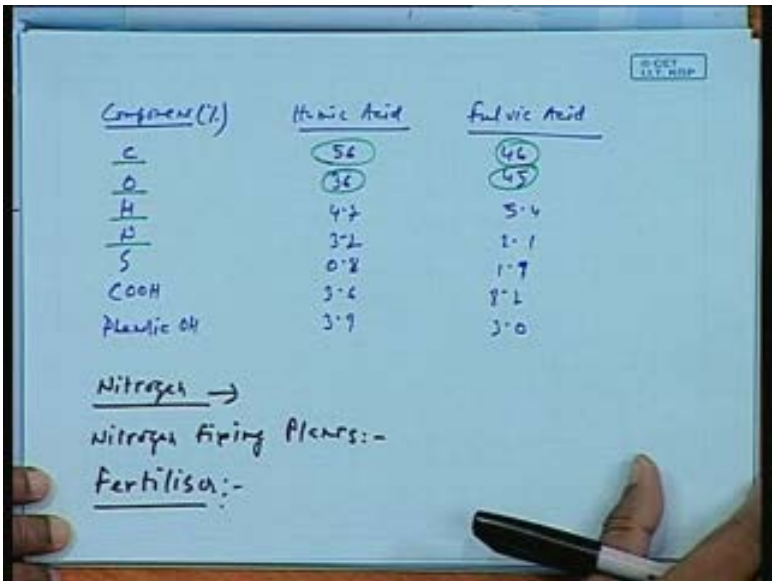

So, here in humic acid you know this is 56, 36, 4.7, 3.2, 0.8, 3.6 and 3.9 whereas this one is fulvic acid here we can see is 46, 45, 54, 5.4 then 2.1, 1.9, 1.9, 8.2 just you know just to give an idea, just to give an, give an idea about the chemical composition of this acids. So, you know here you can see this the two important differences that you can see here is the carbon is more, carbon is more, carbon is relatively less here whereas this oxygen is more here, oxygen is less here.

So, here this just to talk about the compositional difference say about the higher the, this is, this is an, both are organic compounds, both are organic compounds but these are most saturated or more bounded with carbon, these are less bounded with carbon. So, this makes the difference, this makes the difference. So, you know here all we can see is this particularly okay and so this is what is you know the mostly the soil humic substances. So, you know if you are, if you are interested if you are just going to give it you know depending on what the soil suffers from, what the soil suffers from you should be able to use them, you should be able to know from this soil organic matter you know which are the substances you are supposed to provide, you are supposed to provide to the soil, for the soil to be good for vegetative growth, yes. So, this is, this is what is, this is what is about this soil organic compounds. This is, there are many more details to be followed here but we will not go into that you know this apart from that you know other important parts that I would always ask you to know is this you know other important constituents is say other than this organic matter is the nitrogen, nitrogen that you know already. This is specifically nitrogen should be mentioned, specifically nitrogen should be mentioned and you know pertaining to this is, pertaining to this, this lets say nitrogen fixing plants, nitrogen fixing plants, nitrogen fixing plants say then is this fertilizer, there is another important thing that is fertilizer we would fertilizer.

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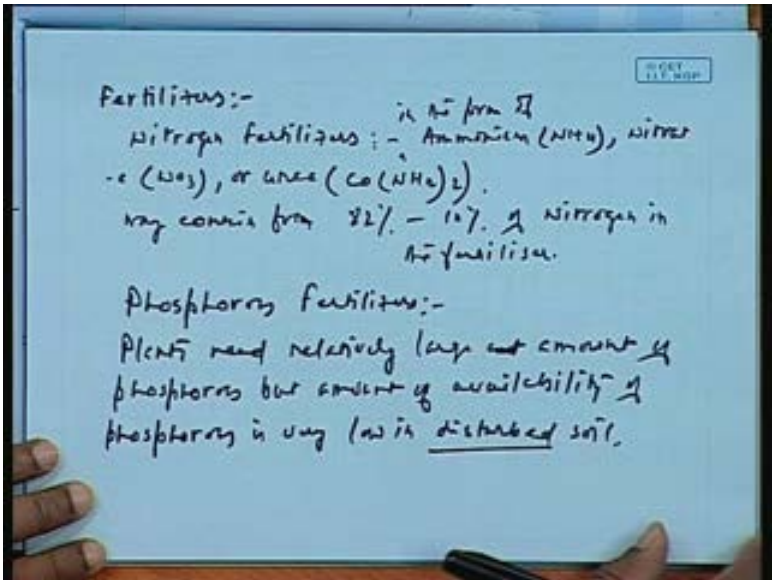

At one level you know initially at, initially before the plant has stabilized, the fertilizers are important, fertilizers are important. So, you know the fertilizer, fertilizers, fertilizers that are important for soil growth, the nitrogen fertilizers, nitrogen fertilizers are say ammonium in the

form, in the form of ammonium NH 4 nitrate okay. So, this so here you know the ammonium in the form of nitrogen fertilizers, this fertilizers may contain, may contain, may contain, may contain from, from, may contain from 82%, 82% to 10% of nitrogen, nitrogen in the fertilizer. So, depending on the requirement of nitrogen, depending on the requirement of the nitrogen this would be taken. So, depending on this, this is phosphorous fertilizers, phosphorous fertilizers, this phosphorous fertilizers are mostly say plants, plants need relatively large amount of, amount of phosphorus, phosphorus but amount of availability, amount of availability of phosphorus, amount of availability of phosphorus, amount of availability of phosphorus is very low in disturbed soil, in disturbed soil. So, it has to be, so it has to be supplemented by phosphorous fertilizers, it has to be supplemented by phosphorous fertilizers.

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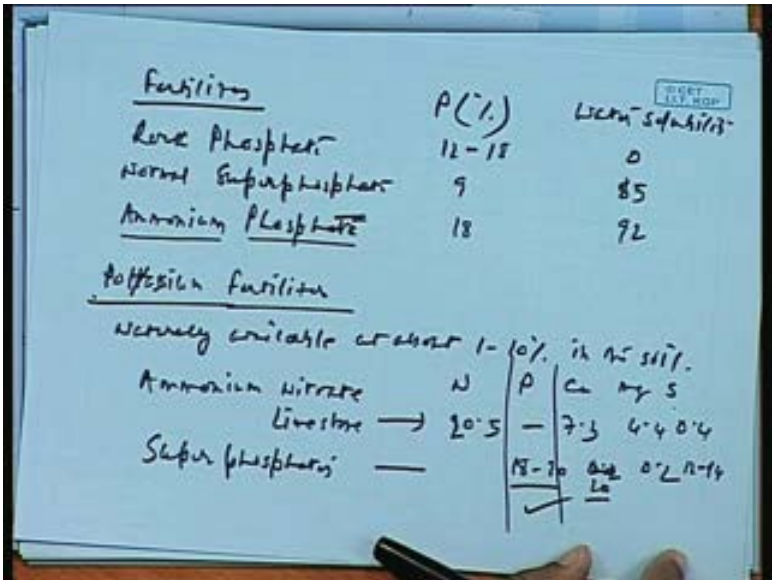

So, generally the typical type of, the typical type of these phosphates that we use the fertilizers, the mostly say this is phosphorus percentage, phosphorus percentage, rock phosphate, rock phosphate will be having 12 to 18% normal, superphosphate would be about in 9% and this ammonium phosphate, ammonium phosphate, ammonium phosphate, ammonium phosphate would be about 18%. So, you see, so there are many more, there are many more I should not have to discuss all these. See, here one very important thing is you have heard of this you know if you just follow any kind of you know any kind of if you just next time you see the pack of fertilizer you know pack of fertilizer you see when it is written superphosphate, normal superphosphate. So, the percentage of phosphorus you know, so this is percentage of phosphorus you know say here it again rock phosphate 12 bar 18%, ammonium phosphate whenever is available apart with you know with other considerations, other considerations you know these are mostly this is the, these are also used, these are also required, this is and they would also require you know mostly a solubility, water soluble you see water solubility, water solubility the mostly the rock phosphates are not soluble in water except 85% water solubility, 85% they generally also you say is a ammonium phosphate would be about 92%. So, whatever this you know mostly this substances you can see this, this would be dissolved, dissolved quantity that would be available of the total mass would be about 92% dissolved. This one is the rock

phosphate, so you know the rock phosphate require a certain kind of you know in not in all cases if they are only when they are weathered they would be useful for the plant because till that time it would not be soluble okay.

So, this, this, this is what is this phosphorus. Another is the potassium, potassium just one few lines on this potassium, potassium fertilizer, potassium, potassium fertilizer, potassium fertilizer, potassium fertilizer. Say third this is deficient is potassium is also you know apart from this nitrogen, phosphorus and you know apart from that potassium is also critically important element for the plant growth, critically important element for plant growth. So, you know you can see this some of this say fertilizers, the standard fertilizers that we use this standard. They are this you can just write this, they are naturally available naturally, naturally available, naturally available at about 1 to 10% in the soil, they are the standard otherwise the fertilizers that are used the fertilizers that are used this is ammonium, ammonium nitrate, ammonium nitrate limestone, ammonium nitrate limestone where the nitrogen would be that you know where we are combiningly using this calcium, magnesium and sulphur is 7.3, 4.4 and 0.4 whereas this another very important the superphosphates, the superphosphates on the other hand would be having say phosphorus would be here, this is the superphosphates should be 18 to 20, 0.2, zero point, this is zero point, this is 20, 20, 0.2 and 12.4, 12 to 14. So, this is how this would be available. So, you know you can see this, all this phosphorus is being supplied by the superphosphates that you can observe here and all right and so here you know this is how this other substances are available say some magnesium, calcium and things like that. So, all this you know just to suggest, so any kind of fertilizers that we use, any kind of fertilizers that we use depends you know we would like to observe the amount of nitrogen, phosphorus and potassium that would be available for the plants, that would be available for the plants.

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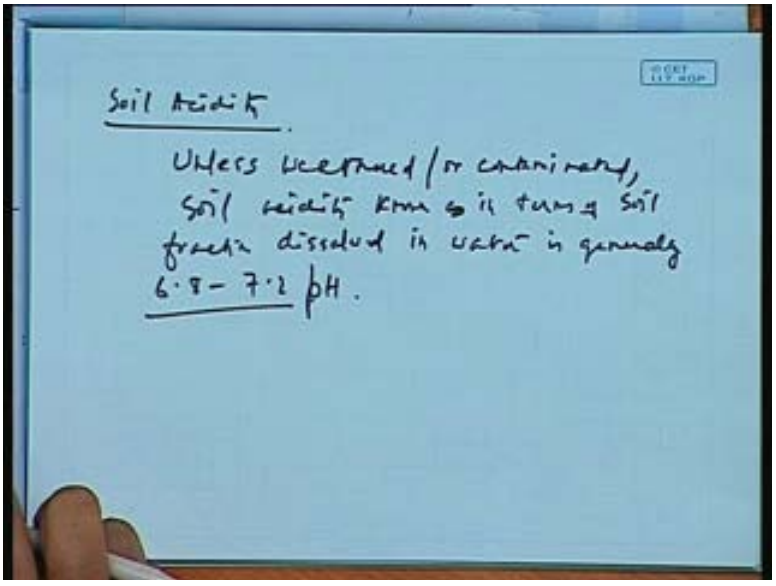

So, this is apart from that there is one thing is that we just you know soil acidity, just acidity you just unless weathered you know you can also write that unless weathered or contaminated soil acidity known as soil acidity, known as, known as, known in, known in terms of, known in terms

of soil fraction dissolved in water, unless weathered or contaminated soil acidity, unless weathered or contaminated soil acidity known in terms of soil fraction dissolved in water is generally between 6.8 to 7.2 pH. So, most of the soil, most of the soil and the soil has a natural tendency you know if the soil is generally left as it is, this is the soil has natural tendency to do which towards the neutral pH.

The soil would also have a, this is 6.8 would remain say slightly alkaline or slightly acidic they might remain in the most of the cases. This is the zone they vary because of you know because of different decomposable substances in the soil. Say, particularly if in the summer time you know say in the winter the soil pH would be towards mostly towards, in mostly towards alkaline but in the summer time when the oxidation increases in the soil, the soil acidity would increase and there will be buffers also to control that but you know you will observe that you know soil acidity is increasing and it might reach to about say you know 6.8 or so slightly, slightly acidic. So, this is what how the soil acidity actually differs but this soil acidity has a great role has an important role for plant growth. So, we will discuss about that in the next class.

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The parameters of soil which are important for vegetative growth particularly two things are important for us, one is that you know germination of the seed the first of all most important thing is that the seed is able to germinate in the soil. That means it will have sufficient amount of air in the soil, water, temperature and other you know nutrients that would make it to germinate, the seed would germinate first. Once the seed germinates the next term thing is the growth of the plant and stabilization of the plant in the soil medium, in the soil medium.

So, we were discussing about what are the parameters that actually influence, this actually influence this, the total soil growth, total plant growth in the soil. Now we have discussed a number of parameters we have you know you in the course of last two classes. Another very important parameter which is a, is basically a part of which we have already discussed you know because you know soil acidity would be a combined effect soil acidity or soil alkalinity is a combined effect of the vegetative say total organic matter in soil, total salt present in the soil, the different the characteristic of the soil, soil structure all this combined together to form soil acidity or soil alkalinity but there is a, the combined effect is very important for us because you know this would deal with you know we would, this would be an important parameter for the seed germination and plant growth.

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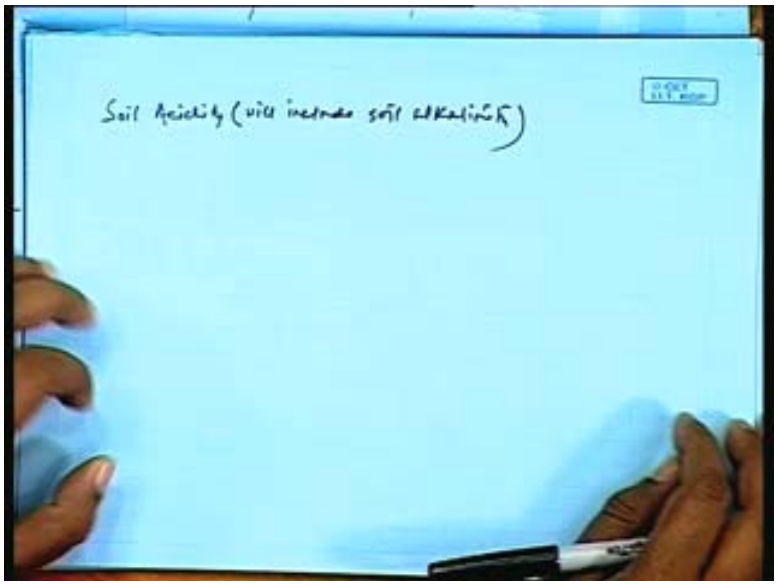

So, here having to say that you know this what we generally observe is we generally start with soil, soil say acidity just to say this, this is you know also would mean include, will include soil alkalinity, soil alkalinity. The soil should not be unnecessarily enriched with phosphorus, so we know we should not try to keep the, we should not try to make the value of phosphorus high in the soil.

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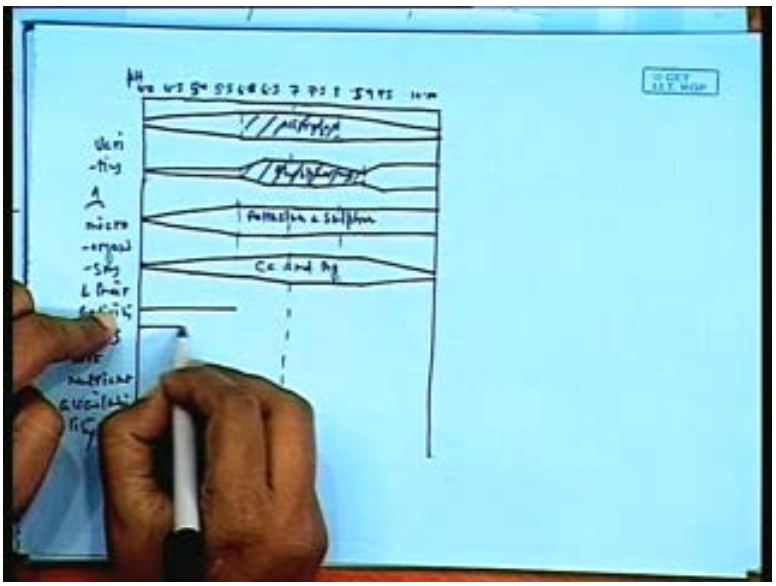

So, you know this is the ideal value you know at which you should work on, which we work on if we just want to keep say there are becomes substances like this. So, here again you know if this is the value for the phosphorus, phosphorus generally is you know is remain almost

unaffected, almost unaffected till about, till about 6. This is potassium and sulphur, this is phosphorus, potassium and sulphur, potassium and sulphur, potassium and sulphur, this one is as I have said phosphorus.

So, here again as you can see we would be very safe if we can keep the pH between say 6 to 8, if we are pretty safe if we are keeping pH at 6 to 8. on the other hand just try to see this, say this about potassium and sulphur, on the other hand this calcium in see if you just observe calcium, calcium at, calcium shows a characteristics like this, calcium and magnesium. So, you can see this calcium and magnesium being here then we have iron which is like this.